

COUNSELLING ON ERGONOMIC ASPECTS OF HANDLING METROLOGY STANDARDS AND OCCUPATIONAL SAFETY TOOLS

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Abstract. A comprehensive study of a community service program focusing on ergonomics and occupational safety at the Regional Technical Service Unit (UPTD) for Legal Metrology in Jepara Regency has been done. The primary focus of this study is to mitigate the risk of musculoskeletal disorders (MSDs) often experienced by metrology officers due to Manual Material Handling (MMH) activities when handling heavy standard test weights (*bidur*). The background of the program is rooted in the high intensity of physical labor across various consumer environments, such as traditional markets, gas stations, and factories, which frequently overlook basic ergonomic principles. The objective of this program is to educate the implementation team on correct lifting techniques (*squat lift*), raise awareness of the importance of Personal Protective Equipment (PPE), and evaluate the effectiveness of educational interventions on officer knowledge. The implementation method includes preparation stages, field observation, pre-tests, theoretical material delivery, practical demonstrations, and final evaluation through post-tests and satisfaction questionnaires managed digitally via the Google Forms platform. The results indicate a significant increase in participant understanding by 55.31%, with average knowledge scores rising from 84.67 to 95.4. The discussion explores the relationship between awkward working postures and the potential for occupational accidents, as well as the challenges in building a safety culture within the public sector. The report concludes with the importance of continuous training and the provision of mechanical aids as a long-term solution to maintain the occupational health of metrology officers.

Keywords: ergonomics, legal metrology, manual material handling, occupational safety

Abstrak. Program pengabdian masyarakat dalam bentuk penyuluhan aspek ergonomi dan keselamatan kerja di Unit Pelaksana Teknis Daerah (UPTD) Metrologi Legal Kabupaten Jepara telah dilakukan. Fokus utama penelitian ini adalah mitigasi risiko cedera muskuloskeletal (MSDs) yang sering dialami oleh petugas penera akibat aktivitas *Manual Material Handling* (MMH) saat menangani anak timbangan standar (*bidur*) berbobot besar. Latar belakang kegiatan didasarkan pada tingginya intensitas pekerjaan fisik di berbagai lingkungan konsumen, seperti pasar tradisional, SPBU, dan pabrik, yang seringkali mengabaikan prinsip-prinsip ergonomi dasar. Tujuan dari program ini adalah untuk mengedukasi tim pelaksana mengenai teknik pengangkatan beban yang benar (*squat lift*), meningkatkan kesadaran akan pentingnya penggunaan Alat Pelindung Diri (APD), serta mengevaluasi efektivitas intervensi edukatif terhadap pengetahuan petugas. Metode pelaksanaan mencakup tahapan persiapan, observasi lapangan, pre-test, penyampaian materi teoritis, demonstrasi praktik, hingga evaluasi akhir melalui post-test dan angket kepuasan yang dikelola secara digital menggunakan platform Google Forms. Hasil kegiatan menunjukkan adanya peningkatan pemahaman peserta secara signifikan sebesar 55,31%, dengan rata-rata nilai pengetahuan yang naik dari 84,67 menjadi 95,4. Pembahasan dalam laporan ini mengeksplorasi hubungan antara postur kerja yang janggal dengan potensi kecelakaan kerja, serta tantangan dalam membangun budaya keselamatan di sektor publik. Simpulan laporan menegaskan pentingnya pelatihan berkelanjutan dan penyediaan alat bantu mekanis sebagai solusi jangka panjang untuk menjaga kesehatan kerja petugas metrologi.

Kata Kunci: ergonomi, keselamatan kerja, manual material handling, metrologi legal

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INTRODUCTION

Legal metrology is a crucial instrument in the national economic structure that ensures trade fairness, consumer protection, and legal certainty in every transaction involving measurements. In Indonesia, the implementation of legal metrology is managed by the Regional Technical Implementation Unit under the auspices of the Department of Industry and Trade, one of which is the Legal Metrology Jepara Regency. The main tasks of this agency include the

implementation of calibration and recalibration of Measuring, Dosing, Weighing, and Equipment as well as the supervision of Packaged Goods. However, behind its vital regulatory function, there is an operational dimension that carries high physical risks for implementing officers or verifiers.

Working in legal metrology is not merely an administrative activity, but also involves intense physical activity, especially in the manual handling of metrology standard equipment (Meškuotienė et al., 2022). Every day, officers must move, lift, and position standard weights or bidur that have varying weights, often reaching 20 kg or more per unit. This Manual Material Handling (MMH) activity is carried out repeatedly for long durations, especially during "Tera Sessions" in traditional markets that demand speed of service. Without an adequate understanding of ergonomic principles, this activity becomes a major source of occupational health disorders, especially muscle and skeletal disorders known as Musculoskeletal Disorders (MSDs) (Hilmi & Hamid, 2023).

Based on secondary data analysis from 2024, workplace ergonomics were shown to significantly contribute to the high incidence of low back pain in Indonesia (Harahap et al., 2025; Kadir et al., 2026). Using the DALYs approach, it was shown that Java recorded the highest disease burden, while eastern Indonesia demonstrated the highest levels of physical risk vulnerability (Alfaqeeh et al., 2025). This study emphasized that without disciplined workplace monitoring and strong enforcement of ergonomic regulations, the health burden due to musculoskeletal disorders in workers aged 15–49 will continue to increase (Harahap et al., 2025).

Ergonomic issues in legal metrology are often overlooked because institutions focus more on the accuracy of measuring instruments than on the health of their users (Singh et al., 2024). Yet, workers who routinely lift heavy loads manually without proper technique are at greater risk of back injury than workers who do not engage in repetitive lifting (Iwakiri et al., 2025). At the Legal Metrology Technical Implementation Unit in Jepara Regency, officers face the additional challenge of an uncontrolled and diverse consumer work environment, ranging from slippery market floors to fire-prone gas stations to high-noise factories. These conditions create a dual risk: chronic ergonomic risks resulting from incorrect working postures and acute workplace accident risks associated with hazardous environments (Bazaluk et al., 2023).

Given the complexity of the issues, an outreach program on ergonomics and handling of standard metrology tools is urgently needed. This program is a concrete manifestation of the implementation of the Tri Dharma of Higher Education, particularly in the aspect of community service based on industrial engineering. The program's relevance lies in mitigating long-term health risks for civil servants and supporting staff in the metrology environment (Benson et al., 2023). By equipping them with knowledge of *squat lift techniques*, proper glove selection, and an understanding of the risk control hierarchy, it is hoped that absenteeism due to illness and the risk of work accidents can be significantly reduced (Sedgwick & Gormley, 2009).

Furthermore, this program supports the vision of the Jepara Regency Legal Metrology Technical Implementation Unit to become a professional and trusted service institution. Professional service is measured not only by the accuracy of calibration results, but also by safe and efficient work processes (Haque, 2024). Physically fit personnel who understand ergonomic principles will have more stable productivity and be able to provide more optimal services for the public. Through a participatory approach based on quantitative data, this program aims to transform the work behaviour of officers from being reactive to injuries to being proactive in preventing them.

METHOD

The implementation method for this community service program is based on a systematic approach to ensure optimal educational goals are achieved. The activity structure is divided into four main stages: preparation, observation and identification, intervention implementation, and evaluation and reporting. The preparation phase involved intensive coordination with the Head of the Jepara Regency Legal Metrology Technical Implementation Unit and relevant staff to determine the schedule and target participants. During this phase, extension materials relevant to field conditions were developed, including the development of presentation modules and the

creation of visual media such as posters and banners. The materials were designed to be not overly theoretical but rather applicable to the daily tasks of metrology officers.

The observation and identification phase was conducted to directly observe how officers handled standard equipment. The observations focused on the weight of the load lifted, the frequency of lifting, and body posture during the activity. Data from these observations was then used to tailor case studies for the outreach sessions. The implementation phase was conducted on December 9, 2025, at the Jepara Regency Legal Metrology Technical Implementation Unit (UPTD) Office. This session began with the completion of an attendance list and a pre-test to measure the participants' initial knowledge level. Next, a presentation was given covering back anatomy, basic ergonomic principles, hazard identification in various consumer locations, and safe manual lifting techniques. This session was interactive, where participants were invited to discuss their experiences in the field. After the theory session, a practical demonstration of the squat lift technique was conducted using a standard 20 kg weight as a prop.

Evaluation is a critical component in measuring the impact of the program on participants. Success is measured through three main indicators. First, a comparison of pre-test and post-test scores. The test questions are designed to assess understanding of basic ergonomic concepts, safe load limits according to regulations, and field safety and health procedures. Scores are processed to obtain a class average and a percentage increase or *Gain Score*. This analysis provides a quantitative overview of the effectiveness of knowledge transfer. Second, an evaluation of participant satisfaction with the implementation of the program is carried out. This evaluation uses a questionnaire with a Likert scale of 1-4 that assesses five parameters: clarity of the program, completeness of the material, relevance of the material to the job, effectiveness of the method (theory & practice), and participant commitment to applying the knowledge. This scale helps identify which aspects of the training are most appreciated and which areas need improvement.

RESULT AND DISCUSSION

The rate of musculoskeletal disorders in Indonesia, which reached 24.7% of the working population, confirms that occupational health risks, particularly Low Back Pain (LBP), are a real threat that requires serious attention. Globally, the WHO (2021) recorded that musculoskeletal disorders or GOTRAK affect around 1.71 billion people, making it the second largest contributor to disability worldwide after low back pain. In Indonesia, this urgency is reinforced by BPJS Ketenagakerjaan data, which recorded 666,899 cases of work-related accidents and diseases during the 2019-2021 period (Pristiwanti et al., 2024). This condition is not only triggered by an ideal sitting posture but is also significantly influenced by extreme work durations exceeding 8 hours a day (Putri et al, 2025). This phenomenon is also clearly evident in catering industry workers in Banguntapan Village, where 60% of employees complain of muscle aches due to the lack of clear work hour limits, often leading them to work more than 40 hours per week (Agustin et al., 2020). This risk even extends to the administrative sector; literature studies indicate that 70% to 91.7% of office workers experience similar complaints, influenced by non-ergonomic work facilities and psychosocial factors in the workplace.

In the context of heavier activities, physical load factors become a more crucial determinant. Findings (Sambeko et al., 2024) using the Oswestry questionnaire indicate that in young workers (average age 26), the weight of the load is more significant in triggering LBP than the frequency of the activity itself. This phenomenon is clearly observed in lift-and-transport workers at CV Amanah, where manual handling activities such as lifting, pushing, and pulling loads significantly influence the onset of musculoskeletal disorders (Khairani & Utami, 2021). Similarly, in the steel fabrication industry, 62.5% of plate-cutting workers using CNC machines and 60% of marking workers reported GOTRAK complaints with a moderate level of risk. The main complaints in this group are concentrated in the knees and calves due to prolonged standing or squatting (Pristiwanti et al., 2024). The significance of the dangers of manual handling activities is clearly illustrated in the ergonomic analysis of loading and unloading activities at PT XYZ. Through the evaluation of the NIOSH Multi-Task method, Composite Lifting Index (CLI)

values were found to exceed safe limits ($CLI > 3$), mainly due to repetitive bending and twisting movements of the body (Muslimah et al., 2025).



Figure 1. Flyer on how to properly remove hives and complete personal protective equipment

Using the SNI 9011:2021 standard as a guideline for evaluating potential national ergonomic hazards, it was found that many technical jobs fall into the hazardous category. For example, marking and cutting steel plates often receive a high risk score (10-11) due to postures that deviate from the body's anatomical position. However, interventions such as redesigning workstations tailored to Indonesian anthropometry have been shown to drastically reduce the risk score to a safe level (1-2) (SNI 2021). The Nordic Body Map data in the study categorizes physical complaints as moderate, which, if left untreated without intervention such as the use of assistive devices or layout redesign, can lead to permanent injury. Similar issues were also found in the GAPOKTAN farming community in Jaten Village, where decreased productivity due to lower back pain during harvest is a major obstacle, necessitating training in work posture techniques and physical exercises such as the William Flexion Exercise (Pristianto et al., 2023).



Figure 1 Documentation of material delivery activities

Based on the urgency of injury prevention, outreach activities were conducted at the Legal Metrology Technical Implementation Unit (UPTD) in Jepara Regency, involving 15 operational and administrative personnel. In addition to facility improvements, internal OHS communication

also plays a crucial role; research shows that effective communication contributes 15.22% to compliance with the use of personal protective equipment (PPE), although compliance rates are often lower than effective communication (Fajar & Giatman, 2022). Participants were predominantly male (73%), who routinely engage in physically demanding field activities, consistent with the risk profile outlined in previous studies. The results of pre- and post-test knowledge measurements showed a very positive educational dynamic. The average pre-test score of 84.67 indicates that metrology personnel in Jepara already possess a fairly good foundational understanding of occupational safety, likely derived from their years of empirical experience in the field (Sherratt & Raiden, 2023).



Figure 2 Documentation of preparation for hives removal practice

However, the intervention of material presentation combined with practical demonstrations proved to provide significant added value. The average post-test score increased to 95.4, representing a 55.31% increase from a knowledge gain normalization perspective. The success of several participants in achieving a perfect score (100) proves that the visual demonstration method is very effective in deepening the technical understanding of ergonomic concepts that were previously considered abstract. With this increased understanding, it is hoped that officers can apply correct posture techniques as an independent preventive measure to avoid the risk of chronic LBP, as occurs in the national working population.

Manual handling activities at the Jepara Legal Metrology Technical Implementation Unit (UPTD) often involve repetitive motions. Studies have shown that repetitive movements with heavy loads without sufficient recovery time are a major cause of muscle fatigue, leading to acute injuries (Aulianingrum & Hendra, 2022). During the practical demonstration, the use of the squat lift technique, where the load is lifted by bending the knees while keeping the back straight, was emphasized (Papadakis et al., 2024). This technique shifts the workload from the relatively small back muscles to the much stronger and larger thigh and leg muscles (Stone et al., 2024). By keeping the load as close to the center of the body as possible, the resulting torque is reduced, thus minimizing the risk of a slipped disc or herniated disc in the spine (McGill, 2025).

Table 1 Results of calculating pre-test and post-test scores

Participant	Pretest	Post Test	GAIN
Average	84.67	95.4	0.5531
AVERAGE INCREASE			55.31%

Participant satisfaction evaluations offer valuable insights into the quality of program implementation. On a scale of 4.0, the program received a total score of 3.36, which is categorized as "Very Good." Interestingly, the parameters "Materials meet worker needs" and "Effective methods, combining theory and practice" received the highest scores, at 3.53. This demonstrates

a strong link and match between the materials prepared by the community service team and the actual needs of officers in the field.

Table 2 *Evaluation parameters and ratings*

No.	Parameter	Rating
1	Clarity of extension activities	3.27
2	Completeness of the materials provided	3.40
3	Materials according to workers' needs	3.53
4	Effective method, a combination of theory and practice	3.53
5	Participants are committed to applying the knowledge they have gained.	3.07
Total Score		3.36

However, one parameter scored the lowest, though still in the good category: "Participants are committed to applying the knowledge gained," with a score of 3.07. This finding reflects a common phenomenon in occupational safety psychology: knowing the correct method does not automatically translate into consistent implementation (Granger & Turner, 2022). Field challenges, such as time constraints in busy traditional markets, often force officers to revert to old habits (bending) for the sake of speed. This suggests that managerial interventions, such as the provision of mechanical aid and regular supervision by superiors, must accompany educational interventions.

CONCLUSION

Based on a series of ergonomics and occupational safety outreach activities carried out at the Legal Metrology Technical Implementation Unit (UPTD) of Jepara Regency, it can be concluded that the outreach program succeeded in significantly increasing the level of participant understanding by 55.31%. The use of a combination of theoretical delivery through digital media (PPT) and direct practical demonstrations using real props (20 kg of bile) proved very effective. This is reflected in the participant satisfaction score, which reached 3.53 on the implementation method parameter, indicating that the practical approach is preferred by field officers. This outreach activity has succeeded in achieving the set target. There has been a transformation in officers' understanding from what was initially intuitive to an understanding based on scientific ergonomic principles. This activity has laid an important foundation for the development of a safety culture within the Legal Metrology Technical Implementation Unit (UPTD) of Jepara Regency. This community service has made the institution aware that officer occupational health is a vital asset that supports the quality of public services and overall metrological accuracy.

To ensure the positive results of this program do not stop at the counseling session alone, it is recommended to conduct a K3 refresher session at least once a year to remind officers of the importance of correct working posture and provide information on the latest developments in occupational safety regulations, for Sultan Agung Islamic University (Unissula) through the community service program it is hoped to build a long-term partnership with the Legal Metrology UPTD to conduct applied research in the field of industrial ergonomics. This could include redesigning workstations or developing more ergonomic lifting aids based on the anthropometric data of local officers.

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