

The Effect of Implementing Tri Hita Karana-Oriented Ergosafety on the Health Quality and Productivity of *Piranti Upakara* Makers

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Abstract

Background: Ergosafety is an approach to ergonomic management that prioritizes the health, safety, and comfort of workers. Ergosafety aims to create an optimal work environment, thereby reducing the risk of injury, fatigue, and work stress, as well as increasing overall productivity and job satisfaction. The purpose of this research is to verify if the implementation of Tri Hita Karana-oriented ergosafety can be a holistic and sustainable solution to improve the quality of health and productivity of *piranti upakara* makers.

Method: The research was conducted for six months, from July to October 2025, and adopted a quasi-experimental design with a one-group pretest-posttest design. The research subjects and the target population were *piranti upakara* makers in Buruan Village, Penebel District, Tabanan Regency. The accessible population was 50 workers who met the inclusion criteria. The number of research samples was 25 people, who were selected by purposive sampling.

Results: The results showed that Tri Hita Karana-oriented ergosafety had a positive impact on the quality of health and work performance. This improvement was indicated by a 15.25% ($p \leq 0.01$) decrease in the score of musculoskeletal complaints, a 28.3% ($p \leq 0.01$) decrease in the score of work fatigue, and a 34.43% ($p \leq 0.01$) increase in work productivity.

Conclusion: The implementation of Tri Hita Karana-oriented ergosafety can improve the quality of health and productivity of *piranti upakara* makers.

Keywords: Ergosafety, Musculoskeletal complaints, Tri Hita Karana, Work fatigue, Work productivity

INTRODUCTION

Jobs that require continuous physical activity can potentially reduce workers' physical capacity, ultimately leading to decreased productivity and an increased risk of occupational diseases. Nationally, this problem is reflected in data on workplace accidents and occupational disease reported through the BPJS Employment Work Accident Insurance program. In 2021, 234,370 cases of workplace accidents were recorded, with 6,552 fatalities—a 5.7% increase compared with the situation in 2020.¹ This increasing trend indicates that the implementation of occupational safety and health remains a challenge and needs to be strengthened across various employment sectors in Indonesia, including the informal sector, which often receives insufficient attention.

One growing informal sector in Bali is the manufacture of *piranti upakara*. In Bali, a region rich in culture and religious traditions, ritual practice is widespread, resulting in a relatively large and ongoing demand for *piranti upakara*. In response to this demand, workers who specialize in producing these ceremonial objects have increased. Based on tradition, the process of making *piranti upakara* is generally done manually, requires high precision, and involves repetitive movements over long periods. Repetitive work activities, particularly those involving the fingers and wrists, have the potential to cause musculoskeletal disorders such as tendinitis and carpal tunnel syndrome.²

These work-related health problems not only reduce the quality of workers' health but also impact productivity. Therefore, implementing occupational safety and health programs is crucial, even

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in the informal sector, to help keep workers safe, healthy, and productive.³ The implementation of occupational safety and health has been shown to reduce the potential for workplace accidents⁴ and the risk of occupational diseases through an ergonomic approach.⁵ An ergonomically designed work environment also contributes to reducing the risk of injury and fatigue.⁶ The application of ergonomics and occupational safety and health concepts in the workplace has been proven to improve health levels, work productivity, and occupational safety.⁷ Every workplace must provide a safe environment for its workers.⁸ This is clarified by Law Number 17 of 2023 concerning health, which states that every employer is obliged to guarantee the health of workers, and every worker is obliged to comply with occupational safety and health regulations.⁹ By prioritizing ergonomics and occupational safety health and in the workplace, companies not only protect workers but also improve performance.

Bali is a region with unique characteristics marked by strong local wisdom in the form of culture, traditions, and customs that are still preserved to this day. These values not only form Bali's social identity but also serve as guidelines for community behavior in daily life. This reflects the consistency of the Balinese people in applying cultural practices to various aspects of life, including social, spiritual, and professional spheres.¹⁰ Several studies also show that the application of local wisdom values has a positive influence on employee performance¹¹ because these values can shape work ethic, responsibility, and harmony in work relationships.

In this study, the author uses the local wisdom of Tri Hita Karana as a conceptual foundation. Tri Hita Karana is a Balinese philosophy of life that emphasizes balance and harmony between three main aspects: the relationship between humans and God (*Parhyangan*), humans and nature (*Palemahan*), and humans and other humans (*Pawongan*). This concept has developed and is universally recognized, making it relevant for application in various work and organizational contexts.¹² By recognizing and integrating local wisdom into work processes, companies can build an inclusive, sustainable, and productive work environment. This approach ultimately contributes to building a strong work community while supporting the company's long-term growth and aspirations.

Research on the application of ergonomics and occupational safety and health to increase work productivity has grown rapidly in the field of ergonomics and occupational health. Empirical evidence consistently shows that systematic improvements in work systems result in substantial productivity gains. Priambudi reported that implementing a total ergonomics approach increased productivity by 97.4%.¹³ Other studies have also shown that improving ergonomic work methods directly increases productivity,¹⁴ while the implementation of effective occupational safety and health programs is positively associated with productivity outcomes¹⁵ and the prevention of occupational diseases.¹⁶ Among the most common occupational health problems in industrial settings are fatigue and musculoskeletal disorders,¹⁷ which not only impair workers' well-being but also reduce work efficiency. Ergonomic workplace redesign has been shown to significantly reduce fatigue and musculoskeletal complaints,¹⁸ and aligning workplace design with appropriate work methods simultaneously contributes to higher productivity and lower health risks.¹⁹

Despite the strong technical and physiological evidence base of ergonomics and occupational safety and health, most studies conceptualize them primarily through biomechanical, organizational, and risk control perspectives. The cultural, social, and spiritual dimensions of the workplace, and the factors that may influence safety behaviors, motivation, compliance, and well-being remain underexplored. Although ergonomics and occupational safety and health interventions are well developed technically, they are rarely contextualized within the local cultural frameworks that shape workers' daily values and practices. In particular, the integration of local wisdom into ergonomics and safety management systems has received limited empirical attention, leaving unanswered questions about how culturally rooted approaches can strengthen health and productivity outcomes.

One relevant yet underutilized framework is Tri Hita Karana. Yuliandari argues that Tri Hita Karana has developed and gained widespread recognition, applied in various areas of life, including the workplace.¹⁴ Devi highlights that local wisdom values positively influence employee performance.¹¹ However, existing literature tends to discuss Tri Hita Karana conceptually or normatively without systematically operationalizing it in measurable ergonomics and safety interventions. Consequently, an integrative model that translates Tri Hita Karana principles into concrete workplace design, task organization, and safety management strategies is lacking.

This study addresses this gap by developing an integrative ergonomics and safety model based on Tri Hita Karana. The novelty of this research is that it positions local wisdom not merely as a

cultural background but as an operational framework that guides ergonomics and safety interventions. In the *Palemahan* dimension, integration is realized through ergonomic work environment design and systematic minimization of occupational hazards. In the *Pawongan* dimension, work tasks are adapted to individual characteristics through the application of ergonomic postures, limiting lifting and carrying loads based on physical capacity, regulating task repetition, and appropriate work duration to prevent fatigue and musculoskeletal strain. In the *Parhyangan* dimension, the promotion of spiritual and cultural values, such as praying before work and providing adequate prayer space, supports holistic well-being and psychological balance.

By embedding technical ergonomics and occupational safety and health measures within a culturally grounded framework, this research develops a context-sensitive model that bridges the biomechanical, organizational, and socio-spiritual dimensions of work. This integration not only enhances the theoretical contribution of ergonomics research by incorporating cultural variables but also offers practical guidance for organizations seeking to improve worker health, safety, and productivity in culturally diverse environments.

METHOD

Participants and Study Design

The type of research is a quasi-experimental design with a one-group pretest-posttest design. The research was conducted in July–October 2025, and the research subjects and the target population were workers who made *piranti upakara* in Buruan Village, Penebel District, Tabanan Regency. The accessible population was 50 workers who met the following inclusion criteria: (a) willing to be a research sample until the end of the research period as evidenced by signing a letter of agreement; (b) working as a *piranti upakara* maker; (c) having worked for more than 1 year; and (d) aged 19–59 years. Twenty-five people were selected as research samples by purposive sampling. In a quasi-experimental research design with a one-group pretest-posttest approach, 50% of the accessible population was included, where each respondent acts as their own control, thus requiring a relatively smaller sample size while still maintaining adequate statistical power.²⁰

Measurements and Procedure

The independent variable in this study is Tri Hita Karana-oriented ergosafety in the following forms: (a) *Palemahan* in an ergonomic work environment design that minimizes hazards; (b) *Pawongan* to adjust work tasks to individual characteristics through the implementation of ergonomic postures, limiting lifting and carrying based on gender, and regulating the repetition and duration of work; and (c) *Parhyangan* to promote cultural and spiritual values for holistic well-being, such as praying before work and designating a prayer space in the work area.

The dependent variables in this study are health quality and work productivity. Health quality was recorded through musculoskeletal complaints recorded using the Nordic Body Map questionnaire. Work fatigue was recorded using the 30-item rating scale questionnaire, and work productivity was recorded based on the number of completed *piranti upakara* (*Output/O*) compared to the energy expended during work as measured by the work pulse rate using the 10-beat method (*Input/I*) unity of time.²¹ Work productivity is calculated using the following formula:

$$\text{Work Productivity} = \frac{\text{Completed Piranti Upakara (Output)}}{\text{Pulse Rate (Input)}} \text{ Per 1 Hour (Time)}$$

Fatigue data in this study were measured using a 30-item of rating scale questionnaire, which consists of 30 items on a Likert scale, covering aspects of decreased activity, motivation, and physical condition.²² Musculoskeletal complaints in this study were measured using the Nordic Body Map questionnaire, which can map the location and intensity of musculoskeletal complaints in various parts of the body and is often used in ergonomic and occupational health studies.²³ Work productivity is recorded based on the number of completed *piranti upakara* (output) compared to the energy expended during work (input) as measured by the work pulse rate using the 10-beat method in one hour (time).²¹

Statistical Analysis

The data underwent editing, coding, entry, and cleaning. Statistical software was used to perform univariate and bivariate data analysis. The univariate analysis aimed to describe the characteristics of the respondents and the distribution of variables (work posture, musculoskeletal complaints, fatigue, and productivity). Bivariate analysis sought to determine the influence between the independent variable and the dependent variable using statistic test paired t-test.

RESULT

Characteristics of Respondents

In this study, a total of 25 respondents participated. A descriptive analysis was conducted to determine the respondents' average age and work experience. The results for average age and length of service are presented in Table 1.

Table 1. Characteristics of Respondents Who Make *Piranti Upakara*

No	Variable	Mean	Standar Deviation (SD)
1	Age (years)	52.5	7.6
2	Work experience (years)	12.5	6.3

Table 1 shows that the respondents had a average age of 52.5 ± 7.6 years and a work experience of 12.5 ± 6.3 years. All respondents were female.

Work fatigue

The data were analyzed in stages, including normality tests, homogeneity tests, and assumption tests. The results of the Shapiro–Wilk normality test showed a normal distribution ($p \geq 0.05$) for both pre- and post-test conditions. The homogeneity test (Levene's test) showed homogeneous data ($p \geq 0.05$). Then, a parametric paired t-test was performed. The results are presented in Table 2.

Table 2. Fatigue of Respondents Who Make *Piranti Upakara*

Variable	n	Mean $\pm$ SD	Average Difference	t-value	p-value
Fatigue before implementing ergosafety	25	83.28 $\pm$ 8.45			
Fatigue after implementing ergosafety	25	57.52 $\pm$ 8.33	25.76	18.147	0.01

Fatigue scores before implementing ergosafety and after implementing ergosafety were analyzed using paired t-test. The results were significantly different ($p < 0.05$) with a t value of 18.147 and $p = 0.01$. This result means that Tri Hita Karana-oriented ergosafety can improve health quality from the aspect of reducing worker fatigue scores.

Musculoskeletal Complaints

The data were analyzed in stages, including normality tests, homogeneity tests, and assumption tests. The results of the Shapiro–Wilk normality test showed a non-normal distribution ($p \leq 0.05$) for the pre-condition, while the data distribution was normal ($p \geq 0.05$) for the post-condition. The homogeneity test (Levene's test) showed homogeneous data ($p \geq 0.05$). Then, a non-parametric Wilcoxon test was performed. The results are presented in Table 3. Musculoskeletal complaint scores before and after implementing ergo safety were analyzed using the Wilcoxon test. The results were significantly different ($p < 0.05$) with a z value of -4.378 and $p = 0.01$. This finding means that Tri Hita Karana-oriented ergo safety can improve health quality in terms of reducing workers' musculoskeletal complaint scores.

Table 3. Musculoskeletal Complaints of Respondents Who Make *Piranti Upakara*

Variable	n	Mean $\pm$ SD	Average Difference	z-value	p-value
MSDs before implementing ergosafety	25	78.36 $\pm$ 7.21			
MSDs after implementing ergosafety	25	66.40 $\pm$ 7.22	25.76	-4.378	0.01

Work Productivity

Similar to the process for work fatigue and musculoskeletal complaints, the data were analyzed in stages, including normality tests, homogeneity tests, and assumption tests. The results of the Shapiro–Wilk normality test showed a non-normal distribution ($p \geq 0.05$) for both pre- and post-test conditions. The homogeneity test (Levene’s test) showed homogeneous data ($p \geq 0.05$). A non-parametric Wilcoxon test was then performed. The results are presented in Table 4.

Table 4. Work Productivity of Respondents Who Make *Piranti Upakara*

Variable	n	Mean $\pm$ SD	Average Difference	z-value	p-value
Productivity before implementing ergosafety	25	6.33 $\pm$ 0.29			
Productivity after implementing ergosafety	25	8.51 $\pm$ 0.28	2.18	-3.372	0.01

The work productivity score before and after implementing ergosafety were analyzed using the Wilcoxon test. The results were significantly different ($p < 0.05$) with a z value of -3.372 and $p = 0.01$. This result means that Tri Hita Karana-oriented ergosafety can increase the work productivity of *piranti upakara* makers.

DISCUSSION

Characteristics of Respondents

The research respondents were *piranti upakara* makers or *serati*, who were all female,²⁶ with an average age range of 44–59 years and an average working period of 6–18 years. Making *piranti upakara* requires an understanding of the ethics of ceremonies, traditions, and inherited techniques.²⁴ The role of *serati* is often filled by people who have long been involved in community practices, so their average age tends to be older. Empowerment research and group studies found that the *serati banten* tradition is characterized by a slow regeneration process and dependence on experienced workers, which means that *serati* tend to be mostly middle aged or older.²⁵ In terms of gender, the division of ceremonial roles in many Hindu communities in the archipelago places women in charge of household rituals and the preparation of *upakara*, with activities such as flower arranging, providing offerings, and maintaining traditional ceremonial procedures often being considered women’s duties and roles.

Work Fatigue

Work fatigue was measured using a 30-item of rating scale questionnaire, which consists of 30 items on a Likert scale, covering aspects of decreased activity, motivation, and physical condition.²² Tri Hita Karana-oriented ergosafety can improve health quality in terms of reducing worker fatigue scores. Making *piranti upakara* involves repetitive hand activities, sitting for long periods, or holding small loads repeatedly, which triggers muscle fatigue and musculoskeletal pain, thereby increasing the scores on many physical items in the questionnaire. Among craft and industrial workers, a strong relationship exists between prolonged sitting and standing positions and work fatigue.²⁷ When the manufacturing process must meet the demands of ceremonies or orders, the workers often work for long hours without regular breaks, increasing the cumulative fatigue score. Hence, in terms of this aspect, many respondents fall into the medium and high categories. Implementing ergosafety comprehensively and incorporating

the principles of Tri Hita Karana can help reduce the fatigue of *piranti upakara* makers. The adoption process and sustainability of interventions are strengthened by a combination of technical elements (improved workstations, work methods, manual lifting) with sociocultural elements (customary legitimacy, community support, spiritual aspects). The recommended implementation of the total ergonomic approach reduced fatigue by up to 9.22% ($p < 0.05$) among metal craftsmen in Tabanan Regency.²⁸

Musculoskeletal Complaints

Tri Hita Karana-oriented ergosafety can improve the quality of health from the aspect of reducing the score of workers' musculoskeletal complaints. Making *piranti upakara* often involves repetitive hand and arm movements, holding small tools, and working on details for long periods without sufficient rest. Performing these repetitive movements causes repeated stress on muscles, tendons, and ligaments. The accumulation of this mechanical stress results in moderate, high, and very high musculoskeletal complaints, especially during long working hours.²¹ Non-ideal working positions (bending, hunched neck, tilted body, hands positioned away, spine not straight) will increase the mechanical load on the musculoskeletal structure and trigger pain in the neck, back, waist, shoulders, forearms, and legs.²⁹ Preventive efforts need to be increased among the factors that influence workers to reduce the risk of musculoskeletal disorders.³⁰ The application of Tri Hita Karana-oriented ergosafety can reduce musculoskeletal complaints in *piranti upakara* makers through a combination of biomechanical improvements and strengthening sociocultural support. Other research indicates that ergonomically oriented improvement mechanisms at work can reduce workers' musculoskeletal disorders by up to 44.45%.²¹

Work Productivity

This research shows that the application of Tri Hita Karana-oriented ergosafety can increase the productivity of *piranti upakara* makers. This increase in productivity will be achieved if all components in the work system are ergonomically designed.³¹ Ergosafety work methods increase productivity because they produce greater output with less input. In addition, reduced musculoskeletal complaints and work fatigue can increase the work time efficiency and productivity of *piranti upakara* makers. Ergonomic intervention by designing an ergonomic workplace can increase work productivity by 20.29%,³² and improvements to workstations and work environments for *perapen* and *nguwad terompong* through a total ergonomics approach has been found to increase work productivity by 55.83%.³³

CONCLUSION

The implementation of Tri Hita Karana-oriented ergosafety had a positive impact on the quality of health and work performance of *piranti upakara* makers, as indicated by a 15.25% ($p \leq 0.01$) decrease in the score of musculoskeletal complaints, a 28.3% ($p \leq 0.01$) decrease in the score of work fatigue, and a 34.43% ($p \leq 0.01$) increase in work productivity by 34.43% ($p \leq 0.01$). These changes are statistically significant. Hence, the application of Tri Hita Karana-oriented ergosafety can help improve the health quality and productivity of *piranti upakara* makers.

ETHICS APPROVAL

This research has been approved by the Research Ethics Committee of Bali International University, Denpasar, Bali. The research was approved on July 14, 2025, with ethics approval number 01.034/UNBI/EC/VII/2025, after considering the risks, benefits, participation, and confidentiality of respondent information.

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COMPETING INTEREST

All authors declare that there are no conflicts of interest.

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UNDERLYING DATA

The data that support the results of this study are available from the corresponding author upon reasonable request.

DECLARATION OF ARTIFICIAL INTELLIGENCE USE

We confirm that no artificial intelligence (AI) was used at any stage of the study, including data collection, analysis, and visualization. All work in this study was conducted manually by the authors without the assistance of AI-based tools or systems

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