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Designing Ergonomic Work Aids to Improve Worker Productivity in Spring Mattress Manufacturing at PT Rentang Buana Niagamakmur

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Abstract.
Background. PT Rentang Buana Niagamakmur is a spring mattress manufacturing company that faces a decrease in productivity due to worker discomfort and ergonomically suboptimal working postures
Purpose. This study aims to identify the causes of workers' physical discomfort in the production process and design work aids that can improve comfort and productivity.
Method. The research process began with data collection through observation and interviews to understand the activities of workers at the production station. The *Nordic Body Map* (NBM) was employed to identify workers' musculoskeletal complaints, while Rapid Entire Body Assessment (REBA) was applied to evaluate ergonomic risk levels.
Results. Based on the results of the analysis, the design of work aids was carried out using an ergonomic approach that suits the needs of workers at fabric measurement and foam cutting stations. Evaluation of the effectiveness of the aids was carried out by comparing REBA scores before and after the use of the aids.
Conclusion. The results showed that the main physical complaints of workers were identified in the right wrist, waist, and calf. The design of work aids at the fabric measuring station lowered the REBA score from 11 to 3 (*low risk*), while the aids at the foam cutting station reduced the score from 7 to 3 (*low risk*).
Implementation. The proposed work aids were shown to significantly reduce physical discomfort and improve productivity at both workstations.

Keywords: REBA, *Nordic Body Map*, Ergonomics, Worker Comfort, Spring MattressManufacturing.

INTRODUCTION

PT Rentang Buana Niagamakmur is a company engaged in manufacturing that was established in 1994 and is a subsidiary of PT Cahaya Buana Intitama. PT Rentang Buana Niagamakmur sells various types of furniture such as plastic cabinets, plastic chairs, spring mattress, and foam mattresses. In addition to selling, PT Rentang Buana Niagamakmur is also engaged in producing various types of spring mattress.

In an increasingly competitive industrial environment, work system efficiency and effectiveness are critical determinants of organizational sustainability and competitiveness. This is also the focus for PT Rentang Buana Niagamakmur in ensuring the company's success. According to Heizer and Render (2011), productivity is a measure of efficiency in using resources such as labor, materials, and technology to produce the desired output.

One of the important elements in PT Rentang Buana Niagamakmur is the process of making spring mattress, which has a strategic role in determining the company's financial success. The efficiency of the work system in the spring mattress manufacturing process is greatly influenced by several factors, such as workflow, interaction between humans and machines, and the application of ergonomic principles. The production process of this spring mattress involves several workstations including cutting stations, measurements, *frame assembly*, *frame side assembly, and* packing stations.

However, there are problems found in the production process of spring mattress where there is a reduction in the number of mattress produced. Companies rely heavily on worker productivity to meet production targets and market demand. Sustained worker productivity is strongly influenced by worker comfort.

The data obtained shows that the production of spring mattress is declining month by month. The specified production target is 140 per month. There are only a few months that meet the target that has been carried out. The data obtained can be said to have decreased continuously from 152 to 127 starting from June 2023 to June 2024. It is mentioned by Kolibi (2024) that ergonomics play an important role in improving comfort and well-being in the workplace. Around 7.30% of the population has *musculoskeletal disorders* (MSDs), which is one of the most common occupational health complaints in Indonesia (Riskesdas, 2018). The application of ergonomic principles in the design of the work environment can reduce the risk of injury and increase efficiency, and significantly impact employee productivity. These findings highlight the importance of workplace ergonomics to support worker productivity in producing a product, in addition to that workers can avoid the risk of long-term injury.

Based on initial observations, one of the factors that affect the inconsistency of producing a product is the discomfort of workers due to a less ergonomic work posture. This discomfort is often caused by inadequate use of work tools, static or repetitive body position, and lack of appropriate support for the aids. Dul and Weerdmeester (2008) stated that an unergonomic work system design can increase discomfort, decrease productivity, and increase the likelihood of work errors. I Ketut Simpen (2018) stated that a work system that is not ergonomic, such as methods, attitudes, and work positions, affects the productivity, efficiency, and effectiveness of workers in completing their work. Tarwaka (2004) explained that with proper ergonomic interventions, work comfort, health, and safety can be improved, which will directly increase work productivity and company profits. Prodia *Occupational Health Institute* (OHI) stated that a poor work system related to the field of ergonomics can cause inefficiencies in production and potentially cause health problems and discomfort to workers, which in turn can cause economic losses for the company. After the implementation of ergonomic work facilities, there is a reduction in complaints among workers and an increase in productivity. To understand the level of discomfort of workers, this study used the *Nordic Body Map* (NBM) method to map the musculoskeletal complaints felt by workers. In addition, ergonomic analysis is carried out with *a Rapid Entire Body Assessment* (REBA), which can evaluate the level of risk based on work posture and other supporting factors. Hignett and McAtamney (2000) explain that REBA is an effective tool for identifying ergonomic risks and designing solutions.

As a solution, this research focuses on the design of work aids designed to reduce worker discomfort and improve the efficiency of work systems at frame stations. According to Kroemer et al. (2001), work aids designed according to ergonomic principles can reduce the physical burden of workers, improve work posture, and increase productivity. The design of this tool will consider factors such as convenience, ease of use, and compatibility with existing workflows.

Ergonomics research in the manufacturing sector, particularly manual work-based industries, is currently developing on several key focuses:

1. Ergonomic Risk Measurement. Modern research uses many methods: Nordic Body Map (NBM) to identify subjective complaints of workers, REBA to assess work posture risks, Supporting methods such as RULA and OWAS. The NBM–REBA combination has become a standard in industrial ergonomics studies because it is able to comprehensively map complaints and risks.
2. Design of Anthropometry-Based Tools. Recent studies emphasize: Use of anthropometric data, Percentile approach (P5–P95), Design of work facilities that adapt to user characteristics. This approach aims to create an inclusive and comfortable work system for the majority of workers.
3. Evaluation of the Effectiveness of Ergonomic Interventions. Many studies have proven that: Ergonomic interventions are able to reduce the risk of MSDs, Posture improvement has an impact on increased productivity, Evaluation is carried out through before–after score comparison.
4. Integration of Ergonomics and Engineering Economics. The latest trends show the merging: Ergonomics analysis, Cost analysis (ROI, Payback Period), Evaluation of the feasibility of the aid investment. This approach reinforces the position of ergonomics as a business strategy, not just occupational health.

This article is in the mainstream of modern ergonomics research because: using NBM and REBA, integrating anthropometry, designing specific tools, conducting quantitative evaluations, including economic analysis of engineering. Thus, this research is in line with the latest ergonomics research practices.

LITERATURE STUDIES

Ergonomics

Ergonomics is a science that studies the interaction between humans and elements in a system to optimize human welfare and overall system performance. According to Sutalaksana et al. (2006), ergonomics aims to create a work system that is in accordance with human abilities and limitations in order to achieve optimal productivity. The main principles of ergonomics include the adjustment of tasks, tools, environments, and work systems to human needs and capabilities, creating safe, comfortable, and efficient working conditions.

The application of ergonomics can improve the physical and mental well-being of workers, reduce the potential for work accidents, and improve product quality and work system efficiency. An ergonomic working environment helps workers to work with optimal posture, reducing discomfort, improving concentration, and producing products with high accuracy. It can also minimize errors that impact product quality.

In addition, ergonomics improves comfort and job satisfaction, which in turn can increase the motivation and morale of workers. With an ergonomic working design, the production process runs more smoothly, the risk of product damage is reduced, and the efficiency of time and labor is increased, allowing products to be completed faster without sacrificing quality. Overall, the application of ergonomics plays an important role in maintaining and improving product quality through improving worker comfort, safety, and efficiency, as well as consistently producing high-quality products.

Anthropometry

Anthropometry is a science that studies the size and proportions of the human body in relation to the design of tools, facilities, and products to achieve human comfort, efficiency, and health and safety. The purpose of anthropometry is to provide data and standards of body dimensions used in interacting with products or work facilities (Pheasant & Haslegrave, 2006). Some of the factors that affect anthropometric data include the individual's age, gender, environment, and physical condition. Age affects body dimensions, such as posture which tends to be more bent as you age. Gender also affects the difference in body dimensions between men and women. In addition, geographical environment and physical conditions such as health, posture, and physical activity also influence the variation of anthropometric data (Sutalaksana et al., 2006).

The basic principle of using anthropometric data is the application of percentile and tolerance. Percentiles are used to cover a large part of the population, e.g. P95 which indicates that 95% of the population has an above average height, and 5% below it. Tolerance in anthropometry considers individual variation beyond the specified percentile, such as providing more tolerance at door height to accommodate individuals with extreme heights (Pheasant & Haslegrave, 2006). Anthropometric measurements can be done manually with traditional measuring tools such as tape measure, or using modern technology such as 3D scanners to obtain faster and more precise data.

Both methods aim to determine the design of products or work facilities that are less ergonomic, so that they can cover the needs of the body of most people who use them (Nielsen et al., 2013).

Nordic Body Map

The Nordic Body Map is a tool to assess body discomfort subjectively based on the pain felt in different parts of the body due to work. The assessment was carried out by filling in the pain scale in areas of the body such as the head, shoulders, back, arms, and legs, which were then calibrated with a value of 1-4. The main purpose of this tool is to identify musculoskeletal problems due to posture or unergonomic work design. The results of the assessment are used to design improvements in the work environment to reduce the risk of injury and improve worker comfort and health (Kuorinka et al., 1987).

REBA (*Rapid Whole Body Assessment*)

REBA is a method for assessing the risk of *musculoskeletal disorders* caused by incorrect posture or strenuous physical work. Developed by Dr. Lynn Hignett and Dr. Steven McAtamney in 2000, REBA helps companies improve aspects of ergonomics in the workplace, such as improving workflows, facility placement, and workload sharing. The use of REBA can reduce the cost of injuries as well as increase productivity and job satisfaction. The assessment is done by scoring the pain felt by workers in different parts of the body, as well as taking into account factors such as lifting weight and duration of work. Although fast and practical, REBA has its drawbacks in dynamic job assessment and relies on observer subjectivity (Hignett & McAtamney, 2000).

Engineering Economics

Engineering Economics is a branch of science that combines economic principles and engineering to help investment decision-making and resource management more efficiently. The main focus is on the calculation of the cost and feasibility analysis of the project (Teece, 2018). Some of the methods used in engineering economics include Net Present Value (NPV), Payback Period, and Return on Investment (ROI).

NPV calculates the current value of future cash, with a positive NPV indicating a profitable project. The Payback Period measures the time it takes to return the initial investment, calculated by dividing the total investment by the annual profit earned. ROI is used to evaluate investment profits, with the formula calculating net profit divided by investment costs, multiplied by 100%. Engineering economics is applied to various sectors such as manufacturing, infrastructure, and the environment. While effective for evaluating project feasibility, this method has drawbacks such as uncertainty due to price changes, regulations, or fluctuations (Teece, 2018).

METHODS

This study was conducted through ten sequential research stages, including preliminary investigation, root cause analysis using fishbone diagrams, problem formulation, scope definition, methodological design, data collection, REBA assessment, analysis, design of interventions, and conclusion formulation..

Preliminary investigations were conducted through on-site observations at PT Rentang Buana Niagamakmur. In addition to making observations, direct interviews were conducted with PT Rentang Buana Niagamakmur. Literature studies are required to be a theoretical framework guideline in research. The research scope was defined to ensure methodological focus and feasibility. The assumption of the research is carried out with the aim that the factors that cannot be controlled can be controlled and the proposals given can be more specific and on target.

At this stage, the purpose of the research is described in detail so that the focus of the research is more directed and in accordance with the problems faced. It also explained the benefits of research, both for companies, workers, and scientific development. These goals and benefits are designed based on the results of initial observation and problem analysis. The research method used is determined according to the problems faced. In this study, the methods chosen were *Nordic Body Map* to identify workers' musculoskeletal complaints and the REBA to evaluate the level of ergonomic risk. These two methods were chosen because they are relevant for analyzing ergonomic factors that contribute to product defects and worker discomfort.

Data were collected through direct observation, interviews, and the completion of *the Nordic Body Map* questionnaire by the workers. In addition, other data such as the layout of the workstation, the duration of work activities, and the condition of the work tools were collected for assessment purposes using the REBA method. This data will be the basis for ergonomic analysis and solution development. Based on the data that has been collected, the data will be processed by the methods mentioned and will also make improvement designs from the data processing results obtained. The results of this assessment will help identify areas of work that need improvement. After doing REBA, the data obtained will be used for reference in making aids for 2 stations. The results of making assistive devices made with *Solidworks* and CATIA software, will be made a

REBA of assistive devices or proposals to see how the risk of injury after the manufacture of assistive devices

After the REBA assessment is completed, the data is analyzed to find the relationship between working conditions and the level of product defects. Based on the results of the analysis, ergonomic work aids design is proposed to reduce the risk of worker discomfort. The analysis also includes practical measures that can be implemented to improve production quality. In the final stage, conclusions are drawn based on the findings of the study, including the main causes of product defects and recommendations for improvement. In addition, advice is given to the company for the application of research results as well as advanced development steps.

DISCUSSION

Measurement Station Auxiliary Design

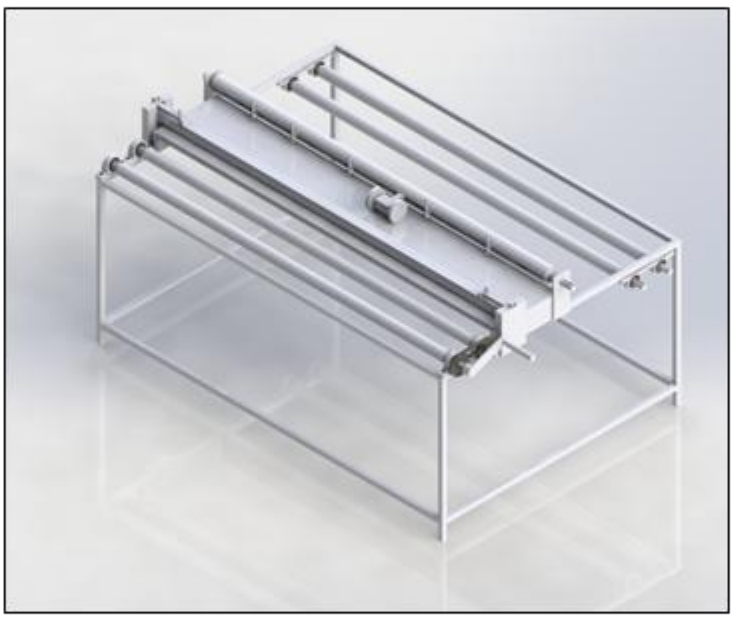


Figure 1 Prototype of the Measurement Aid

In Figure 1 that has been produced, it not only shows the visual design of the prototype, but also conducts a financial analysis related to the cost of developing, manufacturing, and implementing the prototype. This prototype is designed for use at measurement stations with the main goal of helping workers make measurements easier, faster, and more accurately. With an ergonomic design, this prototype is expected to improve work efficiency and reduce the potential for human error in the measurement process. The size of the measuring station aids is 2130 x 1469.1 x 976.5

mm. The length size of 2130 mm is obtained from the width of the fabric obtained from the supplier, which is 2000 mm. The width of 1469.1 mm is obtained from the placement of 4 *rollers*, the width of the tablecloth, and the width of the center space as a space to adjust the distance of markers. The height measurement of 976.5 mm is the height of the base table where the fabric is marked from the floor.

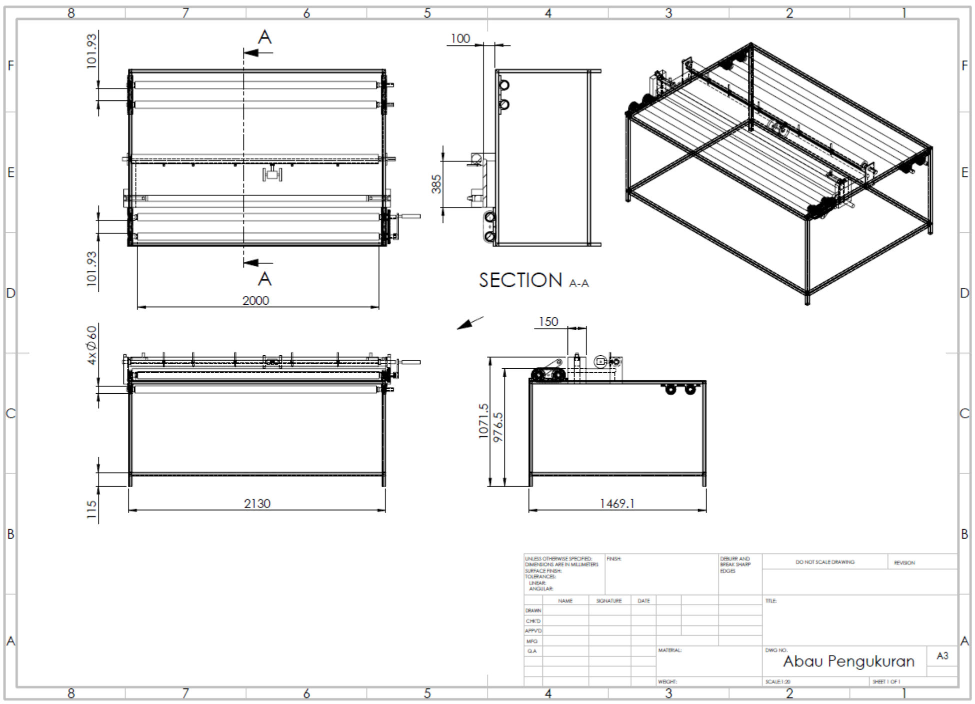
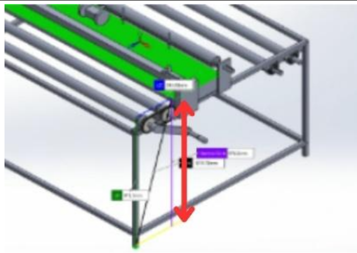
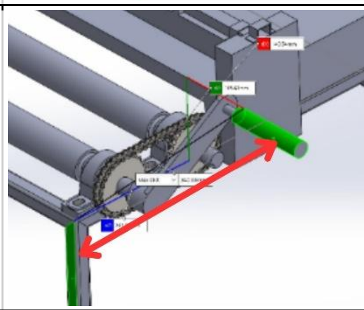
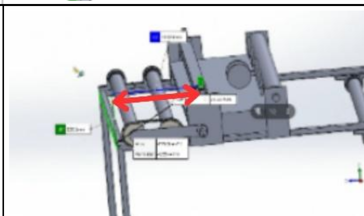
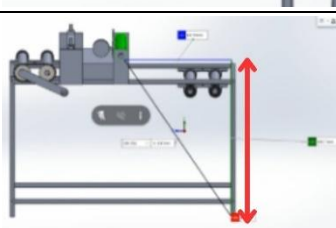
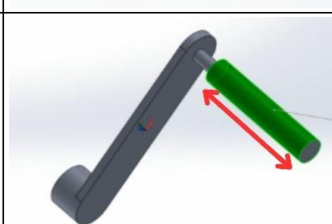


Figure 2 Technical Drawing of Measurement Station Aids

The prototype is designed using a sturdy iron frame as the main material, ensuring durability and stability during use. The frame will be connected using welding techniques to produce a strong and precise structure, according to the needs of the measurement station. The left side of the prototype functioned as a take-up roller for measured fabric. The finished processed fabric is automatically rolled neatly in this part to ensure that there is no clutter or overlapping of the fabric. The right part of the prototype is used as a place for the fabric to be measured. In this part, fabrics that are still in an unmeasured condition can be prepared and arranged so that the measurement process runs more smoothly and more organized. In the middle of the prototype, there is a rail that has an important function as the placement of adjustable markers such as markers, *a roll meter counter* that functions to calculate the length of the fabric, and a slot lock on the line aid.

Table 1 Measurement Station Auxiliary Size Considerations

No.	Machine Parts	Image	Machine Size (cm)	Body Parts	Code	Percentile
1	Height of the tablecloth from the floor		97,65	Elbow Height	D4	P50
2	Farthest distance of rotation *handle*		34	Shoulder Length - Front Hand Grip	D25	P5
3	Distance of the line helper to the end of the tool		38,88	Shoulder Length - Front Hand Grip	D25	P5
4	Space to set marker spacing		32	Thick Belly	D21	P95
5	Height marker marker from the floor		99,86	Elbow Height	D4	P50
6	Handle width		15,17	Palm Width	D29	P95

In Table 1 you can see an overview of *solidworks* from the measuring station auxiliary section. Part number 1 is the height of the measuring station aid with a height of 97.65 cm which uses the P50D4 elbow height reference. For the distance between the worker's hand grip and the rotating knob, it is worth 34 cm using the shoulder-length anthropometric reference – the front hand grip with P5D25. For the distance of workers with the ruler board holding slots, the shoulder-length anthropometric reference is used with a forward hand grip with P5D25, which yields 38.88 cm. For the distance between the gauge and *the fabric gravity roller,* before being measured using the belly thickness P95D21 resulting in a distance of 32 cm. To adjust the distance between marker gauges, use the P50D4 elbow height with a yield of 99.86 cm. Then there is the size for the rotary knob which has a width of 15.17 cm, using the width of the palm of P95D29 with a combination of 3cm diameter (Anthropometry.org, 2013).

Design of Foam Cutting Station Aids

The design of aids is based on ideas from the *Benchmark* from *Hygiex.* Products *Benchmark* This can be seen how it works through *Google Platform* https://hygiex.com.au. *The* function of this product is to be able to cut soft objects without making the wrist become stressed or fatigued when cutting. Here is in Figure 3 of the product *benchmark Hygiex ergonomic knife.*

Figure 3 *Hygiex Ergonomic Knife*

In Figure 3, you can see that the example of the benchmark taken is the handle developed by *Hygiex*. The parts that were not taken were the cutting blade and *the body* of the knife itself. The prototype to be designed has an extension of the body of the knife so that it can reach a considerable distance with the blade pointing backwards. Next, we will discuss the design of an aid for mattress foam cutting. After the REBA method was carried out from the 3 workers, it was found that the one with the second worst risk was in the slaughter worker where the one with the final score of REBA = 7. The researchers decided to make an aid to workers who were at the cutting station. With the help of *Solidworks software* that will be used to create a 3D model.

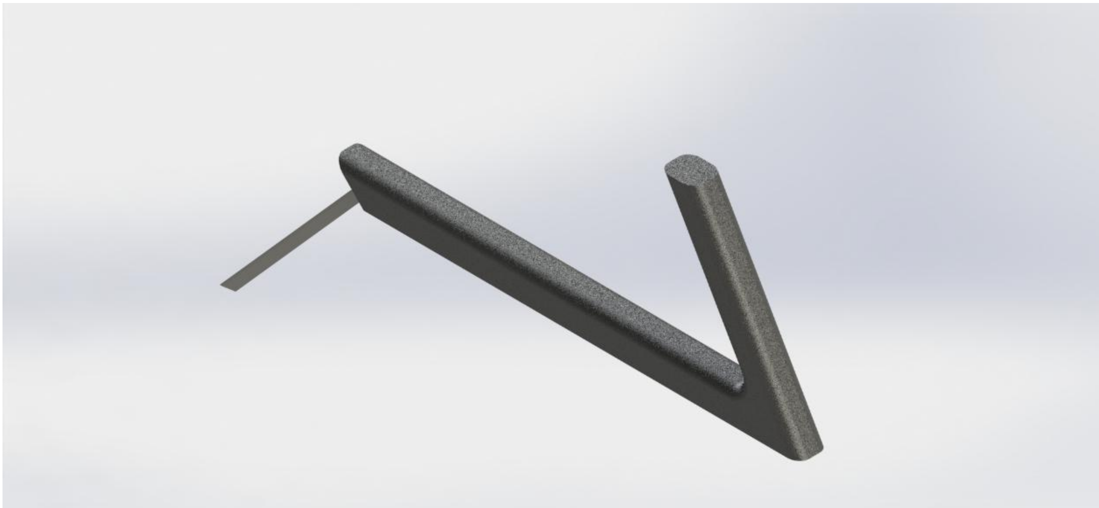


Figure 4 Prototype of Cutting Station Auxiliary

In Figure 4, the prototype featured a blade thickness of 1 mm and a blade length of 20 cm. The blade-to-shaft angle was designed at 131.81°, while the handle inclination angle was set at 60° with a handle length of 15.26 cm. The overall body length of the prototype was 45.19 cm. This ergonomic configuration enabled workers to perform side-edge cutting with improved comfort and reduced trunk flexion. Detailed front, side, and top views with dimensional specifications are presented in Figure 5.

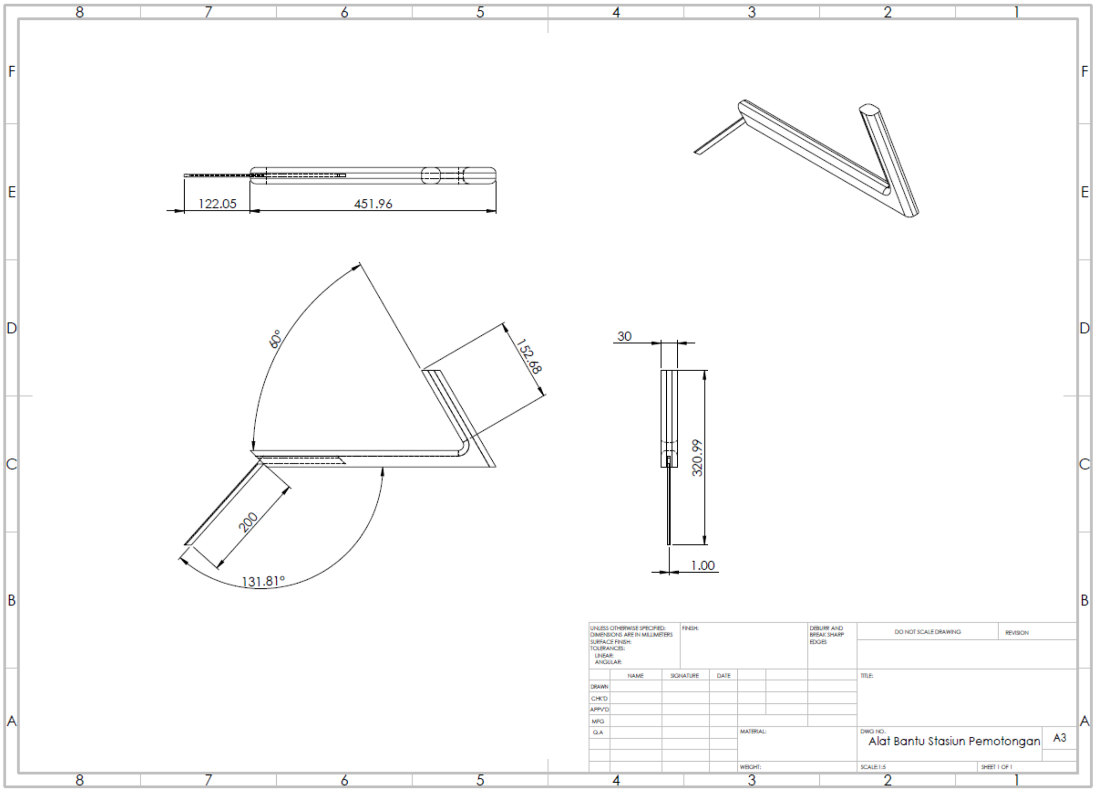
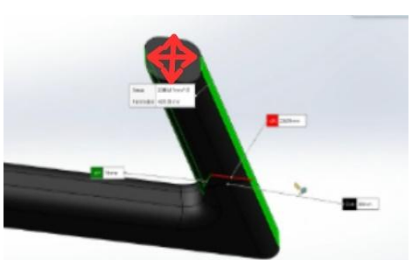
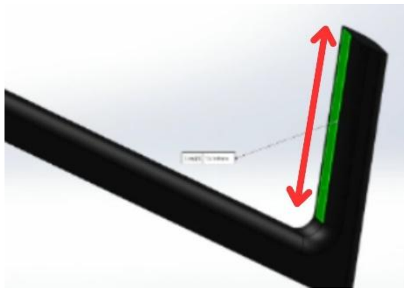


Figure 5 Technical Drawing of Cutting Station Aids

These prototypes are not only designed to meet functional needs, but also provide convenience for workers. By speeding up and simplifying the cutting process, this prototype has the potential to increase worker productivity while reducing fatigue due to repetitive manual activities.

Table 2 Cutting Station Aid Size Considerations

No.	Image	Size on Tool (CM)	Body Parts	Code	Percentile
1		3x3	-	-	-

2		15,26	Palm Width	D14	P95

From Table 2, it can be seen that 2 sectors of this prototype have important sizes such as the handle, which has a size of 3x3 cm. The length of the handle is determined by paying attention to anthropometry, using the width of the palm of P95D14 with a length of 15.26 cm (Anthropometry.org, 2013). The resulting prototype can significantly lower the yield of REBA.

Worker selection based on the slice between complaints of pain in the right wrist and right calf is essential to identify workers who have a high potential risk of fatigue and injury. In this case, workers who have the highest *Nordic Body Map* (NBM) score, which is a score of three, are selected as the top priority. Workers in the packing and measurement section were selected because their complaints were related to the same body location and NBM scores, indicating significant discomfort. Based on ergonomic analysis using *the Nordic Body Map* method, the most discomfort experienced by workers was in the right calf and right wrist. This happens to workers at three workstations, namely sewing, cutting, and measuring stations. Further analysis with the REBA method showed that the working posture at each station presents different ergonomic risks.

Analysis of the Design of Measurement Station Aids

The proposed measuring aid has dimensions of 210 cm in length to adjust to the width of the fabric of 200 cm, a width of 143.91 cm considering the machine setup space, and a table height of 97.65 cm (91 cm table + 4.5 cm bearing + footbed clearance of 2-3 cm) based on the elbow height of P50 (95.65 cm) to be comfortable for various worker heights. The handling pulley for moving the cloth roller uses the shoulder-length of the forward hand (D25) with P5, so that the 34 cm grip distance makes it easy for workers to reach without pressure on the shoulders and wrists.

The 38.88 cm long desk-to-line aid also uses D25 with P5, allowing workers to reach without leaning over. The distance between the fabric roller and the marker of 32 cm is selected based on the size of the abdomen (D21) with an additional 2 cm for the looseness of the garment, so that the operator can set up freely. The height of the marker rail is 99.86 cm using the elbow height of P50 (D4) so that workers can adjust the position of the marker without the need to look up, reducing the risk of fatigue. The handle width of 15.17 cm uses D29 with P95 so that all workers can grip comfortably without pain or soreness.

Analysis of the Design of Cutting Station Aids

The prototype knife for the cutting station was designed with a 60-degree grip tilt angle, based on ergonomics studies that showed that a 45-60 degree angle is optimal to reduce stress on the wrist without sacrificing cutting efficiency. The knife handle is made similar to the rotary knob of a measuring aid, featuring an anti-slip texture and ergonomic contours for comfort and stability in the grip. The blade is made of high-quality stainless steel with a length of 20 cm and a thickness of 1 mm, ideal for cutting foam without damaging the structure. The total length of the knife of 41.04 cm allows workers to reach the other side of the foam without bending overboard, reducing the risk of back pain. This design is based on ergonomic principles to improve comfort and work efficiency, as well as reduce the risk of injury to the wrist and back. In the CATIA V5 application, the Japanese P50 population was used as an initial reference due to the similarity of anthropometric dimensions to Indonesia, compared to the Chinese population, which has a higher torso. This data is often used in global industrial design, but local testing is still needed to adapt to the diversity of body sizes of Indonesian workers, so that products are more suitable for user needs.

Cost Calculation Analysis

Cost calculation analysis shows that the measurement station aids require an investment of IDR 5,384,400 and are able to reduce cycle time from 30 minutes to 15 minutes, saving 3.5 hours per day. With a labor cost of IDR 30,066 per hour, the daily cost savings reach IDR 105,231 or IDR 25,255,440 per year. The payback period was only 2.56 months, with an ROI of 369%, indicating high economic feasibility and rapid return on investment. Meanwhile, cutting station aids cost Rp255,000 and do not reduce cycle time, but increase work comfort so as to reduce workers' health costs. With a saving of Rp28,031 per month, this tool has a payback period of 9 months and 3 days and an ROI of 31.92%, indicating favorable long-term economic benefits in the long run. Both of these tools have proven to be financially feasible and can improve efficiency and worker welfare.

Based on the analysis of the content of the article, the novelty of this research lies in the following aspects:

1. Specific focus on the Spring Mattress Industry,. Most ergonomics research focuses on: Automotive industry, Ceramics, Agriculture, Healthcare. This article specifically examines the spring mattress industry, which is still relatively rarely researched, thus expanding the scope of manufacturing ergonomics research.
2. Multistation Auxiliary Design. The research designed not just one tool, but two tools for: Fabric measuring station, Foam cutting station. This multi-station approach provides a systemic picture of the improvement of the production process.
3. Complete Integration: Ergonomics–Anthropometry–Economics. This study combines simultaneously: Complaint analysis (NBM), Posture risk (REBA), Body dimensions (anthropometrics), Investment analysis (ROI, Payback). The integration of these four approaches is still rarely found in a single integrated study.
4. Local data-driven design. Use: Indonesian anthropometric data, Adjustment to the conditions of local workers, is an added value compared to research that uses global data without local adaptation.
5. Measurable Quantitative Evaluation. Research shows concrete results: REBA down from 11 → 3, REBA down from 7 → 3, ROI up to 369%. This reinforces the empirical contribution of the research.

The main novelty of this research is: the development of local anthropometry-based ergonomic aids in the spring mattress industry with an integrated ergonomic–economic approach that is quantitatively evaluated.

Although this research is robust, there are still some research gaps that can be developed:

1. Limited Number of Respondents. The study involved only a small percentage of workers (±3 key workers). Gap: There has been no validation with large samples for generalization of results. Research opportunities: Longitudinal studies with more respondents.

2. Focus on Physical Risks, Not Psychosocial. The research focuses on: Posture, Physical complaints, Productivity.Gap: Not yet discussed: Work stress, Mental load, Job satisfaction, Motivation. Research opportunities: Integration of physical and psychosocial ergonomics.
3. Short-term evaluation. Evaluation is carried out after the initial implementation. Gap: Unanalyzed: Long-term effects, Sustainability of tool use, Worker adaptation. Research opportunities: 6–12 month follow-up studies.
4. Lack of use of digital technology. The design is still conventional using CAD. Gap: Not yet using: Posture sensor, Wearable device, Motion capture, AI ergonomics. Research opportunities: Ergonomics based on Industry 4.0 technology.
5. Inter-industry generalization. The research is a single case study. Gap: Not tested on: Similar industries, MSMEs, Different scales. Research opportunities: A cross-industry comparative study.
6. Product Quality Aspect. The main focus is on productivity and convenience. Gap: Haven't measured the impact on: Product defect rate, Size precision, Customer satisfaction. Research opportunity: The relationship between ergonomics and product quality.

The research is in the mainstream of modern ergonomics with NBM, REBA, anthropometry, and engineering economics approaches. The research offers: Spring mattress industry focus, Multistation design, Ergonomic–economic integration, Local data-driven approach. There are still development opportunities in: Sample scale, Long-term evaluation, Psychosocial aspect, Digital technology, Industry generalization, Product quality.

CONCLUSION

This study designed ergonomic work aids to reduce the physical discomfort of workers in the production process of spring mattress, especially at measurement stations and mattress foam cutting stations. The tools at the measuring station, in the form of a table with *rollers,* along with *roller meters* and *pen holders,* make it easy for workers to measure cloth manually no longer on the floor. At the cutting station, an ergonomic cutting tool was designed with a blade-to-shaft angle of 131.81° and a handle inclination angle of 60° degrees from the rod to the handle of the knife. The proposed ergonomic work aids effectively reduced ergonomic risk from high to low categories, thereby improving worker comfort and productivity.

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