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ANALYSIS OF NEEDS AND TECHNICAL SPECIFICATIONS OF BENCH GRINDER-BASED BELT SANDER ATTACHMENT

Aries Rohiyanto[1], Muhamad Ramadan[2], Ade Rachmat Johar Pangestu[3], Teo Lukmanul Hakim[4]
[1234] UPA Laboratorium Terpadu, Institut Teknologi Kalimantan, Indonesia.
Corresponding Author: teolukmanulh@gmail.com

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Abstract

Conventional bench grinders at the Integrated Laboratory of Institut Teknologi Kalimantan (ITK) has a circular abrasive contact area unsuitable for angled flat-surface work such as bevel and weld joint preparation. This creates safety risks from workpieces becoming pinched or thrown, and precision results that are difficult to achieve consistently. This study aims to identify user needs for developing a belt sander system based on the existing bench grinder, then translate them into functional requirements and technical specifications as a design basis. A qualitative descriptive approach was used through semi-structured interviews with one laboratory technician and ten students across three study programs (Mechanical Engineering, Mechanical and Manufacturing Engineering, and Industrial Engineering), selected purposively based on direct experience using the tool for precision work, complemented by direct measurement of the work rest and tongue guard gaps using a caliper . The data were analyzed thematically, with priorities determined through triangulation of theme frequency. Four functional needs were identified: limiting the gap between the workpiece and abrasive element per safety standards, an adjustable and lockable angled workpiece support, adequate support area for size variation, and an alternative abrasive surface for non-metal materials. Measurement confirmed informant perceptions: the work rest gap on the left wheel was 3.60 mm, exceeding the 3.175 mm threshold under ASME B7.1/OSHA 1910.215, with a similar pattern in the tongue guard gap (6.80 mm, exceeding 6.35 mm). This study provides a design requirement basis derived from qualitative and quantitative field data for developing a belt sander attachment on the existing bench grinder.

Keywords: bench grinder; belt sanders; user needs; functional requirements; occupational safety

INTRODUCTION

One of facility machine tools the basis provided Laboratory Integrated Institute Kalimantan Technology for support practicals and assignments end student is a bench grinder, or something more known as machine bench grinder . Units available at Workshop A Manufacturing is an industrial bench grinder branded Krisbow type KW07-75, with a wheel diameter of 250 mm, 750 watts of power , and a rotation speed of 2850 rpm. Initially tool This intended for for work sharpen tool cutting and deburring. In practice , its use expanding to needs others , including making bevels and welds on the eye studying welding . Grinding wheel conventional have a contact area narrow circular . Characteristics geometric This make the process of leveling surface field flat tend produce contour concave (undercut), and angle work is difficult guarded consistent . Condition the push emergence idea For modifying an existing bench grinder become system multifunctional , namely with add a belt sander attachment without need stage machine new in need cost and space addition .

Before to the stage design technical , understanding about need real users need sourced from field data , not just assumptions ideal conditions . Unfortunately , research previously about modification and fabrication of belt grinders in general more focus on aspects mechanical and manufacturing tools . Drive pulley and idler pulley mechanism [1], efficiency material consumption [2], as well as adjustment tool For various form object work [3][4] to become more topics often discussed . The excavation process need users in a way structured and triangulated as base formulation specification design generally Not yet included in the studies the .

Point reject study This leave from gap mentioned . Literature existing belt grinding techniques Now dominated by optimization of process parameters, such as size grains abrasive , speed belt , and pressure nutrition , which is associated with output in the form of rudeness surface and depth ingestion of certain materials [9][10]. Similar pattern seen in the literature welding . Research latest more Lots modeling quality connection based on process parameters, both use network nerve imitation and testing not damaging [11][12], rather than highlight stage

preparation workshop which is actually produce geometry connection said . As far as the search conducted , not yet found research that is explicit make excavation need users as stage beginning before bench grinder modifications in the environment laboratory education . In a way practically , there are sufficient practical gap wide documented in the literature safety work . study retrospective multicenter to patient injury consequence tool cut speed tall find that injury head and neck happen Far more frequently on users grinder compared to users tool similar others , and highlight lack of regulations safety work that is special obligatory device engine protection grinder compared to tool cut speed other high [13]. Study cases in organizations student affairs technique participate report that knowledge safety from formal lectures do not necessarily carried away to activity informal laboratory , with fear blamed participate hinder willingness student report incident and incident almost woe [14], while review on safety university laboratories in general general emphasize importance strengthening control engineering and administration For pressing incident [15]. Study case in the workshop education other techniques also identify retainer machine guarding and points clamp as weakness the most frequent critical found in the assessment risk workshop [16]. Although Thus , the implementation control engineering in the field No always walk smooth : a studies observational to coordinator safety Work construction take notes that of 351 attempts implementation control observed safety , around one fifth still rejected by the party management although majority successful efforts implemented precisely originate from category control administrative and engineering , showing that implementation of a permanent hierarchy of control face obstacle practical in the field [17].

The gap research also appears from side academic . Method elicitation need structured users Still seldom applied to the context modification equipment workshop scale laboratory education . In fact , the trend research in a number of year final precisely move to direction method scale data based large and automation . Mining and analysis online reviews using processing Language experience be one of for example [18][19], as well as prototypes augmented reality based for dig need users device interactive [20]. Approach interview direct with A little informant key , which is combined instrument practice clinical and methods engineering , still more Lots applied to the technology domain assistive [22] compared to equipment workshop manufacturing . Research This take position in the gap said . Semi- structured interviews with multiple informants cross- study program used as base formulation need design , a methodological approach more near with tradition elicitation based interview direct [22] compared trend automation in progress developing [18][19][20]. Approach kind of This Not yet Lots implemented in a way explicit in the study bench grinder modification , which during This dominated report design get up without stage elicitation documented requirements [1]-[4].

Study previously regarding belt grinders [1]-[4] basically can mapped to There are two trends . The first is the creation of large-scale industrial machines from scratch. The second is the DIY (do-it-yourself) approach to machine assembly, which proceeds directly to the fabrication stage without exploring documented requirements. Both leave the same gap. Design decisions, such as platen dimensions, work rest angles, or belt material types, are essentially derived from the designer's assumptions about ideal requirements, rather than from traceable field data. The contribution of this study therefore rests on two complementary aspects. This study does not claim to be the first to modify a bench grinder into a belt sander, as such modifications have been widely reported [1]-[4]. The first contribution is domain transfer, namely applying a multi-informant interview-based needs elicitation approach, commonly used in consumer and assistive product design, to the context of educational manufacturing workshop equipment that has not yet been touched by similar approaches. The second contribution is the triangulation of layered evidence.

The needs uncovered from the interviews do not stop as mere perceptual data, but are cross-verified with direct physical measurements against international safety standard thresholds [5][7]. This type of verification step is not found in the online review-based needs elicitation studies or AR prototypes mentioned previously, which generally stop at the needs identification stage without verification against technical or regulatory thresholds. The combination of the two produces a design requirements basis that is not only sourced from the field, but can also be traced and cross-checked by other researchers. This is an implicit weakness in previous belt grinder design reports, which rarely document the origins of their design specifications. From this description, a research question arises: what are the user needs for the development of a belt sander system based on an existing bench grinder, and how are these needs translated into functional requirements and technical specifications that can be used as a basis for design? This research attempts to answer these questions by collecting field data from laboratory assistants and student users, while simultaneously compiling a needs translation matrix that can serve as a reference for the next technical design stage.

METHOD

This study uses a descriptive qualitative approach with a user needs assessment design. This approach was chosen because the goal is to explore and understand user needs in depth, not to test the relationship between variables statistically. This study was conducted in Workshop A Manufacturing, Integrated Laboratory of the Kalimantan Institute of Technology, with the physical object being a unit of industrial bench grinder Krisbow brand type KW07-75 (250 mm, 750 watt, 2850 rpm) which is the main facility for machining and welding practicum activities in the laboratory. Respondents were selected purposively (purposive sampling) based on direct experience using a bench grinder for precision-demanding work, such as bevels, weld seams, or final project component polishing. There was only one laboratory assistant responsible for tool operations in Workshop A Manufacturing, so the laboratory assistant informant was treated as a single key informant, not as a sample deficiency. Ten students were also involved as informants, representing three study programs that use the tool, namely Mechanical Engineering, Mechanical and Manufacturing Engineering (TMM), and Industrial Engineering, with a distribution of semesters 5 and 7 (Table 1). To maintain anonymity, the informant's name in this manuscript is disguised into a code.

Table 1. Composition informant study

Code	Group	Study program	Semester
L1	Laboratory assistant	-	-
M1	Student	Mechanical Engineering	5
M2	Student	Mechanical Engineering	7
M3	Student	Mechanical Engineering	5
M4	Student	Mechanical Engineering	7
M5	Student	Mechanical Engineering and Manufacturing	5
M6	Student	Mechanical Engineering and Manufacturing	5
M7	Student	Mechanical Engineering and Manufacturing	7
M8	Student	Industrial Engineering	5
M9	Student	Industrial Engineering	7
M10	Student	Industrial Engineering	7

Source : Research Data , 2026

Data collected through semi- structured interviews with four core questions , tailored the language For laboratory assistant and students . Fourth question the covers type regular work done using a bench grinder, difficulty perceived technical difficulties (especially in bevel work or welding seam), concerns or experience related safety work , and need development perceived tool important by the informant . Every interview done in a way face face , then transcribed verbatim before analyzed . Data analyzed in a way thematic , with identify pattern needs and problems that arise cross informant . This process follow principle analysis thematic that emphasizes coherence methodological and clarity reporting of the coding process [24][25][26]. Priority need Then determined through triangulation , namely count frequency emergence the same theme in different informants , not through quantitative Likert scale approach This chosen Because amount informants (n=11) no adequate For give impression precision actual statistics No supported by size sample said . Triangulation qualitative assessed more Honest reflect strength available evidence compared to method that . Need noted , literature methodology latest show that amount adequate interview For reach saturation the theme is very dependent on the structure guidelines interviews and approaches the encoding used .

The range is also reported varies wide inter-study , even appear debate about relevance draft saturation That Alone as gauge measuring adequacy sample in analysis thematic reflective [27][28][29][30]. On the basis of that , sufficiency samples in research This more based on considerations representation group user (purposive), not on the threshold number standard . The needs that have been identified translated in a way gradually , starting from need user (user requirements), become need functional requirements that explain function What only one must can done tools , up to Finally become need technical requirements in the form of characteristics technical matters that must be fulfilled . This translation process follows the systematic design principles as adopted in the VDI 2221 approach. This method is still actively applied and adapted to various design contexts in recent years, ranging from small-scale recycling equipment [23] to the integration of environmental sustainability aspects in aerospace product development [21].

RESULTS AND DISCUSSION

Existing Bench Grinder Condition

The bench grinder studied was a Krisbow KW07-75 unit, with nameplate specifications of 750 watts of power, wheel dimensions of 250 x 25.4 x 20 mm (diameter x thickness x bore diameter), voltage of 230V/50Hz, and rotational speed of 2850 rpm. All informants reported that the gap between the work rest and the grinding wheel surface was perceived as too wide, and this contributed to the occurrence of workpieces being pinched or thrown. This perception was then verified through direct measurements using calipers at several points along the face width of both grinding wheels. These points were chosen because the workpiece is generally pressed in the center area of the cross-section, so that this part has the potential to wear faster and form non-uniform gaps compared to the edges. Measurement results presented in Table 2.

Table 2. Measurement results work rest and tongue guard gap

Element	Point Measurement	Measurement Results (mm)	Threshold [5][7]	Status
Work rest	Left Wheel - Left Side	3.60	3,175 mm	FAIL
Work rest	Left Wheel - Center	2.65	3,175 mm	PASS
Work rest	Left Wheel - Right Side	2.80	3,175 mm	PASS
Work rest	Right Wheel - Left Side	3.10	3,175 mm	PASS
Work rest	Right Wheel - Center	2.75	3,175 mm	PASS
Work rest	Right Wheel - Right Side	2.75	3,175 mm	PASS
Tongue guard	Left Wheel	5.00	6.35 mm	PASS
Tongue guard	Right Wheel	6.80	6.35 mm	FAIL

Source : Research Data , 2026

Of the six measured point , the average work rest gap was recorded at 2.94 mm, with mark maximum 3.60 mm at the Left Wheel - Left Side point . Note gauge mention existence indication wear and tear concave in the middle area cross section wheel left , which is technical can explain Why gap in the part edge cross section precisely recorded more wide compared to part the middle . The criteria used set that One point only those who exceed threshold Already Enough make element stated No in accordance standard . Based on criteria said , the work rest on the bench grinder being studied status FAILS to meet ASME B7.1/OSHA 1910.215 standard , although five of six measured point individually actually Still is at within safe limits .

Characteristics Activity Use

Interview to eleven informant show that activity You can use a bench grinder grouped become three category main . Category First is making a bevel or welding seam in practicum welding , which was reported eight from eleven informant as most frequently used categories second is sharpening tool cut like eye drill and chisel lathe . Category third is fireplace component task end or task manufacturing , for example manufacture of fixtures, brackets, and test specimens . In addition that , a number of informant report use external tools its intended use , such as smoothing wood and acrylic , which are actually cause damage to materials due to hot from wheel grinder .

Identified Problems

Analysis thematic to eleven transcript interview produce pattern The problems are summarized in Table 3. The frequency figures in the table the show amount informants who are independent report same theme .

Table 3. Frequency of problem themes across informants

Problem Theme	Frequency (from 11 informants)
Workpiece squeezed / thrown consequence wide work rest gap	10
Bevel/butt angle is difficult to maintain consistently	8
The backrest does not support wide or small workpieces.	5
Need surface abrasive alternative for non- metallic materials	6
Need flat finishing surface For metal / welding scrap	6

Source : Research Data , 2026

Findings with level triangulation highest is question Wide work rest gap , reported ten from eleven informant in a way independent . Laboratory assistant even write it down as source incident almost repeated near - misses . Measurement directly in Table 2 then confirm findings qualitative This : the gap between the work rest at the Left Wheel point - Left Side (3.60 mm) and the gap between the tongue guard at the Right Wheel (6.80 mm) are both the same. exceed ASME B7.1/OSHA 1910.215(a)(4) threshold [5][7] . Convergence between perception users and results measurement instrument this is what strengthens validity findings the as need priority highest , not just perception subjective informant . Difficulty guard corner Work in a way consistent in making bevels and weld seams findings the second most prominent . Eight informant report matter this : without guide fixed angle , object Work forced held manually , so that results hem tend No symmetrical , tilted at one angle side , or varies its depth between end One with end others . Findings This relevant with need practical work welding , remembering quality preparation hem follow determine quality results welding end .

Need Functional and Technical Specifications

From the findings in Table 3, the need users translated become four need functional and technical priority , as presented in Table 4. Determination priority follow frequency triangulation : increasingly Lots informant who reported something needs , increasingly the priority is also high .

Table 4. Matrix of translation of user requirements into functional and technical requirements

Priority	Need Users	Need Functional	Technical Requirements
1	Security from object Work squeezed / thrown	System must limit gap between object work and elements abrasive	Work rest gap against surface abrasive <= 3 mm (referring to ASME B7.1/OSHA 1910.215)
2	Bevel/ seam corner precision and consistency	System must provide buffer object Work angled which can set and locked	Adjustable angle work rest with scale angles and mechanisms lock
3	Workpiece support for various sizes	System must provide support areas object adequate work	Work rest/platen with contact area more wide compared to design existing
4	metallic materials without material damage	System must provide surface abrasive alternative for soft materials	Belt sander attachment with platen separate from the grinding wheel side

Source: Primary Data, 2026

The first and second priority requirements were identified as the most pressing design requirements, as they directly relate to the safety and precision aspects of work, which were the most frequently complained about by informants. Meanwhile, the third and fourth requirements were complementary: they expanded the tool's functionality to

accommodate a variety of workpiece sizes and material types that had previously used the bench grinder beyond its intended purpose.

Findings Outside the Scope of the Tool's Technical Requirements

The interviews also revealed a number of other relevant findings, although they were beyond the scope of the technical specifications of the tools in this study. Four informants, for example, reported hand vibrations that disrupted stability when manually holding the workpiece. This qualitative finding aligns with the work ergonomics literature, which links manual handling of workpieces in the grinding process with the risk of hand-arm vibration syndrome . This is supported both by modeling vibration transmission in the machine-workpiece-operator hand system [8], and by physiological biomarkers in workers exposed to similar vibrations [31]. In addition, three informants reported symptoms of overheating of the workpiece due to uneven pressure or contact time. Several other informants also admitted to tending to avoid wearing gloves for fear of getting caught in rotating elements, even though this habit actually poses a risk to hand safety on the other side. These findings are more appropriate to be considered in the development of a Standard Operating Procedure (SOP) Module for tool use, rather than being forced into a technical requirement at the current attachment design stage.

Research Position in Relation to Previous Studies

Previous studies on belt grinder design and fabrication [1]-[4] have generally focused on the mechanical and manufacturing aspects of the tool, such as drive mechanism selection and material feed efficiency. This trend aligns with the broader technical literature on belt grinding, which focuses more on process parameter optimization than on early user requirements elicitation [9][10]. This study positions the user requirements exploration process as a stage that precedes technical design, with data sourced from multi-informant interviews across study programs analyzed using qualitative triangulation. This methodological position is closer to the tradition of interview-based requirements elicitation in assistive technology product design [22], although applied to a different context, namely manufacturing workshop equipment in an educational laboratory. This approach is expected to provide a more accountable basis for design requirements, compared to requirements formulation based solely on the assumption of ideal laboratory conditions.

CONCLUSION

Study This answer formulation the problem raised with identify four need functional main For development of belt sander attachment on Krisbow KW07-75 bench grinder in Workshop A Manufaktur Laboratory Integrated ITK: limitations work rest gap according to standard safety , support object Work angled which can set , support area object adequate work For variation size and surface abrasive alternative for non- metallic materials . Triangulation cross eleven informant put need related work rest gap and consistency corner work on urgency highest . Needs functional This become base specification technical that can direct used at the stage belt sander attachment design in the Laboratory Integrated ITK, replacing practice bench grinder modifications that have been This generally walk without stage elicitation documented needs .

A number of limitations need recorded . The number of informants (n=11) and one laboratory technicians involved reflect condition power and users actual in Workshop A Manufacturing , so that priority generated needs nature specific to the case mentioned . Verification protector point nip -point guard according to ANSI B11.19 [6] is outside room scope measurement study this . Resolution Tongue guard measurements are also more low compared to work rest, namely two points compared six point per wheel , because limitations time field measurements ; measurements multipoint on the part This recommended For study continued . Although Thus , the fourth need functional results produced still give the basis that can traced and accounted for for development technical attachment of belt sander on the same bench grinder .

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