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Analysis of the Effect of Cutting Speed on Surface Quality in AISI 1045 Steel Turning: A Systematic Literature Review

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Abstract

Surface quality is one of the important parameters in the turning process because it affects the performance and service life of mechanical components. Cutting speed is a cutting parameter that has a significant influence on the quality of the machining surface. This study aims to analyze the effect of cutting speed on surface quality in the turning process of AISI 1045 Steel using the Systematic Literature Review (SLR) method. Four relevant studies were included in the final synthesis. Data were obtained through the search and selection of relevant scientific articles based on the inclusion and exclusion criteria that have been set. The results of the study show that increasing the cutting speed to the optimum range tends to reduce the surface roughness value (Ra) because the cutting process occurs more stably and the formation of built-up edges can be minimized. Conversely, Excessively high cutting speeds can increase cutting temperature and tool wear, resulting in decreased surface quality. In addition to cutting speed, other factors such as feed rate, cutting depth, chisel material, and the use of coolant also affect the surface quality of the turning. Therefore, optimization of cutting parameters is necessary to obtain optimal surface quality in the turning of AISI 1045 Steel.

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INTRODUCTION

The development of the manufacturing industry demands a machining process that is capable of producing products with a high level of precision and surface quality. Surface quality is one of the important indicators in determining the performance of mechanical components because it is directly related to wear resistance, fatigue strength, friction level, and component service life during operation. Poor machining surfaces can lead to increased wear rates, reduce the efficiency of mechanical systems, and affect the surface integrity of components during their operating life (Colares et al., 2022; Mia & Dhar; Thakur & Gangopadhyay, 2016). Therefore, the optimization of cutting parameters is an important aspect in modern manufacturing processes (Kalpakjian et al., 2014; Mallick et al., 2023).

One of the machining processes that is widely used in industry is the turning process. This process is used to shape cylindrical workpieces through a material cutting mechanism using a cutting chisel. In the turning process, the quality of the surface is influenced by several main parameters, such as cutting speed, feed rate, and depth of cut. Among these parameters, cutting speed is a factor that has a great influence on the formation of the grunt, the cutting temperature, the stability of the process, and the surface quality of the machined workpiece (Ehibor & Aliemeke, 2021; Kashkool, 2022; Omoniyi, 2025; Singh et al., 2021). Several studies have shown that optimization of cutting parameters can significantly improve surface quality and manufacturing process efficiency (Ehibor, & Aliemeke, 2021; Gupta et al., 2016; Mia, 2017).

AISI 1045 steel is a medium carbon steel material that is widely used in the manufacturing industry because it has a combination of good mechanical properties, such as high tensile strength, good toughness, and fairly high machinability ability. This material is commonly applied to machine components such as shafts, gears, spindles, and other mechanical elements that require good strength and wear resistance (Wiratama & Kurniawan, 2021; Fhaizal & Sunyoto, 2025).

In the process of turning AISI 1045 Steel, surface quality is an important parameter because it greatly affects the performance and durability of components when used.

Some studies have shown that an increase in cutting speed within a certain range can improve surface quality as the cutting process becomes more stable and the formation of rage is more regular. These conditions are able to produce a lower surface roughness value compared to the use of low cutting speed (Suresh et al., 2012). However, the use of cutting speeds that are too high can lead to a significant increase in cutting temperature, accelerating the wear of the chisel, causing vibration, and degrading the surface quality of the workpiece (Colares et al., 2022; Kashkool, 2022). In addition, differences in cutting conditions, types of chisels, cooling methods, and material characteristics cause the results of studies on the effect of cutting speed on surface quality to still show quite diverse variations.

Many studies on the turning of AISI 1045 Steel show that studies related to the effect of cutting speed on surface quality are still relevant topics to be studied further. However, the results of research scattered across various sources of the literature require a more structured analysis in order to provide a comprehensive understanding of the relationship between cutting speed and the surface quality of the turning.

Although various studies have discussed the influence of cutting parameters on surface quality in the turning process of AISI 1045 Steel, the results obtained still show variations due to differences in cutting conditions, types of chisels, cooling methods, and analytical approaches used. In addition, surface quality is also related to the surface integrity of the material which can affect the performance of components against loads and the working environment (Abbas et al., 2019). In addition, most studies focus on individual experimental testing, so there are not many studies that synthesize the results of these studies systematically. Therefore, a literature review is needed that is able to integrate various research findings to obtain a more comprehensive understanding of the effect of cutting speed on surface quality in the turning process of AISI 1045 Steel.

Therefore, the Systematic Literature Review (SLR) approach was used in this study to identify, evaluate, and synthesize various previous studies related to the effect of cutting speed on surface quality in the turning process of AISI 1045 Steel.

Through the SLR approach, this study is expected to be able to provide a more systematic scientific picture of the effect of cutting speed variations on the surface quality of AISI 1045 Steel turning. In addition, the results of this study are expected to be a reference in determining optimal cutting parameters to improve the quality of machining results and the efficiency of the manufacturing process in the industry.

Although many studies have examined the effect of cutting speed on surface roughness, the findings remain scattered across different cutting conditions, tool materials, cooling methods, and measurement approaches. Therefore, a systematic synthesis is needed to clarify the role of cutting speed in determining surface quality in AISI 1045 steel turning

RESEARCH METHODS

This study uses the Systematic Literature Review (SLR) method to examine the effect of cutting speed on surface quality in the turning process of AISI 1045 Steel. The SLR method was chosen because it is able to identify, evaluate, and synthesize various previous research results systematically so that a more comprehensive understanding of the relationship between cutting parameters and the surface quality of turning results is obtained. The research stages are carried out in a structured manner starting from the formulation of research questions, literature search, article selection, to research data analysis.

A. Object of Research

The object of this study is the effect of cutting speed variation (*cutting speed*) on the surface quality in the turning process of AISI 1045 Steel. AISI 1045 steel is a medium carbon steel (*medium carbon steel*) which is widely used in the manufacturing industry because it has a combination of good mechanical properties, such as high tensile strength, good toughness, as well as machining ability (*machinability*) that are adequate. This material is widely applied to mechanical components, such as shafts, gears, spindles, and various other machine elements that require good strength and wear resistance (Wiratama &

Kurniawan, 2021; Kalpakjian et al., 2014; Fhaizal & Sunyoto, 2025).

In this study, AISI 1045 steel was used as an object of study based on various previous studies that discussed the influence of cutting parameters on the surface quality of turning results. The main focus of the study is directed at the relationship between cutting speed and *surface roughness* (Ra), as well as other factors that affect the quality of machining results, such as *feed rate*, *depth of cut*, type of sculpting material, and the use of *coolant*.

B. Literature Search Strategy

To ensure a wide and credible coverage of the literature, searches were conducted on reputable databases of international and national scientific journals. The main databases used include ScienceDirect, Scopus, and Google Scholar.

The search strategy is carried out by combining keywords using Boolean (AND/OR) operators to sharpen search results. The keywords used include: ("Turning process" OR "Turning") AND ("AISI 1045") AND ("Cutting speed" OR "Cutting speed") AND ("Surface roughness" OR "Surface roughness"). This ensures that the netted article has a direct correlation between the AISI 1045 material and the parameters being studied.

C. Inclusion and Exclusion Criteria

In order to keep the analyzed data focused and of high quality, the researcher sets strict selection criteria. Inclusions only include AISI 1045 steel turning studies that present quantitative data of surface quality (Ra or Rz), while machining processes or other materials are excluded. The publication time span is limited to the last ten years (2014–2024) to ensure industry relevance. In addition, literature sources are required to come from *peer-reviewed* journals or scientific proceedings, by eliminating opinion articles, blogs, and scientific works that are not officially published.

D. Literature Selection Process

The literature selection process is carried out in stages to obtain articles that are in accordance with the research objectives. The first stage is carried out by collecting all articles based on keywords that have been determined in a scientific database. Next, an initial screening was carried out based on the title and abstract to determine the suitability of the article with the research topic.

Articles that meet the initial criteria are then further analyzed through the process of reading the entire content of the article (*full-text review*). In the final stage, articles that meet all inclusion criteria are selected as the primary source in the research analysis process.

E. Data Analysis Techniques

Data obtained from various literature were analyzed using a qualitative descriptive approach. The analysis was carried out by comparing the results of previous research related to the effect of variations in cutting speed on surface quality in the turning process of AISI 1045 Steel.

In addition, this study also analyzes other factors that affect surface quality, such as *feed rate*, *depth of cut*, type of chisel material, and the use of *coolant*. The results of the analysis are then presented in the form of narratives, comparison tables, and graphs to facilitate data interpretation and the process of drawing conclusions.

RESULTS AND DISCUSSION

Based on the results of the selection process and literature analysis, a number of studies were obtained that discussed the effect of cutting speed on surface quality in the turning process of AISI 1045 Steel. The synthesis results show that cutting speed is one of the cutting parameters that has a dominant influence on *the surface roughness* value (Ra), which is often used as an indicator of the quality of machining results.

Surface quality is generally evaluated based on surface roughness values (*surface roughness*, Ra), where lower Ra values indicate smoother surfaces and better quality machining results (Mia & Dhar, 2016; Gultom & Kiswandono, 2020).

To obtain a more comprehensive picture of the effect of cutting speed on surface quality, a comparison was made of several relevant studies as presented in Table 1.

Table 1. Synthesis of Research Results on the Effect of Cutting Speed on the Surface Quality of AISI 1045 Steel

Source	Vc (m/min)	Key Findings
Lubis et al. (2020)	141-169	BUE influenced by Vc
Kashkool (2022)	27.9–55.8	Ra changes against Vc
Colares et al. (2022)	175–275	Feed rate is more dominant
Wilujeng et al. (2024)	75.36–90.40	Parameters affect Ra

Based on Table 1, all the studies reviewed showed that the cutting speed (*cutting speed*) affects the quality of the surface of the turning of AISI 1045 Steel. Lubis et al., (2020) report that changes in cutting speed affect the formation of *built-up edge* (BUE), while Kashkool (2022) indicates a change in the value of surface roughness (*surface roughness*,

Ra) due to variations in cutting speed. Meanwhile,(Colares et al., 2022) find that the quality of the surface is affected by the cutting speed, *feed rate*, and chisel wear. Consistent results were also reported by Wilujeng et al. (2024), which indicates that the combination of machining parameters exerts an influence on the degree of roughness of the surface produced.

In general, increasing cutting speed up to a certain range tends to improve the stability of the cutting process and result in better surface quality. However, the effect of cutting speed cannot be separated from other cutting parameters, such as *feed rate*, the depth of cutting, and the condition of the tool used (Mallick et al., 2023; Omoniyi, 2025; Raul, et al., 2016).

To clarify the variation in the cutting speed used in the reviewed study, the data from the synthesis is presented in Figure 1.

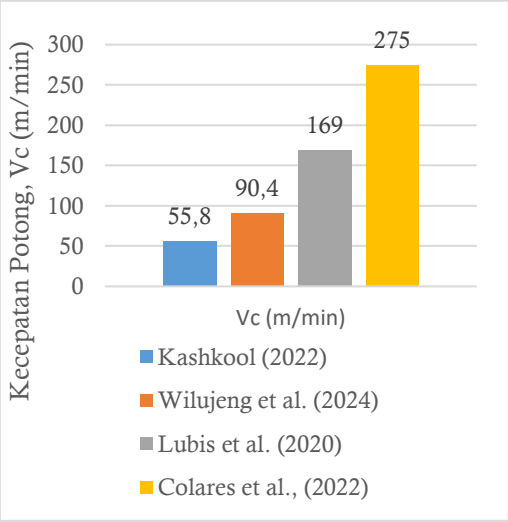

Figure 1. Comparison of Cutting Speed (Vc)

Based on Figure 1, it can be seen that the cutting speed used in the reviewed study has a fairly varied range, which is between 27.9 m/min to 275 m/min. These variations show that there are differences in machining conditions applied to each study according to the objectives and parameters studied. The highest cutting speed is used by Colares et al., (2022), while the lowest score was reported by Kashkool, (2022).

Although the range of cutting speeds used is different, all studies show that cutting speed is one of the parameters that affect the surface quality of AISI 1045 Steel turning. Lubis et al., (2020) report that changes in cutting speed affect the formation of *built-up edge* (BUE) at the end of the chisel, while Kashkool, (2022) shows a change in the surface roughness value due to variations in cutting speed. These results indicate that the selection of the right cutting speed plays a role in resulting in more stable cutting conditions and better surface quality.

In addition to cutting speed, the quality of the surface is also affected by other cutting parameters, such as *feed rate*, the depth of the cut (*depth of cut*), and the condition of the tool used. Colares et al., (2022) indicates that the increased wear of the tool and *feed rate* higher can increase the roughness value of the surface. Meanwhile, Wilujeng et al., (2024) concluded that the combination of machining parameters has an influence on the quality of the resulting surface.

Overall, the results of the literature synthesis show that cutting speed is one of the important parameters in the turning process of AISI 1045 Steel. However, its effect is inseparable from other cutting parameters. Therefore, thorough optimization of cutting parameters is required to obtain optimal surface quality and improve the effectiveness of the machining process (Kang & Lee, 2024; Pimenov, et al., 2017).

CONCLUSION

Based on the results *of the Systematic Literature Review* that has been conducted, it can be concluded that cutting speed has a significant influence on the surface quality in the turning process of AISI 1045 Steel. Increasing the cutting speed up to a certain range tends to lower the *surface roughness* value (Ra) because the cutting process takes place more stable and the formation of *built-up edges* (BUE) can be minimized. These conditions result in smoother workpiece surfaces and better machining quality. The results of the literature synthesis also show that there is an optimal cutting speed range that is able to produce the lowest surface roughness value. However, the use of cutting speeds that are too high can increase the cutting temperature and accelerate the wear of the tool causing the surface quality to deteriorate. In addition to the cutting speed, the quality of the turning surface is also influenced by other parameters, such as *feed rate*, cutting depth, type of sculpting material, and the use of coolant. Therefore, it is necessary to obtain optimal surface quality in the turning process of AISI 1045 Steel.

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AUTHORS' CONTRIBUTIONS

The first author contributes to the process of collecting literature, analyzing data, preparing research methodologies, and writing article manuscripts. The second author contributes to the

process of data validation, refinement of discussions, revision of manuscripts, and evaluation of the overall content of the article so that research can be systematically arranged according to the rules of scientific writing.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest related to the preparation, authorship, or publication of this article.

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