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Systematic Literature Review: The Effect of Depth of Cut on Surface Roughness in the Lathe Process

Satria Sasikirana[1)*], Muhammad Ikhsanul Hakim[1)], Dafa Indra Praditya[1)], Bagas Ananta Satria Wicaksana[1)], Nafhan Nazal Arifin[1)], Danendra Falla Muhammad[1)]
[1]Department of Mechanical Engineering, Faculty of Engineering, Universitas Negeri Semarang, UNNES Campus Sekaran Gunungpati, Semarang, 50229, Indonesia

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Abstract

Surface roughness is a critical indicator of machining quality because it influences component friction, wear resistance, dimensional performance, and service life. Among the primary turning parameters, depth of cut affects material-removal productivity but may also increase cutting forces, vibration, and surface irregularities. This study systematically examined the effect of depth of cut on surface roughness in turning processes and identified the factors that influence this relationship. A systematic literature review was conducted by searching Scopus, ScienceDirect, Google Scholar, and other relevant academic sources using keywords related to depth of cut, surface roughness, turning processes, and cutting parameters. Articles were selected through identification, screening, eligibility assessment, and final inclusion stages. Twenty Scopus-indexed articles published between 2016 and 2026 met the inclusion criteria and were analyzed descriptively. The findings indicate that increasing the depth of cut generally increases surface roughness because of higher cutting forces, machining vibration, tool loading, and material deformation. However, the magnitude and direction of this effect vary according to workpiece material, feed rate, cutting speed, tool geometry, cooling conditions, and machine stability. Several studies found that feed rate contributed more strongly to surface roughness than depth of cut, demonstrating that machining parameters should not be evaluated independently. Therefore, optimal surface quality requires an integrated selection of depth of cut and other machining parameters. Future research should investigate advanced alloys and composite materials and develop artificial-intelligence-based prediction models to optimize machining productivity, tool life, and surface quality.

✉ Correspondence Address: Sekaran, Gunungpati, Semarang City, Jawa Tengah 50229, Indonesia
E-mail: satria_kirana17@students.unnes.ac.id

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INTRODUCTION

The development of the global manufacturing industry shows a significant increase in the demands of product quality, especially in the aspects of precision and surface quality. The turning process is one of the most widely used machining methods due to its ability to produce components with a high level of accuracy. This process has an important role in determining the final quality of the product because most of the engineering components are produced through the turning method (Arga et al., 2025). In addition, surface quality affects not only aesthetics, but also mechanical performance such as wear resistance and component life. Therefore, controlling cutting parameters is a crucial aspect in improving the quality of manufactured products. Thus, research on the factors that affect surface roughness is very important.

Globally, surface roughness is a key indicator in determining the quality of machining results. The value of surface roughness has a direct effect on the tribological properties and performance of components in the long term (Rifai et al., 2023). In addition, cutting parameters such as rotational speed, feeding rate, and cutting depth have a significant influence on the surface quality of the turning results (Fahrizal et al., 2022). Errors in determining these parameters can lead to increased production costs due to products that do not meet quality standards. Therefore, optimization of cutting parameters is an important need in the modern manufacturing industry. Thus, a comprehensive understanding of the relationship between parameters is indispensable.

Theoretically, the relationship between the cutting parameters and the roughness of the surface is explained through the theory of metal cutting mechanics. The interaction between the chisel and the workpiece results in plastic deformation that affects the texture of the surface (Manta, 2023). Depth of cut as one of the main parameters affects the size of the cutting force and the stability of the machining process. Increasing the depth of cut will increase the load on the chisel so that it can trigger vibrations and increase surface roughness (Arga et al., 2025). The combination of cutting parameters was analyzed using statistical methods to determine optimal conditions (Julianto et al., 2023). This shows that theoretical and experimental approaches complement each other in understanding the phenomenon of surface roughness.

A problem that often occurs in industrial practice is that there is not optimal understanding of the influence of each cutting parameter on surface quality. Determination of cutting parameters is still largely done using a trial and error approach so that production results are inconsistent (Fahrizal et al., 2022). In addition, material variations and cutting conditions cause significant differences in surface roughness (Rifai et al., 2023). There are differences in research findings related to the dominance of parameters, where some studies state that feed rate is more dominant, while other studies show that depth of cut also has a significant influence. This condition shows that there is an inconsistency in research results that leads to a research gap. Therefore, a systematic approach is needed to integrate the various existing findings.

Based on this, this study aims to systematically analyze the effect of depth of cut on surface roughness in the turning process using the Systematic Literature Review method. A systematic approach can help integrate various previously separate research results (Julianto et al., 2023). Literature integration is also able to provide a more comprehensive understanding of the relationships between variables in the machining process (Manta, 2023). Theoretically, this study is expected to enrich scientific studies on the relationship between cutting parameters and surface quality. Practically, the results of this study can be a reference for the industry in determining optimal cutting parameters. Thus, this research has an important contribution in improving the quality and efficiency of the manufacturing process.

Based on the background that has been described, there are still differences in the results of the study regarding the effect of depth of cut on surface roughness in the turning process. Therefore, this study was formulated to examine how the effect of depth of cut on surface roughness based on the results of previous research that was systematically analyzed through the Systematic Literature Review (SLR) method.

LITERATURE REVIEW

A. Turning Process

The turning process is one of the machining processes that is carried out by cutting the material using a cutting tool on a rotating workpiece. This process is widely used in the manufacturing industry because it produces cylindrical shaped components with a high degree of dimensional accuracy. The quality of the turning results is affected by various cutting parameters which include cutting speed, feeding rate, and cutting depth. According to Debnath et al. (2016), the right combination of cutting parameters can improve surface quality while reducing tool wear during the machining process. Therefore, setting cutting parameters is an important aspect in obtaining optimal turning results.

In the turning process, the interaction between the tool and the workpiece results in a cutting force that affects the quality of the surface finish. Changes in cutting parameters can cause changes in cutting conditions, temperature, vibration, as well as the stability of the machining process. Lakshmanan et al. (2023) explain that cutting parameters have a direct relationship to the cutting force, machining temperature, and quality of the resulting surface. In addition, Setyono et al. (2022) stated that the quality of turning results is highly dependent on the ability of cutting parameters to control the process of forming rags and deformation of materials during shearing.

B. Surface Roughness

Surface roughness or surface roughness is a surface characteristic that indicates the degree of texture irregularity resulting from the machining process. Surface roughness is often used as an indicator of product quality because it relates to the functional properties of components, such as wear resistance, friction, and service life. The value of surface roughness is generally expressed using the arithmetic mean parameter (Ra) which describes the deviation of the surface profile from its mean line. According to Putra et al. (2023), the Ra value is the most widely used parameter to evaluate the surface quality of the turning process results because it is able to describe surface conditions quantitatively.

Good surface quality is one of the main goals in the machining process because it affects the performance of components when used. Hernández González et al. (2018) explain that changes in cutting conditions can cause variations in surface roughness values due to changes in the mechanism of anger formation and material deformation. In addition, Huynh et al. (2025) stated that the quality of the turning surface is influenced by the interaction of various cutting parameters that determine the stability of the process and the characteristics of the formed surface. Therefore, controlling surface roughness is an important part of efforts to improve the quality of manufactured products.

C. Depth of cut

Depth of cut is the distance between the initial surface of the workpiece and the surface that has been cut by the chisel in one cut. This parameter indicates the amount of material removed during the machining process and plays a role in determining the productivity of the turning process. The greater the depth of cut value, the greater the volume of material that is cut in a given time. According to Lubis et al. (2025), depth of cut is one of the main parameters that affect the cutting condition because it is directly related to the amount of load received by the tool during the turning process.

Theoretically, increasing the depth of cut can increase the cutting force and the possibility of vibration occurring, potentially affecting the surface quality of the machining results. Sönmez (2024) explains that changes in cutting depth can cause changes in surface characteristics due to increased interaction between the tool and the material of the workpiece. Similar findings were also presented by Doluk et al. (2025) which showed that variations in depth of cut affect the homogeneity and quality of the machining surface. Thus, the depth of cut has a close relationship with surface roughness so it is necessary to conduct a more in-depth analysis to obtain the cutting process conditions that produce optimal surface quality.

RESEARCH METHODS

A. Research Design

This study uses the Systematic Literature Review (SLR) method to identify, evaluate, and synthesize various research results that discuss the effect of depth of cut on surface roughness in the turning process. The SLR method was chosen because it is able to present a systematic, structured, and accountable literature review so as to produce a more comprehensive understanding of a research topic. According to Carrera-Rivera et al. (2022), SLR is a research approach that is carried out through planned stages ranging from search, selection, to analysis of relevant literature. In addition, the use of SLR allows researchers to integrate various research findings that were previously spread across various sources of scientific publications (Dwi Hernanik et al., 2023).

B. Literature Data Collection

Research data is obtained through searching for scientific articles published on various academic databases such as Scopus, ScienceDirect, Google Scholar, and other relevant scientific sources. The search process was carried out using a combination of keywords related to the research topic, namely "depth of cut", "surface roughness", "turning process", "turning machining", and "cutting parameters". The selected article is a scientific publication that discusses the relationship between cutting depth and surface roughness in the turning process. The inclusion criteria include research articles published in scientific journals, available in full-text form, and relevant to the research focus. Meanwhile, articles that do not directly discuss research variables or have incomplete information are excluded from the analysis process.

C. Literature Selection and Analysis

The literature selection process is carried out through the stages of identification, screening, feasibility assessment, and determination of the final article analyzed. The stage aims to ensure that all articles used have quality and relevance in accordance with the research objectives. Smela et al. (2023) explain that a systematic selection process is an important factor in producing a synthesis of valid and transparent literature. Furthermore, articles that meet the criteria are analyzed descriptively by identifying the characteristics of the research, the methods used, and the main findings related to the effect of depth of cut on surface roughness. According to Azarian et al. (2023), analysis in SLR focuses not only on information collection, but also on the synthesis of findings to obtain research patterns and tendencies that can be used as a basis for further research development.

The process starts from identifying articles through various scientific databases, followed by the screening stage based on the suitability of titles and abstracts, full article feasibility assessment, until articles that meet the criteria are obtained for further analysis. These stages are carried out to ensure that the literature used is relevant to the topic of the effect of depth of cut on surface roughness in the turning process.

RESULTS AND DISCUSSION

In this study, 20 articles were obtained that have met the inclusion criteria and will be used as a source of data in the Systematic Literature Review process. The articles come from the international journal Scopus indexed which discusses the relationship between depth of cut and surface roughness in the turning process. A summary of the characteristics of the analyzed articles is presented in Table 1.

Table 1. Characteristics of Articles Reviewed in Research

No.	Author	Year	Research Objectives	Research Methods	Research Results
1	Putra et al.	2023	Optimizing machining parameters against the roughness of the aluminum surface in the CNC lathe process	Method Taguchi	The cutting parameters have an effect on the surface roughness value, and the optimal combination of parameters is able to produce a lower Ra value
2	Hernández González et al.	2018	Analyzes the influence of cutting parameters on surface roughness and material hardness	Machining experiments and analysis of cutting parameters	Variations in cutting parameters affect the surface quality and material characteristics of the machined results
3	Doluk et al.	2025	Examine the effect of *depth of cut* and number of layers on the surface quality of composite materials	Surface experiments and analysis	The increase *in depth of cut* affects the homogeneity and roughness of the machining surface
4	Lakshmanan et al.	2023	Optimizes turning parameters based on surface roughness, cutting force, and temperature	TOPSIS and turning experiments	The cutting parameters affect the surface quality and efficiency of the machining process
5	Lubis et al.	2025	To determine the effect of cutting parameters on the surface roughness of AISI D3 material	Turning experiments	*The depth of cut* and other parameters affect the surface quality of the turning
6	Huynh et al.	2025	Investigating the effect of cutting parameters on *the surface roughness of* C45 steel	Taguchi dan ANOVA	The cutting parameters have different contributions to changes in the surface roughness value
7	Kilickap and Celik	2026	Analyzes the influence of cutting parameters on surface roughness and chisel wear	Full factorial design and GEP	Variations in cutting parameters affect the surface quality and life of the chisel
8	Sönmez	2024	Examine the effect *of feed rate* and *depth of cut* on surface roughness	Turning experiments	*The depth of cut* contributes to changes in surface roughness and fury morphology
9	Setyono et al.	2022	To know the effect of cutting parameters on the surface roughness of the tool steel	Turning experiments	The quality of the surface is affected by the combination of cutting parameters used
10	Debnath et al.	2016	Analyze the influence of cutting fluid conditions and cutting parameters	Taguchi method	Cutting and cooling parameters affect surface roughness and chisel wear
11	Ghazali et al.	2019	Compare the influence of machining parameters on different types of materials	Experiment comparatif	The effect of the cutting parameters on the roughness of the surface differs in each material
12	Mubarok et al.	2023	Investigating the influence of machining parameters on surface roughness and wear of ST-42 steel chisels	Exploratory experience	Changes in cutting parameters affect the surface quality and condition of the chisel
13	Baba and Tumba	2025	To determine the effect of cutting speed and *depth of cut* on the Ra value of AISI 1027 steel	Turning experiments	*Depth of cut* shows the relationship to the change in the roughness value of the surface
14	Zurita et al.	2018	To examine the effect of cutting parameters on the surface roughness of AISI 1020 steel	Turning experiments	Variations in cutting parameters result in different levels of surface roughness
15	Rajman	2021	Knowing the influence of the type of chisel on the surface roughness of the workpiece	Turning experiments	The characteristics of the tool affect the quality of the machining surface.

16	Hossain et al.	2025	Optimizes the cutting temperature and surface roughness at the Ti-6Al-4V turning	Response Surface Methodology (RSM)	The combination of certain cutting parameters is capable of producing better surface quality
17	Nisar et al.	2021	Investigate the influence of process parameters on surface roughness and dimensional accuracy	Grey-Based Taguchi Method	The cutting parameters affect the surface roughness and accuracy of the machining results
18	Kónya et al.	2024	Analyze the influence of cutting parameters on cutting force and surface properties	Experiential dry turning	Changes in cutting parameters affect the surface characteristics of the turning results
19	Demirpolat et al.	2023	Compare chisel wear, surface roughness, cutting force, and temperature during turning	Experiment comparatif	Surface quality is related to the cutting conditions and performance of the chisel
20	Bhushan	2020	Examine the influence of nose radius and machining parameters on surface roughness	Experiment and analysis of parameters	The roughness of the surface is affected by the combination of the cutting parameters and the geometry of the chisel

A. Characteristics of Reviewed Research

Based on the results of the literature selection, 20 international articles were obtained indexed by Scopus that met the inclusion criteria and were used in the study process. The articles were published in the 2016–2026 period, with the majority of publications coming from the 2021–2025 period. This condition shows that research on the influence of cutting parameters on surface quality is still a relevant topic in manufacturing and machining. The high number of publications in the last five years also indicates that there is a growing focus on optimizing the turning process to produce better surface quality and increase production efficiency.

The materials used in these studies show quite wide variations. Some studies use carbon steel such as AISI 1020, AISI 1027, and C45, while other studies use stainless steel, tool steel, aluminum alloy, and composite materials (Zurita et al., 2018; Baba & Tumba, 2025; Doluk et al., 2025). Material variations lead to different cutting criteria because each material has different mechanical properties, such as hardness, tensile strength, and resistance to plastic deformation. The effect of depth of cut on surface roughness did not always show the same value in every study, although the pattern tendencies were relatively similar.

From the methodological aspect, most of the studies used an experimental approach with optimization methods such as Taguchi, ANOVA, Response Surface Methodology (RSM), TOPSIS, and full factorial design. The Taguchi method is one of the most frequently used approaches because it is able to determine the optimal combination of cutting parameters with a more efficient number of experiments (Putra et al., 2023; Huynh et al., 2025). Several studies combine statistical and optimization methods to gain a deeper understanding of the relationship between cutting parameters and the surface quality of machining results. The use of diverse methods shows that research in this field focuses not only on empirical observations, but also on efforts to develop optimization models that can be applied in industrial practice.

The results of the review show that depth of cut is rarely studied as a single variable. Most studies combine feed rate and cutting speed because these three parameters are directly related to the process of forming anger and the quality of the surface of the turning. Some studies even include additional variables such as the type of chisel, the radius of the chisel, the cutting temperature, and the use of coolant to obtain a comprehensive picture of the machining process (Debnath et al., 2016; Bhushan, 2020; Rajmane & Sodal, 2021). This shows that the surface quality is the result of the interaction of various cutting parameters that affect each other during the turning process.

B. Effect of Depth of cut on Surface Roughness on the Turning Process

Based on the results of synthesis from various reviewed studies, a general pattern was found that the depth of cut has an influence on the value of surface roughness in the turning process. Most studies show that an increase in depth of cut tends to be followed by an increase in surface roughness values, although the degree of effect differs on each material and cutting conditions. These findings can be seen in the research of Sönmez (2024), Lubis et al. (2025), and Baba and Tumba (2025) which showed that changes in the depth of the cut resulted in changes in the surface characteristics of the workpiece after turning. Thus, depth of cut is categorized as one of the important parameters that need to be considered in an effort to produce better surface quality.

Theoretically, increasing the depth of cut will increase the cross-sectional area of the material slashed by the chisel so that the resulting cutting force becomes larger. This condition causes the working load of the tool to increase and has the potential to cause deformation in the machining system. Lakshmanan et al. (2023) and Kónya et al. (2024) explain that increased cutting force due to changes in cutting parameters can affect the contact conditions between the tool and the workpiece. When the cutting force increases excessively, the stability of the cutting process may decrease, resulting in a less smooth surface than a more stable cut.

In addition to being related to the cutting force, the effect of depth of cut on surface roughness can also be explained through the phenomenon of vibration or chatter that occurs during the turning process. Greater cutting depths generally result in higher excitation forces thus increasing the likelihood of vibrations appearing in machine systems, chisels, and workpieces. According to Mohan et al. (2021), changes in cutting conditions affect the morphology of the sore and the quality of the surface formed during the machining process. Similar findings were also described by Demirpolat et al. (2023) which showed a relationship between cutting conditions, cutting force, temperature, and surface quality of turning results. Therefore, an increase in depth of cut that is not offset by other suitable parameters leads to a decrease in surface quality.

However, the results of the review show that the effect of depth of cut is not always the most dominant factor compared to other parameters. Several studies have found that feed rate has a greater influence on surface roughness than depth of cut, especially on certain materials and certain cutting conditions (Yousefi & Zohoor, 2019; Setyono et al., 2022). However, almost all studies agree that depth of cut still contributes to changes in surface quality because it is related to the mechanism of material cutting. Based on the results of the literature synthesis, it is understood that the relationship between depth of cut and surface roughness is complex because it is influenced by interactions with other cutting parameters. Determining the optimal depth of cut value needs to consider the overall machining conditions in order to obtain surface quality that is in accordance with manufacturing needs.

C. Factors Affecting the Relationship between Depth of Cut and Surface Roughness

The results of the review show that the relationship between depth of cut and surface roughness does not stand alone, but is influenced by other cutting parameters. One of the most commonly found factors is the feed rate. Some studies report that an increase in feed rate results in a greater influence on surface roughness than depth of cut. Sönmez (2024) shows that the combination of high feed rate and large depth of cut results in a higher surface roughness value than an increase in depth of cut alone. Similar findings were also reported by Putra et al. (2023) and Huynh et al. (2025), who stated that the interaction between cutting parameters needs to be well considered to obtain optimal surface quality.

In addition to feed rate, cutting speed is also an important factor that affects the turning results. In general, the increase in cutting speed tends to result in a smoother surface because the cutting process takes place more stably and the formation of built-up edges can be reduced. Baba and Tumba (2025) found that the combination of high cutting speed with moderate depth of cut was able to produce lower surface roughness values compared to the combination of low speed and large cutting depth. These results are in line with the research of Yousefi and Zohoor (2019) who explained in their findings that surface quality is influenced by the complex interaction between cutting speed, feed rate, and depth of cut, so the influence on each parameter cannot be evaluated separately.

Differences in the material characteristics of the workpiece are also the cause of variations in results between studies. High-hardness materials or complex microstructures tend to produce different responses to changes in depth of cut. Research by Lubis et al. (2025) on AISI D3 material shows that an increase in cutting parameters can significantly increase surface roughness due to the high resistance of the material to the cutting process. In contrast, Putra et al. (2023) who examined aluminum found that changes in cutting parameters had a relatively smaller impact on surface quality. These findings show that the mechanical properties of materials such as hardness, ductility, and wear resistance also determine the magnitude of the influence of depth of cut on surface roughness.

Other factors that also affect the relationship are the geometry of the chisel and the use of cutting fluid. Rajmane and Sodal (2021) explain that the appropriate geometry of the chisel tip can improve the quality of the surface by reducing the concentration of tension during the cutting process. In addition, Debnath et al. (2016) found that the use of cutting fluid was able to reduce cutting temperature and reduce chisel wear, so that the surface of the turning became smoother. Mohan et al.'s (2021) research also shows that dry turning conditions can produce different surface characteristics compared to processes that use refrigeration. Therefore, the differences in the results between studies regarding the effect of depth of cut on surface roughness are explained by variations in cutting conditions, material characteristics, and the configuration of the cutting tools used.

D. Synthesis of Findings and Implications for the Turning Process

Based on the results of the review of 20 articles that met the inclusion criteria, it can be concluded that the depth of cut is one of the important parameters that affect the surface quality of the turning. Most studies show a tendency to increase the value of surface roughness along with the increase in depth of cut. This condition occurs because a greater depth of cut increases the contact area between the tool and the workpiece, resulting in increased cutting forces, vibration, and material deformation. The findings were found consistently in different types of materials and machining conditions although the degree of influence varies (Sönmez, 2024; Baba & Tumba, 2025; Lubis et al., 2025).

However, the results of the review also show that depth of cut is not the only parameter that determines the quality of the surface. In many studies, feed rate and cutting speed actually contribute more dominantly to changes in surface roughness values. Therefore, the determination of the optimal depth of cut needs to be done simultaneously with the setting of other cutting parameters. Lakshmanan et al. (2023) and Huynh et al. (2025) affirm that the right combination of parameters is able to produce a balance aspect between machining productivity and desired surface quality. In other words, increasing productivity through the use of large depth of cut must still consider the risk of degrading the quality of turning results.

From the perspective of the manufacturing industry, these findings have important practical implications. In mass production processes, increased depth of cut is often used to speed up material release and reduce machining time. However, if not balanced with other appropriate parameter settings, surface quality can decrease and potentially increase costs due to the need for additional finishing processes. Therefore, the industry needs to implement a machining parameter optimization approach by considering the material characteristics, the type of chisel, the cooling condition, and the product quality target to be achieved (Demirpolat et al., 2023; Hossain et al., 2025).

The results of this review also show that there are several research gaps that can still be developed in the future. Most research still focuses on conventional metal materials such as carbon steel, alloy steel, and aluminum, while research on composite materials or modern engineering materials is still relatively limited. In addition, the development of prediction models based on artificial intelligence and machine learning to predict the relationship between depth of cut and surface roughness still has great opportunities for further research. Thus, further research can be directed to the integration of modern optimization technology to obtain cutting parameters that are more efficient and adaptive to various turning process conditions.

CONCLUSION

Based on the results of the Systematic Literature Review of 20 articles that met the inclusion criteria, it was concluded that the depth of cut had an effect on surface roughness in the turning process. Increased depth of cut tends to increase surface roughness due to increased cutting forces, vibrations, and deformation during the machining process. However, these influences are also influenced by other parameters such as feed rate, cutting speed, material type, sculpting geometry, and coolant usage. Therefore, the optimal surface quality is determined not only by the depth of cut, but also by the appropriate combination of cutting parameters. Integrated control of machining parameters is an important factor to produce good surface quality while maintaining the efficiency of the turning process.

Further research is suggested to examine the effect of depth of cut on more diverse materials, such as composite materials and advanced alloys that are increasingly used in the manufacturing industry. In addition, the research is directed at the development of predictive models based on artificial intelligence or machine learning to determine the optimal combination of cutting parameters. For industry practitioners, the selection of depth of cut should consider its interaction with other cutting parameters in order to achieve a balance between productivity, tool life, and surface quality of the turning.

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AUTHOR'S CONTRIBUTION

The author is fully responsible for all stages of research which include problem identification, data collection and analysis, literature review, manuscript preparation, article revision, and article finalization.

CONFLICT OF INTEREST

The author states that there is no conflict of interest in the implementation of research, preparation, or publication of this article. The author also stated that there are no financial, professional, or other interests that can affect the objectivity of the research results presented.

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