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Critical Success Factors of ICT Implementation in Vocational High Schools

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ABSTRACT

Implementing Information and Communication Technology (ICT) in Vocational High Schools (SMK) plays a crucial role in enhancing the quality of learning, improving administrative efficiency, and preparing students for a technology-driven workforce. However, its implementation still faces various challenges, such as limited infrastructure, the readiness of educators, and uneven policy support. This study aims to identify the Critical Success Factors (CSFs) in ICT implementation in SMKs and analyze the challenges and opportunities for its development. A qualitative approach was employed, utilizing interviews with teachers, school principals, and students from various vocational schools to obtain a comprehensive perspective on ICT adoption in vocational education. The findings reveal eight key factors contributing to the success of ICT implementation: infrastructure availability, teacher competence, the role of school principals, government policy support, student engagement, curriculum integration, digital ethics, and continuous evaluation and monitoring. The study concludes that the success of ICT implementation heavily depends on the synergy between schools, the government, and industry. Therefore, more effective strategies are needed to ensure equitable access to technology, enhance teacher competencies, and strengthen digital-based curricula to optimize ICT to produce competitive SMK graduates in the Industry 4.0 era

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1. INTRODUCTION

The success of implementing Information and Communication Technology (ICT) in education is influenced by various factors, including in Vocational High Schools (SMK). Many developed and developing countries have realized the importance of investing in the education sector, especially in educational technology. This is an important tool to educate and equip students with the skills to prepare them for future challenges [1][2]. The real gap currently occurs between those who can access ICT and those who do not. Therefore, ICT has become an important resource in the teaching and learning environment and a major tool for improving the quality of education [3][4]. In vocational schools, ICT can increase student involvement in the learning process more actively, compared to traditional teaching methods that tend to make students passive observers [5]. In addition, ICT also encourages collaborative learning, improves problem-solving skills, and provides more flexible learning opportunities for vocational school students [6][7]. In an era that increasingly demands ICT skills for a job, mastery of technology among vocational school students is also a crucial factor in preparing them to meet the demands of the labor market [8].

However, although many countries allocate significant funds to education and ICT, its implementation still faces challenges, including in Bengkulu City. One of the obstacles faced is limited resources, such as hardware, software, and adequate internet access in several vocational schools. Other factors that play a role in the success of ICT implementation include infrastructure readiness, teacher competence in managing technology, and a curriculum that supports the integration of ICT in learning [9]. In addition, support from government policies at the regional and national levels also greatly influences the effectiveness of ICT implementation in vocational schools. In Indonesia, one of the government's supports in ICT implementation is the Indonesian Ministry of Education and Culture (Kemendikbud) program, namely PembaTIK. PembaTIK aims to improve teacher competence through ICT training and procurement of digital resources. This program supports teachers in integrating ICT into the learning process, ultimately improving the quality of education in vocational schools [10]. In addition, the Indonesian government has introduced an E-Government initiative to improve public services, including in the education sector. Through Presidential Instruction No. 6/2001, the government encourages the use of ICT in educational administration to improve the management and operational performance of vocational schools [11]. Similar efforts need to be made, especially in Bengkulu City, to improve the quality of education by providing adequate facilities and implementing training.

However, to implement ICT effectively in vocational schools in Bengkulu City, it is necessary to identify various factors that influence its use, such as school readiness, teacher competence, education policies, and long-term planning in resource development. A study published in the International Journal of Education and Development using Information

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and Communication Technology emphasized that the integration of ICT in education can help teachers replace traditional teaching methods with technology-based tools. This integration is very important in transforming the education system to suit the needs of future developments [3]. Likewise, research in the same journal shows that teachers need to have confidence and competence in using various ICT tools to build trust in technology. Without teacher competence and mastery of skills in ICT integration, the potential benefits of technology in education cannot be fully realized [12].

The International Institute for Educational Planning notes that ICT can have an impact on student learning if teachers have digital literacy and understand how to integrate it into the curriculum. This emphasizes the importance of teacher training and curriculum development in the successful implementation of ICT in education [13]. In addition, a study published in PhilArchive discusses critical factors for optimizing ICT integration in education. The alignment of technology use with learning objectives emerges as a fundamental and effective aspect of pedagogical integration [14]. This insight as a whole shows that effective ICT implementation in education depends on strategic planning, teacher competence, and alignment with educational objectives. Addressing these factors is essential to be able to utilize ICT in improving the learning process.

Therefore, a deeper understanding of the factors that influence ICT implementation, such as technology readiness, teacher skills, education policies, and funding, is essential to analyze to improve the quality of education and ensure that vocational high school students acquire the skills needed to face future challenges [15]. These factors must be carefully considered so that the implementation of ICT in vocational high schools in Bengkulu City can be optimized, which ultimately helps prepare students for success in a technology-based and ever-evolving workforce [16].

2. RESEARCH METHOD

This study employed a semi-structured interview method with a purposive sampling technique, targeting principals, teachers, and students from vocational high schools in Bengkulu City. Semi-structured interviews were chosen because they allow researchers to obtain detailed and comprehensive information from respondents, while still maintaining alignment with the study's objectives and main research questions [17]. A case study approach was applied, as the research focused on a specific unit of analysis, namely the implementation of ICT in vocational high schools in Bengkulu City. This approach enables in-depth exploration of the phenomenon in its real-life context, considering various influencing [18].

The study was grounded in the philosophy of critical realism, which emphasizes deeper investigation to understand and explain why certain events occur, as well as to explore the underlying structures and mechanisms shaping social phenomena [19]. In this context, the study examined the conditions, challenges, barriers, and enabling factors

affecting ICT implementation in vocational high schools, involving human, technological, process-related, policy, and financial aspects.

Data collection was conducted through informal yet semi-structured interviews [20][21], which offered flexibility for follow-up questions during and after the interview session [22][23]. The unit of analysis comprised actors directly involved in ICT implementation at vocational high schools in Bengkulu City.

For data analysis, the study used *template analysis*, which involves developing a list of codes (a "template") representing themes identified in the textual data [24][25],This method offers flexibility, enabling researchers to refine codes as the analysis progresses, ensuring alignment with the research focus [23].

3. RESULTS AND DISCUSSION

This study involved three main groups as informants namely teachers, principals, and students from various vocational schools. Each group has a different perspective on the implementation of ICT in the school environment, including the benefits felt, challenges faced, and hopes for its development in the future.

The group of teachers in this study consisted of 10 people with diverse teaching experiences. Several teachers have participated in various training related to ICT, such as Web Design, Canva AI, Adobe Animate, and the creation of technology-based learning media, which make it easier to integrate technology into the teaching and learning process. However, there are still teachers who have never received formal training, so they face difficulties in optimizing the use of technology in learning. In addition, although some teachers have used devices such as laptops, InFocus, and various learning software, limited facilities and a lack of motivation to utilize technology are still obstacles for some of them.

In addition to teachers, this study also involved five principals, who have strategic roles in planning, budgeting, and evaluating the implementation of ICT in their respective schools. From the interviews conducted, it was found that ICT has been integrated into school learning and administration, but there are still many challenges. Several principals expressed that lack of infrastructure, budget constraints, and unstable internet access, especially in remote areas, were the main inhibiting factors in the implementation of ICT. In addition, they also tried to ensure that ICT could be used more widely, not only in learning but also in school administration processes, data management, and communication between teachers and education personnel.

The last group of informants were 10 vocational high school students from various majors, such as Graphic Design, Computer and Network Engineering, and Office Administration. Students generally gave a very positive view of the implementation of ICT in their schools to support a more innovative and interactive learning process. Some students are already accustomed to using software such as CorelDRAW, Adobe Illustrator, Microsoft Office, and Google Classroom, which help them develop skills according to their

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respective fields of expertise. However, access to ICT devices in their schools is not evenly distributed, resulting in not all students being able to learn with the same facilities. In addition, they also emphasized the importance of learning materials that are more applicable to industry needs so that they are better prepared to face the challenges of the increasingly technology-based world of work.

A summary of the categories and roles of informants involved in this study is shown in Table 1.

Tabel 1. Categories and Roles of Informants

No	Informant Category	Number of Informan	Role in Research	Aspects Studied
1	Teachers	10	Educators implementing ICT in learning	1) Use of ICT in the teaching and learning process 2) Readiness and competence in using ICT 3) Challenges in technology adoption 4) Training and support obtained
2	Principals	5	Policy makers and school administrators	1) Planning and policies related to ICT 2) Budget and procurement of ICT devices 3) Evaluation and monitoring of ICT implementation 4) Challenges in managing ICT facilities
3	Students	10	Main users of ICT in learning	1) Experience in using ICT in schools 2) Access to digital devices and applications 3) Readiness in facing the world of technology-based work 4) Challenges in using ICT

The results of the analysis found that the majority of informants highlighted the importance of the availability of hardware and software needed for learning. The principal stated that the quality of computers, internet connectivity, and electricity stability are still the main obstacles in several schools. As expressed by R1, "*The quality of computers and software in our school is quite good, but the internet connection is often problematic*". Students also expressed that although some schools have complete computer laboratories, access to ICT devices is still not optimal for all students. This opinion is in line with the statements of R18 and R20: "*Computer laboratories are available, but the number of devices is still lacking to meet the needs of all students*". The teacher added that infrastructure needs to be updated regularly to remain relevant to technological developments (R05, R07, R12). In addition, vocational schools in remote areas still face obstacles in internet access and electricity stability, as stated by R2: "*Vocational schools in remote areas still experience obstacles in internet access and unstable electricity*".

Teacher readiness is one of the key factors in the success of ICT implementation. Interviews showed that not all teachers have adequate skills in using ICT in learning (R06, R07). Some teachers have attended training like ICT Guidance, Web Design, Canva AI, and

Adobe Animate, but there are still those who have never received any training (R10, R12, R13). Informant R10 explained, "*I have attended Canva AI and Adobe Animate training, so I am quite confident in using ICT for learning*." However, several other teachers admitted that they had never attended ICT training. R06 and R07 stated, "*There has never been any ICT training in our school, so many teachers are not used to using it in teaching*." This statement was also mentioned by R08 and R11, "*We use laptops and inFocus in learning but more training is needed to optimize its use.*" Several teachers also emphasized that they needed more training to utilize technology optimally in the teaching and learning process. In addition, teachers' skills in using devices such as laptops, InFocus, and learning software still vary, depending on the experience and training they have received.

Principals play a significant role in supporting ICT implementation. They are responsible for planning, procuring devices, and ensuring the use of technology in schools (R01, R02). Informant R01 explained, "*The principal must plan the procurement of ICT devices in the RKAS so that the school can meet technology needs*." Several principals emphasized that they had included ICT procurement in the RKAS (School Activity and Budget Plan) and supervised its implementation in learning (R03, R04). In addition, the principal also acts as a motivator and facilitator for teachers in the use of ICT (R06, R07). As conveyed by R06 and R07, "*The role of the principal is very important in ensuring that teachers and students can use ICT optimally*." However, challenges remain. Several principals stated that they still face constraints in terms of budget and uneven distribution of devices across schools (R09). R09 added, "*Our main constraint is the limited budget, making it difficult to develop ICT facilities further*."

On the other hand, the government plays a role in providing infrastructure, policies, and budgets to support the implementation of ICT in schools. Several principals stated that the government has assisted with computer devices and internet access, but the distribution is still uneven (R01, R02, R10). As expressed by R01, "*The government has assisted with computers and internet access, but the distribution is still uneven*." Teachers also emphasized the importance of clearer regulations and proper allocation of funds so that all schools can implement ICT optimally (R06, R07). One teacher, R06, said, "*We need clearer policies regarding the integration of ICT in learning so that its implementation is comprehensive.*" Meanwhile, some students said that although their schools had received assistance with devices, some still felt that the facilities were inadequate, this was mentioned by R22, "*Our school has not received assistance with devices, so it still relies on existing resources*."

Students generally have a positive attitude towards ICT and consider it a significant part of learning (R18, R19, R21). Some students have learned software such as CorelDRAW, Adobe Illustrator, and network engineering, but some have not received additional training outside the school curriculum (R20, R25). As conveyed by R18, "*I often use CorelDRAW and Adobe Illustrator in learning because I want to hone my graphic design skills.*" However, limited facilities are an obstacle for some students. R25 stated, "*Students in our school want to learn more about programming, but the facilities are still limited.*" This opinion was also reinforced by

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R23, "*We need more access to computers so that all students can practice well.*" In addition, students want wider access to ICT devices and more applicable learning materials to support their skills in the world of work (R23, R24).

Teachers and principals believe that ICT should be integrated into the curriculum to make it more applicable and relevant to industry needs (R06, R07, R10). Several schools have used digital learning platforms such as Google Classroom, Microsoft Teams, and other interactive applications (R24). As explained by R24, "*We use Google Classroom and Microsoft Teams to support online learning.*" This opinion was also reinforced by R12, "*ICT subjects need to be more applicable and adapt to the industrial world so that students are ready to face work challenges.*" However, several teachers felt that ICT materials were still too theoretical and had not fully adapted to the needs of the world of work (R12, R13, R15). R12 said, "*ICT-based learning is very helpful, but not all teachers use this method optimally.*" Therefore, further efforts are needed to ensure that the integration of ICT in learning can truly improve students' skills according to industry needs.

The importance of digital ethics in the use of ICT is also a concern for informants. Teachers and principals emphasize that religious and moral values must be the basis for utilizing technology (R06, R07, R08). As mentioned by R06, "Religion and moral values are very important in guiding students not to misuse technology." Students also understand that ICT must be used positively and responsibly, especially in facing the challenges of the digital era such as misuse of social media and plagiarism (R13, R19, R26). R13 said, "We want to ensure that students use ICT for positive purposes, such as learning and creativity." This statement is also supported by R26, "Digital ethics must be taught so that students understand the limits of using technology."

Evaluations of ICT implementation should be periodically to measure its effectiveness in improving the quality of learning (R01, R02, R03). As expressed by R01, "*Evaluation of ICT implementation should be periodically to determine its effectiveness.*" This was reinforced by R02, "*Schools need to have a monitoring system so that all teachers and students truly utilize ICT in learning*." Teachers also proposed a better monitoring mechanism to ensure optimal utilization of ICT (R06, R09). R09 explained, "*Without clear evaluation, it is difficult to know whether the use of ICT has been effective*." Therefore, a more structured strategy is needed to measure the extent to which ICT has had a positive impact on learning.

Based on the analysis, eight main factors contribute to the successful implementation of Information and Communication Technology (ICT) in Vocational High Schools (SMK). These factors reflect crucial aspects that need to be considered in supporting the effective implementation of ICT in terms of infrastructure, human resource readiness, and supporting policies. Table 2 presents a list of Critical Success Factors (CSF) identified in this study, including the number of informants who revealed the factors and the respondent codes involved.

Table 2. Critical Success Factors for ICT Implementation of Vocational High Schools Bengkulu City

No	Respondent (Informant Code)	Number of Informants	Critical Success Factors (CSF)
1	R01, R02, R05, R07, R09, R10, R12, R18, R20, R23	10	Availability of Adequate Infrastructure and Technology
2	R06, R07, R08, R10, R11, R12, R13, R15, R16, R18, R20, R23	12	Teacher Competence and Readiness in Using ICT
3	R01, R02, R03, R04, R06, R07, R09	7	The Principal's Strategic Role in Encouraging ICT Implementation
4	R01, R02, R04, R06, R07, R10, R12, R22	8	Government Policy and Regulation Support
5	R18, R19, R20, R21, R22, R23, R24, R25, R26	9	Student Engagement and Readiness in ICT-Based Learning
6	R06, R07, R08, R09, R10, R11, R12, R13, R15, R24	10	Integration of ICT in Curriculum and Learning Methods
7	R06, R07, R08, R13, R19, R26	6	Digital Ethics and Awareness in Using ICT
8	R01, R02, R03, R06, R09	5	Continuous Evaluation and Monitoring

Table 3 below provides a detailed description of each factor. Table 3 explains the reasons why each factor is important in the implementation of ICT in SMK.

Table 3. Detailed description of CSF in ICT Implementation in Vocational High Schools

N0	Critical Success Factors (CSF)	Rincian
1	Availability of Adequate Infrastructure	Adequate infrastructure is essential to support ICT implementation.
2	Teacher Competence in Using ICT	Trained teachers will be more effective in using ICT in learning.
3	Strategic Role of School Principals	Principals must ensure planning, procurement, and evaluation of ICT implementation.
4	Government Support	Clear policies and an equitable budget are essential
5	Student Engagement	Students must have adequate access and training to master ICT.
6	Integration in Curriculum	ICT-based learning must be more applicable and in line with the industrial world.
7	Digital Ethics	Ethical awareness in the use of technology must continue to be instilled.
8	Continuous Evaluation and Monitoring	There must be regular evaluations so that ICT implementation runs effectively and sustainably.

4. CONCLUSION

Conclusion This study aims to identify the critical success factors (CSF) in the implementation of Information and Communication Technology (ICT) in Vocational High Schools (SMK). Based on the results of the analysis of interviews with teachers, principals, and students, it was found that the implementation of ICT has had a positive impact on improving the quality of learning, supporting the efficiency of school administration, and equipping students with digital skills relevant to the world of work. However, the

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implementation of ICT in SMK still faces various challenges that require strategic solutions so that technology can be utilized optimally and evenly.

One of the main factors in the success of ICT implementation is the availability of adequate infrastructure, including hardware, software, internet access, and stable electricity. Schools that have complete facilities tend to be more effective in implementing ICT compared to schools that still experience limited resources. In addition, teacher competence and readiness in using ICT are also crucial factors. Teachers who have received training can better integrate technology into learning, while teachers who are less trained often have difficulty optimizing the available devices. Therefore, improving teacher skills through ongoing training should be a top priority in developing technology-based education policies.

The role of the principal as a strategic leader in ICT implementation is also an important aspect. Principals who are proactive in planning, budgeting, and evaluating the use of ICT can encourage more systematic and sustainable technology implementation. However, challenges in budget management and facility distribution are still obstacles, so government support in the form of clearer policies and regulations and equitable funding is needed. In addition, student involvement and readiness in ICT-based learning are also factors that cannot be ignored. Students who have access to technology and adequate training are more prepared to face the world of work compared to those who still experience limited facilities and digital-based learning materials.

In the context of ICT integration in the curriculum, it was found that the use of digital platforms such as Google Classroom, Microsoft Teams, and technology-based learning applications have been implemented in several schools but are still uneven. It is necessary to develop a curriculum that is more applicable and in line with industry needs so that students not only understand the basic concepts of ICT but can also improve student skills according to industry needs. In addition, digital ethics and moral awareness in the use of ICT are aspects that need to be strengthened so that technology is not misused and continues to provide maximum benefits for education.

In terms of development prospects, the results of this study can be used as a basis for designing a more effective ICT implementation strategy in vocational schools, by considering equal access to technology, improving the skills of educators, and routine evaluation of the effectiveness of ICT use in learning. The application prospects of this research can also be developed on a wider scale by conducting comparative studies on ICT implementation in various types of vocational schools, both in urban and rural areas, to obtain a more comprehensive picture of the challenges and solutions that suit the needs of each school.

In the future, this research can be further developed by exploring how industry involvement supports the implementation of ICT in vocational schools, especially in the provision of devices, training for teachers, and internship opportunities for students in technology-based companies. In addition, further research can examine the effectiveness of

digital-based learning models and their impact on the work skills of vocational school students. With the right strategy and synergy between schools, government, and industry, the implementation of ICT in vocational schools can be one of the main pillars in producing competitive graduates who are ready to face the challenges of the digital era.

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