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IMPACT OF IT KNOWLEDGE ON REDUCING FAULT RATES IN INDUSTRIAL COMPUTERS

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ABSTRACT

This study investigates the impact of users' information technology (IT) knowledge on the fault rate of industrial computers, particularly in manufacturing settings where such systems are integral. The importance of IT knowledge becomes evident in industries such as manufacturing plants, where the use of industrial computers is prevalent. Detecting and addressing the fault rate of these computers is crucial for saving time, minimizing damage, and making resource utilization a top priority across various industries. This research highlights that higher levels of IT knowledge among users can significantly decrease system faults, leading to improved operational efficiency and reduced downtime. Data is collected from stopped workstation reports and users' educational backgrounds, focusing on IT-related training. Statistical analyses support the hypothesis that better IT education correlates with lower fault rates. Based on these findings, the study recommends that companies invest in comprehensive IT training programs for their workforce to enhance system reliability and performance.

Keywords: Information Technology, Industrial Computers, IT Training, Knowledge Management, Human-Computer Interaction

1. INTRODUCTION

Industrial computers are pivotal in modern manufacturing, controlling processes and machinery critical to production lines. A minor malfunction in these systems can halt operations, leading to significant financial losses (Singh et al. 2004). These computers endure harsh conditions such as temperature extremes, electrical stress, and mechanical vibrations, necessitating robust design and maintenance. Unlike conventional computers, they have a longer lifespan and are subjected to unique operational demands (Barroso and Wilson, 2000; Riera, 2001). Their primary function is to ensure seamless operation within industrial environments, where any disruption can have severe temporal and economic repercussions (Choi et al., 2022).

Human error, defined as any unintended or incorrect action by individuals operating these systems, is a critical factor influencing fault rates. Such errors include misinterpretation of instructions, procedural mistakes, and lapses in attention, all of which can degrade system performance and reliability (Brown and Duguid, 1998). Industrial computers are essential in environments prone to power surges and temperature variations, where they must be resistant to electrical shocks and capable of real-time command execution. The complexity of tasks in these environments often requires operators to make intricate decisions, which underscores the importance of adequate IT knowledge and literacy among users (Li and Wieringa, 2000).

Information technology (IT) knowledge, encompassing familiarity with hardware, software, and troubleshooting, is crucial for maintaining these systems. IT literacy extends this knowledge to include the

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practical application of IT principles in diagnosing and resolving system faults, optimizing performance, and minimizing disruptions (Sriram, 2012). Effective knowledge management within organizations plays a significant role in maintaining competitive advantage by enhancing decision-making, creativity, and innovation (Sadq et al., 2020; Ode and Ayavoo, 2020). The cost of training and the strategic value of skilled employees highlight the necessity of knowledge management systems that facilitate the capture and utilization of both explicit and tacit knowledge (Jafari et al., 2008; Zagzebski, 2017).

Industrial environments require a high level of IT knowledge for effective operation and maintenance of computer systems. Research indicates that better IT training and knowledge lead to fewer system faults and improved operational efficiency (Dai and Gao, 2013). Maintenance, which includes managing hardware and ensuring proper ventilation, is critical in preventing downtime and extending the lifespan of these systems. The advent of wearable cognitive assistants, which facilitate access to information and support operators in managing their workload, further underscores the importance of IT literacy in industrial settings (Belletier et al., 2019).

This study aims to investigate the correlation between users' IT knowledge and the fault rate of industrial computers. By examining production lines with frequent stoppages and analyzing the IT-related training completed by users, the research seeks to demonstrate the significance of IT proficiency in maintaining system reliability. This involves reviewing reports and assessing training outcomes, with the goal of highlighting the broader implications of IT knowledge in fault prevention and minimizing production disruptions.

In addition to examining IT knowledge, the study will explore the role of both tacit and explicit knowledge in influencing system performance. Tacit knowledge, gained through user experience, and explicit knowledge, acquired through formal training, will be assessed to understand their impact on system reliability (Shahzad et al., 2024). By triangulating data from various sources, including qualitative interviews and documented work experience, the research aims to provide a comprehensive understanding of how different forms of knowledge contribute to reducing industrial computer faults.

The remainder of this paper is structured as follows. Section 2 presents the methodology employed in this study with respect to the data collection processes, including the types of data gathered and the statistical method. Section 3 considers experiment analysis and provides an examination of the correlation between users' IT knowledge and the fault rate of industrial computers. Section 4 delves into the discussion and explore the limitations of the study to ensure a comprehensive understanding of the implications. Section 5 concludes the paper by summarizing the key findings and outlining suggestions for future research by emphasizing the importance of continued exploration into the impact of IT knowledge on industrial system performance.

2. RESEARCH METHODOLOGY

This section outlines the research methodology adopted to investigate the correlation between users' IT knowledge and the fault rate of industrial computers. The approach includes data collection, quality control, and verification methods.

2.1. DATA COLLECTION

Data was collected through inspection forms and human resource records to assess the IT knowledge and work experience of operators using industrial computers in production lines. The process involved examining inspection forms from halted workstations to identify operators and their work history. This six-year study gathered data from 58 production line operators, documenting each fault and stoppage, including the time, cause, actions taken, and personnel involved.

2.1.1. USAGE OF INSPECTION FORMS

The initial step in data collection involved reviewing inspection forms from halted workstations to identify those equipped with industrial computers. The operators' identities were determined, and their records were assessed to evaluate their work experience and completed courses. The data provided insights into the operators' tacit knowledge based on their work history.

2.1.2. Quality Control Measures

Quality control measures ensured the accuracy of data collection. Inspection forms were reviewed and validated by trained personnel before distribution. Training sessions familiarized data collectors with the correct procedures for completing forms and identifying relevant data points. Periodic audits were conducted to maintain data reliability and address discrepancies.

2.1.3. Access and Verification of Human Resources Records

Collaboration with the human resources department facilitated the collection of employees' educational backgrounds, training histories, and work experiences. Verification involved comparing human resources documents with employee-provided details to confirm the accuracy of data. Any discrepancies were resolved through direct communication with employees or by consulting additional documentation from stakeholders.

2.2. Data Description

The data description involves presenting descriptive statistics and conducting data analysis to assess the research data. The analysis included examining the educational background, IT training, operator training, and work experience of the operators. Herein, descriptive statistics, including the mean, standard deviation, and percentiles, will be provided for the collected data. This will involve detailing the educational qualifications of operators, their IT-related training, specific role training, and work experience. The section will also present graphical representations of these variables to illustrate the distribution of the collected data and to provide context for the subsequent analysis.

2.3. Assessment of Tacit Knowledge

The assessment of tacit knowledge was conducted using qualitative methods, including semi-structured interviews, direct observations, and contextual inquiries. These methods captured operators' experiences, problem-solving skills, and familiarity with industrial computer systems.

2.3.1. Evaluation Criteria

Operators' tacit knowledge was assessed based on criteria such as familiarity with industrial computer systems, proficiency in troubleshooting, decision-making capabilities, and adaptability to changing production environments.

2.3.2. Quantification and Categorization

This section will describe the qualitative analysis approach used to quantify and categorize tacit knowledge among operators. It will involve coding interview transcripts, observational notes, and contextual data to identify themes related to operators' implicit knowledge. The categorization will cover various facets of tacit knowledge, including technical skills, problem-solving abilities, and adaptability.

2.4. Hypothesis Test

The Mann-Whitney test was employed to evaluate the hypotheses concerning the impact of IT training on fault rates in industrial computers. The analysis compared the fault rates between IT-trained and non-trained operators, using descriptive statistics to summarize the data and inferential statistics to test the hypotheses.

This section will outline the hypothesis testing methodology, including the formulation of null and alternative hypotheses, the use of the Mann-Whitney test, and the statistical analysis procedures. It will describe the process of comparing fault rates between two groups of operators based on their IT training to determine the statistical significance of the observed differences.

3. EXPERIMENT ANALYSIS

This section delves into the experimental analysis conducted to investigate the correlation between users' IT knowledge and the fault rate of industrial computers. The focus is on the detailed steps and methodologies applied in the analysis of the collected data, providing insights into the impact of IT knowledge on fault prevention and reduction in production line stoppages.

3.1. DATA DESCRIPTION

In this section, we present descriptive analysis to assess the research data. The conducted analysis and classification yielded the following results interms of educational background, IT training, operator training, and the work experience. The first one provides insights into the distribution of educational qualifications among operators, including the percentage of employees holding associate degrees, diplomas, and bachelor's degrees. Approximately 55% of the employees held an associate degree, 31% had a diploma, and 14% possessed a bachelor's degree. The graph of the education level of users is placed in this section (Fig. 1).

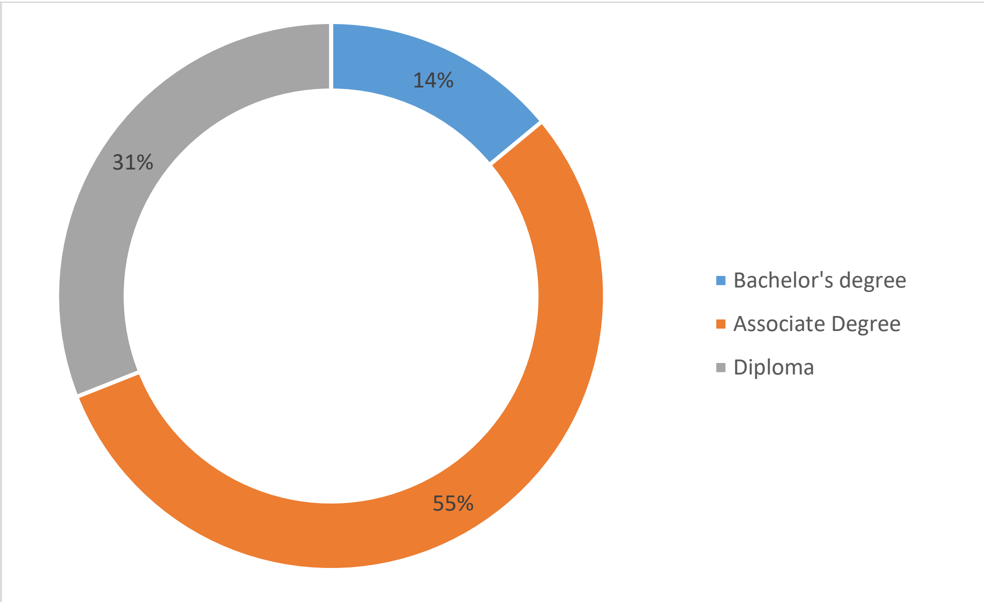

Fig. 1. Education level of users

Also, IT Training indicates the proportion of operators who received IT-related training courses, highlighting the disparity between trained and untrained individuals. A significant majority (81%) of employees had not received training in IT-related courses, while only 19% had undergone such training (Fig. 2).

Additionally, the operator training presents the number of operators who underwent specific training related to their roles, offering insights into the level of preparation within the workforce. Out of the 58 operators examined, only 11 had received training. Furthermore, work experience provides information on the distribution of operators based on their years of work experience, offering context for their level of expertise and familiarity with industrial computer systems. Sixty-four percent of the employees had more than two years of work experience, while 36% had less than two years of experience (Fig. 3). The breakdown report revealed insights into the segmentation of damage caused by device users and the types of breakdowns, primarily hardware-related, where users played an insignificant role.

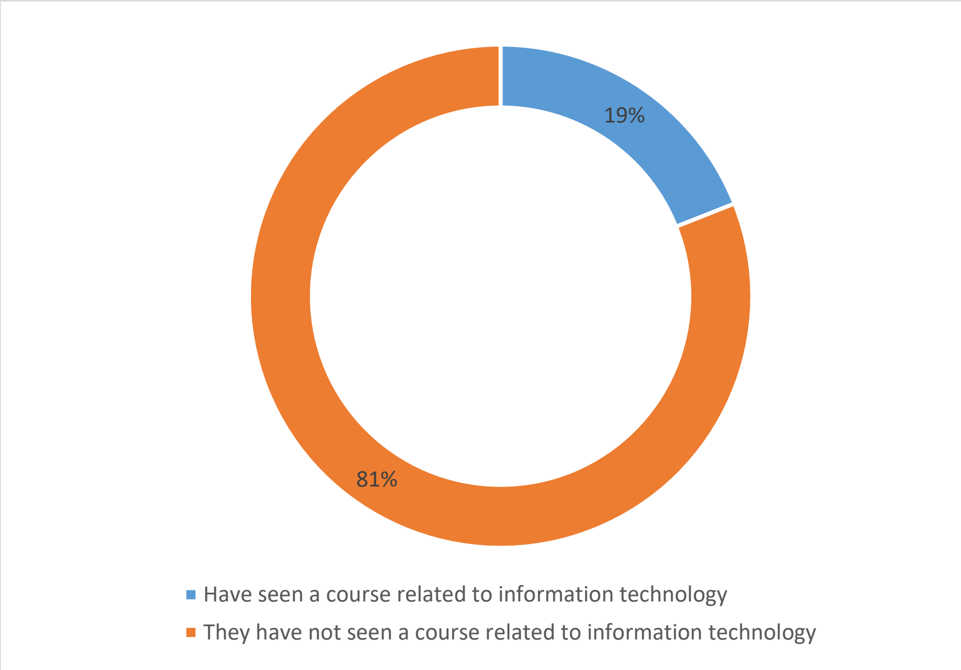

Fig. 2. Courses related to information technology

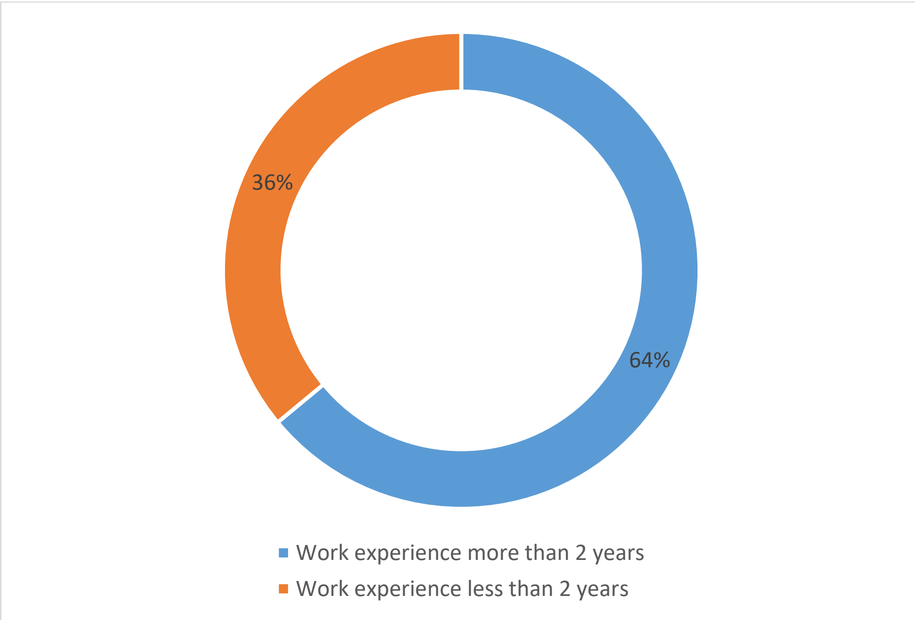

Fig. 3. Work Experience

Specifically, 89% of breakdowns, equivalent to 347 cases, led to workstation stoppages. Reducing such problems would directly result in decreased station and line downtime, leading to improved production efficiency and reduced cost wastage. Additionally, 1% of breakdowns were attributed to non-software and hardware changes, such as clutter in production program items. While not directly related to software, these issues contributed to waste and the production of defective parts, necessitating attention. For example, the clutter of production program items in industrial systems leads to a decrease in the accuracy of the device and the production of defective parts, and it cannot be considered equal to software problems, but cause waste and defective production of parts. Addressing hardware problems presents challenges, as repairs are often time-consuming or not feasible. In such cases, quick replacement of spare parts is crucial to minimize production stoppage.

3.2. Quantification and Categorization of Tacit Knowledge

Quantifying and categorizing tacit knowledge involved a qualitative analysis of interview transcripts, observational notes, and contextual data collected during fieldwork. Themes and patterns linked to operators' implicit knowledge were recognized by iterative coding and thematic analysis. These themes were then categorized based on various facets of tacit knowledge, including technical skills, problem-solving abilities, and adaptability. Even though tacit knowledge is difficult to quantify because it is based on personal experience and specific situations, the qualitative analysis helped to recognize and understand important insights and results. Fig. 4 illustrates the fault rate of systems, providing visual support for the analysis presented.

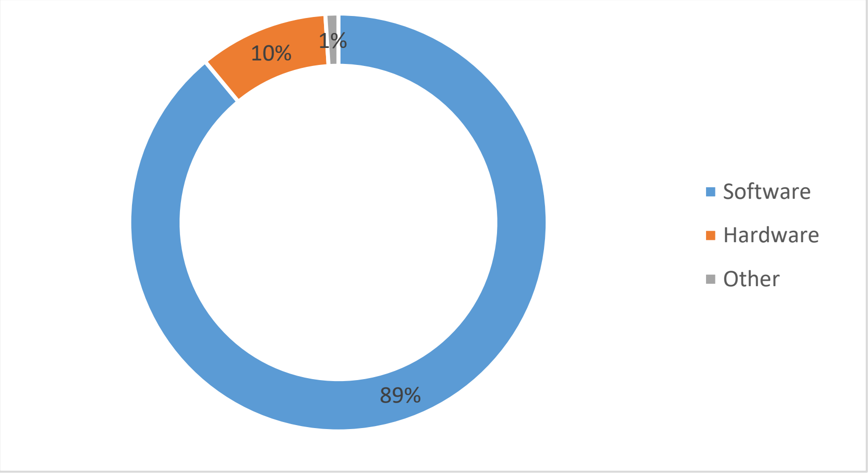

Fig. 4. Workstation fault reports

3.3. Hypothesis Test Analysis

In this part, we detail the approach used to evaluate the hypotheses put forward in our study. The Mann-Whitney test is the main statistical tool used for testing hypotheses. This examination is selected for its appropriateness in assessing two separate groups when the dependent variable is ordinal or continuous but does not follow a normal distribution, matching well with our research goals. The Mann-Whitney test, also referred to as the Mann-Whitney U test, is a non-parametric test utilized to evaluate variances between two separate groups. It assesses if the distributions of two groups are the same or if one group typically has higher values than the other. Given our focus on comparing the fault rates of industrial computers between two groups based on IT training, the Mann-Whitney test provides a robust method for analyzing our data. As previously stated, our research hypotheses are framed as follows:

• Null Hypothesis (H0): IT-trained operators working with industrial computers do not cause less damage and repairs to machines than others.

• Alternative Hypothesis (H1): Trained IT operators working with industrial machinery cause less breakdown and repair of machinery than others.

These hypotheses form the basis for our hypothesis testing process, where we seek to either accept or reject the null hypothesis based on empirical evidence obtained from our data analysis. Table 1 provides descriptive statistics for the given Groups A and B indicating High and Low IT knowledge, respectively. After capturing a summarized perspective on the two groups, it comes to making inferences. In this regard, the Mann-Whitney test is used according to Table 2.

Table 1. Descriptive statistics

Group	Mean	Std. Deviation	Minimum	Maximum	percentiles		
					25th	50th(Median)	75th
Group A	34.3000	10.82191	12.00	56.00	25.0000	36.0000	44.0000
Group B	1.5000	.50855	1.00	2.00	1.0000	1.5000	2.0000

Table 2. Results of the information entered in the statistical program

Item	point
Mann-Whitney U	4.500
Wilcoxon W	124.500
Z	-4.491
asymp.Sig.(2-tailed)	.000
Exact Sig.[2*(tailed sig.)]	.000*

Upon analyzing the output from the Mann-Whitney test, we found that the significance level (p-value) was below the conventional threshold of 0.05. This indicates strong evidence against the null hypothesis, leading us to reject it in favor of the alternative hypothesis. In other words, IT-trained operators demonstrate a statistically significant difference in causing fewer breakdowns and repairs to industrial computers compared to their non-trained counterparts.

4. Discussion

This study endeavors to illuminate the relationship between IT knowledge and fault rates in industrial computers, but it is crucial to acknowledge several potential limitations that may affect the generalizability and robustness of our findings. Firstly, the study's focus on a specific case study and its production lines may limit the broader applicability of the results to other industrial settings with different operational contexts or technological infrastructures. Additionally, the challenge of capturing tacit knowledge, which often resides within individuals' experiences and interactions with industrial systems, poses inherent difficulties in quantifying and analyzing this form of knowledge. Despite these limitations, we believe that our findings provide valuable insights into the role of IT knowledge in mitigating system faults, and we encourage further research to explore these dynamics in diverse industrial environments.

Research limitations, such as accessing personal employee information and accurately documenting system failures, hindered comprehensive data gathering. Moreover, providing a systematic approach to IT training is essential for enhancing operators' familiarity with industrial computer systems. Specialized courses conducted by experts within the organization can impart crucial knowledge, ensuring that operators are well-versed in the functionalities and maintenance of these systems. Additionally, developing knowledge packages on general industrial computer training, with input from field experts, can offer concise introductions to industrial systems and clear instructions on device usage. These packages will minimize the need for repeated training sessions for new users and enhance overall system efficiency.

Further, the study highlights the importance of IT training in reducing system faults and improving operational efficiency. While the focus was on a specific production line, the implications of the findings suggest that similar benefits could be realized in other industrial environments with proper training and knowledge dissemination. The integration of comprehensive IT training courses, tailored to the specific needs of industrial computer systems, and the development of practical knowledge packages, can significantly reduce the fault rate and enhance the reliability of industrial operations. Future research should expand the scope to include diverse industrial contexts and explore additional factors that may influence the effectiveness of IT training in reducing system faults.

5. Coclusion

The statistical analysis conducted in this study provides valuable insights into the relationship between information technology (IT) knowledge and the fault rates of industrial computers. Employees with IT-related knowledge showed a significantly lower likelihood of experiencing failures in industrial computers compared to those without such knowledge. These findings highlight the critical role of IT knowledge in reducing system failures and optimizing the performance of industrial computer systems. To leverage the benefits of IT knowledge, organizations should develop comprehensive training programs for users of industrial computer systems. These training initiatives should encompass diverse learning methods, including reading materials, electronic resources, and interactive instructions. Additionally, implicit knowledge gained through hands-on experience should be incorporated into training to ensure its practical applicability.

Beyond formal training, effective knowledge management strategies are essential to facilitate continuous learning and skill development. Organizations can enhance job competency and performance by enabling easy access to and sharing of information through robust knowledge management systems. Continuous assessment by professionals and senior executives is also necessary to validate and improve the knowledge acquired, ensuring its relevance and practical use in industrial environments. While this study underscores the significant role of IT knowledge in mitigating system failures, further research is needed. Future studies could explore the effectiveness of various training methods and knowledge management practices in enhancing user performance and system reliability. As technology evolves, ongoing evaluation of training programs and user interfaces is crucial to meet changing user needs and technological advancements.

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