




Article

How Low-Code Tools Contribute to Diversity, Equity, and Inclusion (DEI) in the Workplace: A Case Study of a Large Japanese Corporation

Natsumi Takahashi ^{1,2,*} , Amna Javed ¹  and Youji Kohda ¹ 

¹ Japan Advanced Institute of Science and Technology, 1-1 Asahidai, Nomi 923-1292, Ishikawa, Japan; amna@jaist.ac.jp (A.J.); kohda@jaist.ac.jp (Y.K.)

² Hitachi, Ltd., Nippon Seimei Marunouchi Bldg., 1-6-6, Marunouchi, Chiyoda-ku, Tokyo 100-8280, Japan

* Correspondence: natsumi.takahashi@jaist.ac.jp

Abstract: Learning and using technology in the workplace are essential for a company's commitment to the sustainable development of its resources. Finding competent engineers who can handle information communication technologies (ICTs) is a challenge for companies. Currently, however, the ability to use these technologies is limited to technicians with specialized training, and not everyone can engage in development. Therefore, it is safe to conclude that equity in the use of technology has not yet been realized. This study aims to analyze, based on actual cases, the necessary conditions and mechanisms for people with diverse experiences and circumstances, not limited to engineers, to participate in ICT development to address human resource diversity. The use of technology such as low-code platforms (LCPs) that have recently emerged on the market has shown that nonprofessional engineers without programming training can participate in development projects. This research will be useful to managers in advancing Diversity, Equity, and Inclusion (DEI) strategies in their workplaces and contribute to organizational research regarding new trends in technology use by individuals: low codability. The findings of this study are of significant relevance to the Sustainable Development Goals (SDGs) of decent work and economic growth, as well as gender equality.

Keywords: DEI; diversity management; gender equality; sustainable development; low-code; generative AI; knowledge management



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1. Introduction

Today, the use of information communication technology (ICT) has become an integral part of the corporate environment [1], and ICT is an important part of this environment. Additionally, there is a concern that there will be a shortage of engineers involved in the development and operation of ICT in the future in regions facing problems caused by environmental changes such as an aging population [2]. Moreover, companies are faced with the challenge of securing resources. From the perspective of sustainable human resource management [3], companies must provide work environments and systems that enable individuals with different abilities, conditions, and circumstances to play active roles. Therefore, Diversity, Equity, and Inclusion (DEI) are important factors in the workplace [4] when considering resource sustainability. To become an engineer engaged in software development, it is necessary to acquire information technology knowledge, such as programming languages, and have practical experience in development project work; however, it is difficult for all individuals to gain experience and learn equally. Therefore, it is impractical for individuals with different circumstances to change jobs and become software engineers, and it is imperative for enterprises to consider DEI strategies [5] to ensure the sustainability of their professional ICT resources.

However, in recent years, the development of IT has brought to the market a type of technology that differs from conventional general-purpose ICT in terms of opportunities

for technology use. Low-code platforms (LCPs) [6] and interactive artificial intelligence (AI) such as ChatGPT [7] have been found to have characteristics that can eliminate the need for education on ICT technology. If we identify how the use of these technologies can influence the inclusion of diversity in the workplace and improve equity in the use of technology [8], it is assumed that we will be able to develop new solutions to promote DEI through the use of technology. Although this study is mainly a case analysis of the use of low-code platforms in the workplace, that is, the feature of not using a programming language, this can extend to interactive Generative AI, which also has the same feature. It is imperative to study the potential of new technology tools with low-code characteristics to advance the objectives of the Sustainable Development Goals (SDGs).

1.1. Background and Problem Posed

First, we examined ICT, which has become an integral workplace technology, and its relationship with DEI. Generally, ICT development in the workplace [9] is limited to a group of people involved in planning and development, as it is a well-established requirement that the people involved have knowledge and practical experience with ICT, such as programming. Other employees are primarily involved in using the ICT installed in the workplace as a business system to perform their work. In other words, there is a gap between the planning and development of ICT and its operations, and access to ICT as a technology is not equally distributed. First, we observe a state in which the inequity referred to in DEI is limited in terms of access to this technology.

Fundamental systems such as Enterprise Resource Planning (ERP) are designed to standardize and streamline processes [10]. Generally, business-critical systems clearly segregate the roles and authority of individuals who use the system and fix and restrict their job descriptions. Under these conditions, the diversity of individual knowledge and experience is fixed and limited to the definitions of the roles and positions of authority in the workplace [11]. Therefore, the company's ability to draw on the diverse knowledge of individuals and the expansion of employees' skill sets and career directions [12] are not considered. Modern business systems aim to streamline operations, set rules, and clearly classify roles, as shown in Figure 1, so that the system is restricted to a fixed framework rather than one that demonstrates diversity and equity.

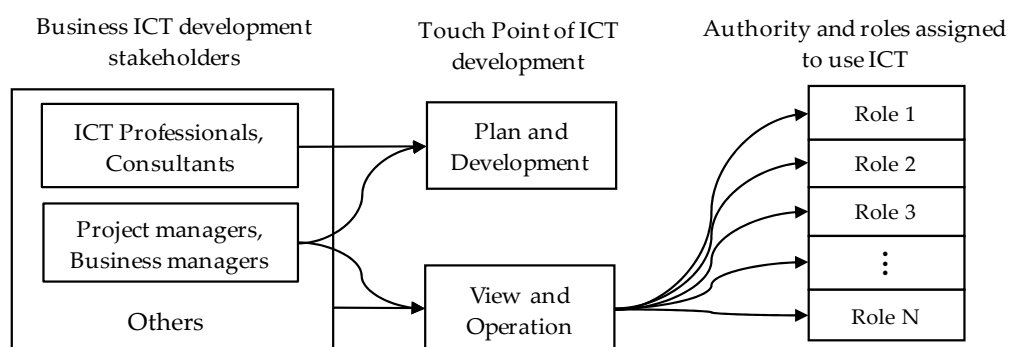


Figure 1. Assignments and limitations of roles in the use of IT systems in the workplace.

In a workplace where rationalization, division of employees, and information technology have become commonplace, the goal of implementing diversity and equity at the level of individual awareness seems counterintuitive. Therefore, to realize DEI in workplaces [4] where ICT has been introduced, it is necessary to propose new and simple ways of using ICT that can be practiced at each workplace level.

1.2. Manuscript Structure

The following is the structure of this paper:

Section 1 provides an introduction and background to this study. Section 2 presents a literature review on Diversity, Equity, and Inclusion (DEI) and low-code tools. Section 3

describes the research methodology. Sections 4 and 5 present the results of the study. Section 4 presents the results of a project that utilized low-code development in a company and a subsequent observation of the evolution of the employees' skills in information and communication technology (ICT) over time. Section 5 refers to public databases for quantitative verification. The results of the qualitative analysis presented in Section 4 are validated through the quantitative analysis demonstrated in Section 5. Section 6 offers a synthesis of the characteristics that considerations and low-coding contribute to the field of DEI. Section 7 then presents the responses to the research questions. Section 8 is the concluding section.

2. Literature Review

2.1. Diversity, Equity, and Inclusion Perspectives on Technology Use

Diversity, Equity, and Inclusion (DEI) are essential elements for organizational transformation and development [13] and are increasingly considered indispensable for organizational success and societal well-being [14]. However, fundamental solutions have yet to be discovered. Extensive research has been conducted to understand the complexity of DEI management and develop strategies to foster diverse perspectives and environments [15]. In the context of how diversity impacts business activities, it has been suggested that changes in sales, customers, market share, and relative profits are influenced by the increase in racial and gender diversity [16]. Diversity [17] is defined as the distribution of personal attributes among the members of an interdependent workplace. Various classification methods to explain the contents of diversity have been proposed [18]. There is also a multilevel perspective on diversity, with extensive research focusing on the impact of team-level diversity on team and organizational outcomes, whereas studies on larger organizational or societal-level diversity are relatively scarce. Regarding the impact of team diversity on group performance, Jehn et al. [19] suggest that interactions among members with different backgrounds and perspectives within workplace teams can enhance a team's problem-solving ability and creativity. Furthermore, Jehn [20] suggests that focusing on different aspects of diversity can have different effects on group performance, implying that diversity can have both positive and negative impacts.

Additionally, regarding cultural diversity, it is suggested that individuals with different cultural perspectives actively discussing within work groups may lead to more creative and effective solutions [21]. Jackson and Ruderman [22] explored diversity within teams in organizations, suggesting that organizational diversity promotes creativity and efficiency, and that teams with diverse backgrounds and perspectives have a higher ability to generate innovative solutions. Accepting diversity within teams enriches the organizational culture and results in improved the ability to capitalize on new opportunities and address various challenges. Cox and Blake [23] suggest the importance of developing strategies to collect different perspectives from employees with diverse cultural backgrounds and turn them into competitive advantages to maintain organizational competitiveness. Although diversity management is a widely recognized management approach, its definition is ambiguous [24]. Recent research has increasingly explored the impact of the DEI concept on consumer behavior, market trends, and brand management [25]. Furthermore, Ferraro et al. [26] examined the importance of DEI for brand managers, providing suggestions for utilizing DEI to enhance brand value and image, and considering how actively incorporating diversity contributes to business success. These research trends clearly show that leveraging diversity and inclusion is essential for business success.

Although many studies on how diversity affects organizations have been conducted, applied research from the perspective of practice such as how to implement Equity and Inclusion in the workplace and methods of DEI management [4] is still lacking. Inequality and disparities in the use of computer technology have been discussed as digital divides [27,28].

2.2. Low-Code Development and Interactive Generative AI Tools

Recently, organizations have begun using no-code/low-code development platforms [6] to create applications for digital transformation [29]. Organizations drive digital transformation by adopting low-code platform development [30], which can alleviate past software development problems. The main feature of no-code development platforms is that flexible and low-cost applications can be created in a short time by integrating components in a drag-and-drop manner through a visual interface, without the need for in-depth programming knowledge [31]. This allows organizations to utilize their existing human resources for application production, instead of requiring specialized software programmers. This can alleviate difficulties such as the need for software development resources from a sustainable perspective, which require skilled ICT technicians and involve high running costs for program coding and maintenance [32]. However, low-code application development platforms are less flexible and have limited functionality because they have their own specific templates, and developed applications have limited scalability compared with program-coded software [31]. There are different definitions of no-code and low-code platforms [33]; however, this study uses the term “Low-code platforms” (LCPs) encompassing those two platforms, as they are handled by employees without programming skills, and are used without any coding.

Second, if we define low-code features as functions that enable a person to program a computer without a programming language [34], then we can assume that interactive Generative AI tools also have low-code-type capabilities. Since its public release in 2022, the Generative AI tool ChatGPT [35] has captured the world’s attention owing to its sophisticated ability to perform extremely complex tasks and has rapidly increased its enrollment. ChatGPT has advantages and disadvantages in facilitating teaching and learning, which include individualized, optimized, interactive learning promotion, and a variety of other features. However, ChatGPT has inherent problems such as the invasion of privacy, generation of bias owing to learning data, and generation of incorrect information [36]. New AI tools can change the way workers perform and learn; however, information on their impact on operations is limited. Brynjolfsson and Raymond [37] examined the staggered introduction of Generative AI-based conversational assistants in customer support operations and reported improvements for novice and low-skilled workers but little impact on experienced, high-skilled workers. The results suggest that access to Generative AI improves work productivity and that this effect is more likely to affect unskilled workers [37]. Noy and Zhang [38] examined the impact of generative artificial intelligence (AI) technology, the assistive chatbot ChatGPT, on productivity and found that ChatGPT increased productivity in a mid-level professional task. Lower-skilled participants benefited from ChatGPT the most, suggesting that it has reduced inequality among workers. Therefore, recent research suggests that Generative AI tools can help improve equity among workers.

2.3. Advantages and Uniqueness of This Study

This study explores a new integrated perspective: the relationship between DEI and the conditions of ICT use in workplaces, such as low-code platforms and interactive AI tools. We conducted applied research based on a corporate case study to address the impact of these new tools on actual business operations and their potential contributions to DEI in the workplace, considering areas still lacking despite the results of the aforementioned prior studies. The findings of this study are intended to assist organizational managers in implementing DEI strategies in the workplace and provide a new perspective on improving equity through the use of technology in organizational research, such as in studies on DEI and sustainable resource management.

3. Research Methods

3.1. Purpose of This Study

This study aims to examine whether low-code tools, which appear to attract a more diverse user base than traditional ICT requiring conventional programming skills, contribute

to DEI, and to enhance the understanding of the characteristics that promote DEI in the workplace. By uncovering this insight, it will be possible to more accurately understand how to use tools to advance workplace DEI strategies, thus benefiting managers and organizational researchers in their practical endeavors. To achieve this objective, the following research question was posed:

Research Questions:

RQ1: How do low-coding tools contribute to workplace Diversity, Equity, and Inclusion (DEI) in the workplace?

RQ2: How applicable are the DEI advancements observed in a large Japanese corporation across different geographical and organizational contexts?

3.2. Research Methods

Answers to the research questions were proposed through the inference of the hypothesis by case study analysis and verification by interview analysis with relevant parties, in addition to the results of follow-up observations. Further, a mixed research method was employed, whereby the results of the case studies and interviews were used for qualitative analysis, and the results of a questionnaire survey of 1000 general residents were used for quantitative analysis.

3.3. Field of Study

This study examined the workplaces of large Japanese companies. This is because many large Japanese companies have already published their DEI policies, target setting, and systems but are struggling to achieve their goals compared with those in other developed countries [39], meaning that they are therefore considered suitable for a deep dive into the profound issues. The case study uses a Project Palette, which was conducted in the commercial department of a large Japanese company, A. Company A is a global company headquartered in Japan and is a conglomerate with approximately 300,000 employees on a consolidated basis as of 2023. Interviews were administered to employees and managers at Company A's plants and headquarters. Project 1 (Project Palette), from which data were obtained, was an internal business reform project conducted by the commercial department of Company A's factory in Japan, with the first author serving as the project leader. We used the results from an internal audit of the situation as of 2021, when Project 1 (Project Palette) was implemented, and the subsequent natural progression of the situation in 2023. This project focused on the previously unrepresented knowledge of administrative staff and women working as assistants, with a focus on representation and conditions that support equity in their use of technology. We investigated the inhibitions of persons who are not engineers regarding their use of technology through demonstration of their knowledge, as well as how technology can provide them with support.

4. Result: Result of Project Palette 1

4.1. Project 1 (Project Palette) Results (2021 End)

Project 1 (Project Palette) was an ICT construction project conducted by working members under the theme "Sharing Diverse Knowledge", in which applications and portal sites were created using the LCP over a period of approximately six months. The application was produced by non-engineering clerical members of the team, from specification studies to implementation, without the intervention of ICT specialists or consultants, which differentiates this project from typical ICT development projects. The twelve members who collaborated on Project Palette 1 comprised administrative and clerical groups in the commercial department of Company A's heavy industrial manufacturing plant. Before the project began, members were concerned about their lack of programming experience and ICT knowledge when they heard about ICT development; however, once they understood that working with LCP did not require complicated procedures or programming, they accepted the task.

Several applications were created in Project Palette; however, the most focused was the creation framework for knowledge-sharing [40] applications. Eight members contributed to this workshop on the creation of knowledge applications. By repeating the framework for sharing and refining the business knowledge of general affairs, which has not been manualized, from individuals to group members, the group members were able to go from 0 at the start to producing 94 knowledge applications in six months. The framework consists of iterations intended to spiral [41,42] of the following four items.

- (1) Prepare a memo explaining the procedure (personal);
- (2) Review content to improve and add information (group);
- (3) Creation of LCP applications (personal);
- (4) Review applications and post them on the portal (group).

Additionally, the requirement to create a knowledge-sharing application was initially met with concern [43], especially by women, who said, “There is nothing to share in terms of knowledge because it is general affairs work.” However, the result was first a representation of 223 knowledge memos, followed by group discussions that improved the content, ultimately resulting in the creation of 94 knowledge-sharing applications recognized by group members as organizational knowledge assets [44]. Table 1 presents the transition in the quantity of knowledge units represented by workshop participants from the beginning to the end of the workshop.

Table 1. Number of members’ knowledge and applications formalized through workshops.

Stage	Description	Count of Knowledge Units
Workshop Start	Before framework no knowledge formalized	0
First iteration	Original number of knowledge units shared by individuals at first	223
Second iteration	The number of knowledge units after refined by team members	127
Workshop End	The number of knowledge units released as an application	94

Two notable results were obtained. First, the organization recognized 94 pieces of knowledge as shared assets, from a state of tacit knowledge that individuals assumed to be zero, to the deliverable, known as an application. This demonstrates the diversity of knowledge and practices of inclusion in the organization. Second, administrative staff, who had no learning or practical experience in ICT development, implemented ICT production for business use by the LCP without any special introductory training. They created many applications and a portal site on which to post them.

4.2. Interviews for Project Palette 1 (2021 End)

In interviews conducted with the eight members at the end of Project Palette 1, we asked about their impressions of the use of LCP and the asset value of the knowledge-sharing application(s) they produced. The person in charge, who was mainly active in creating applications, highly rated the fact that no programming knowledge was required, saying, “I used to shy away from ICT programming because I was not good at it, but LCP is very good because there is no programming required and it can be operated intuitively.” Furthermore, regarding the knowledge application, they pointed out the value of diverse knowledge being expressed and the importance of being able to refine and recognize such knowledge as an organizational asset, stating “It was good to be able to understand other people’s work”, and “I think we created an asset because we all brushed up on the knowledge that was expressed”. The value of diverse knowledge being represented and the importance of being able to refine and recognize such knowledge as an organizational asset were also recognized.

4.3. Project Palette 1 Follow-Up Results (2023)

To find out what changes Project Palette 1 has brought to the clerical members of the administrative group, interviews were conducted with seven group members who had remained in the same department at the end of 2023, asking them to report on the current situation. Consequently, new changes were observed. One of the members left the workplace and her results could not be confirmed, but it was confirmed that women tend to fluctuate their workplaces due to life events and the need for support. Table 2 summarizes the changes from 2021 (at the time of the project) to 2023 for each person in charge.

Table 2. Changes in involvement in application development (2021–2023).

Group Member	A	B	C	D	E	F	G	H
Work experience (2021) Rounded to nearest 5 years	20	20	10	5	5	20	20	25
Job (2021–2023)	Assistant				Admin Staff			
ICT development or programming experience	No	No	Yes	No	No	No	No	Yes
LCP Usage Status: Before project start (2021)	I	I	I	I	I	I	I	I
LCP Usage Status: At project completion (2021)	II	II	III	III	II	II	III	III
LCP Usage Status: Follow-up observation (2023)	II	III	-	III	II	III	III	III
Question: Do you want to learn programming? (2023)	No	Yes	-	Yes	No	Yes	No	No
Question: Do you want to use AI tools in your work? (2023)	Yes	Yes	-	Yes	Yes	Yes	Yes	Yes

I: No experience using low-code platforms. II: Using applications as a user. III: Creating and maintaining applications. -: No data.

First, we checked the operational status of the knowledge-sharing applications created during the execution of Project Palette 1 and found that many were left in a state of stagnation, wherein updates had been delayed but new applications had been added, and the mechanism itself continued to operate.

Next, when the status of LCP utilization was checked, it was confirmed that after Project Palette 1, the practical skills of the members progressed further, with new functions being planned, more applications being created, and other functions being used to experiment with their application to business operations. Assistant B, who had no experience in ICT development and was in charge of unrelated administrative work at the start of the project in 2021, was assigned to create and operate applications in the LCP in 2023. Assistant B, in an interview, said, “I never had the opportunity to learn about ICT and programs before, but now that I have the chance to be involved in technology, I want to try it myself”. The first step in unleashing a diverse range of talent is providing opportunities.

4.4. Summary of Project Palette 1

Project Palette 1 proved that specifications, talent, and knowledge that did not exist before could be built using low-code tools and involving people who had not previously been directly involved in ICT development in the production of applications. Additionally, two elements were found to be needed to enable individuals with diverse circumstances to participate in ICT development in the workplace: (1) reduce the burden of learning program language and (2) ensure equal opportunities to experience technology use and support. As a technology specification to help diverse individuals develop their skills, it is necessary to ensure fairness in individuals’ use of technology. This can be achieved by

minimizing the need to acquire prerequisite knowledge and skills, such as programming languages and low-code tools. However, the introduction of technology into the workplace alone does not eliminate inequality in use, and environmental support, such as workshops on the use of technology and advice from those around them, is essential.

5. Comparison with Statistics

To compare the general trend with the Project Palette 1 results, a comparison is made with survey data from the IPA (Information-Technology Promotion Agency, Japan). The data in question are derived from the database of a survey conducted by the IPA in 2021 on Japanese companies. A total of 15,000 companies (5000 of which are classified as IT companies) were invited to participate in the survey, and 1935 companies responded (a response rate of 12.9%) [45].

First, we analyzed the results of the survey on the demand for IT personnel in companies. Figure 2 illustrates the responses to this question. For companies with more than 1001 employees, 49.8% of respondents indicated that there is a “significant shortage”, and together with the “slight shortage”, more than 95% of them indicated that there is a shortage. The same results were observed for companies with 301 to 1000 employees, with a total of more than 90% of respondents indicating that they are experiencing a shortage. For smaller companies with less than 300 employees, 59.4% of respondents answered that there was a shortage. These findings indicate that companies are inadequately staffed relative to the demand for IT personnel.

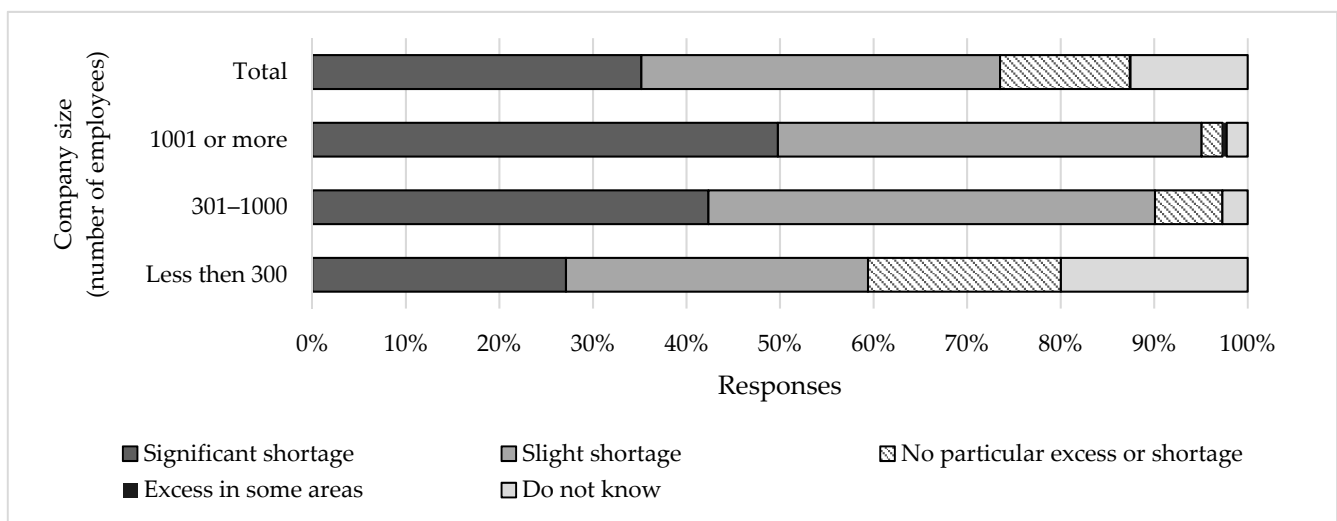


Figure 2. Responses to the question: “Does your company currently have the requisite number of IT personnel to implement your business strategy?” created based on [45].

The next step is to examine the situation in ICT education in the workplace. To this end, we review the results of a survey on the education of IT personnel in companies. Figure 3 shows the results of responses to the question, “What kind of career support do you provide to your IT personnel development?”. The survey revealed that 37.7% of large companies (1001 or more employees) and 9.8% of small companies (less than 300 employees) reported that their companies provide training to improve their employees’ IT skills. This indicates that there may be inequity in the allocation of time or budget for training. Moreover, 70% of the companies, particularly among small companies (less than 300 employees), indicated that they had not implemented any measures, in contrast to the companies that indicated that they had taken some measures. It is challenging for SMEs to invest in IT training [45].

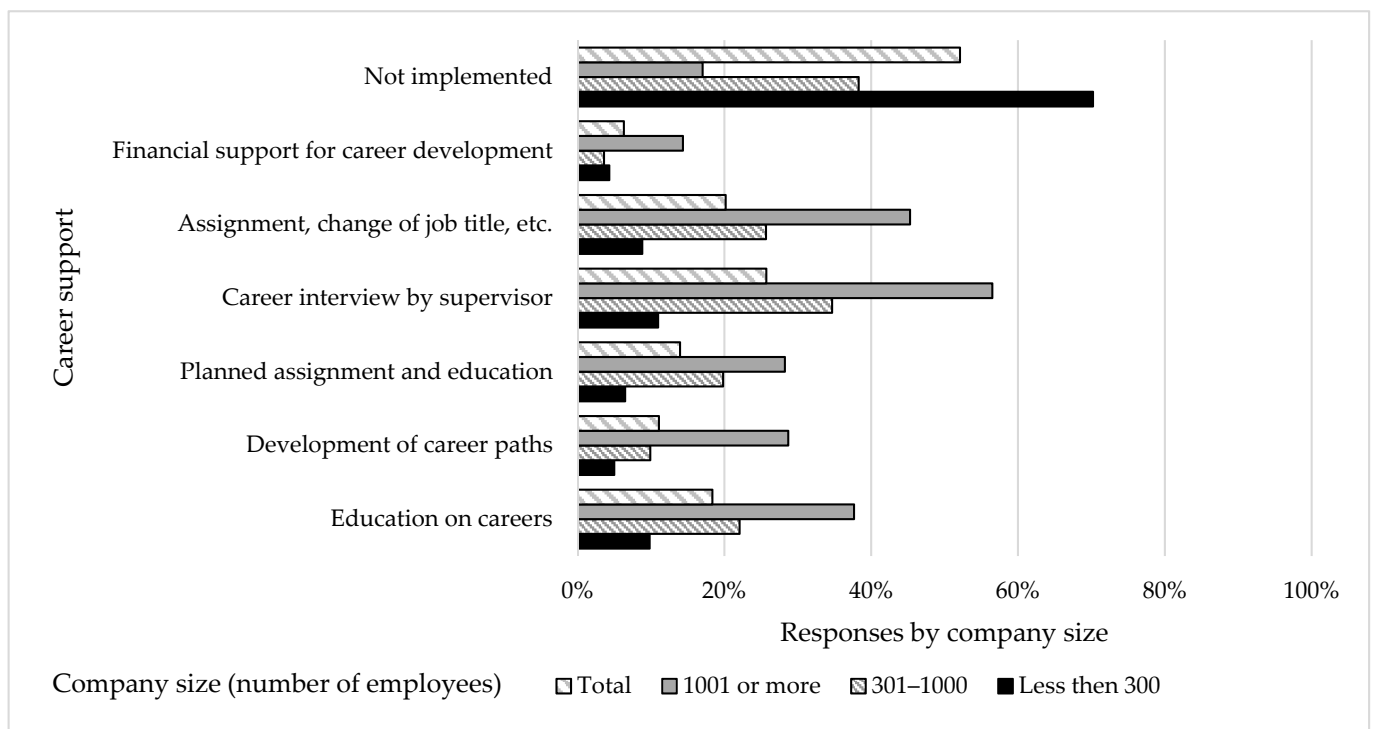


Figure 3. Responses to the question: “What types of career support do you provide for IT personnel development? (Multiple Selections Allowed)” created based on [45].

The data indicate that two significant barriers to integrating DEI into ICT development in Japanese companies are the reluctance towards ICT education and investment and the inequitable opportunities for experiencing and learning technological skills. Consequently, it is evident that acquiring programming skills is generally challenging for novices, given the inequities in workplace education. To achieve DEI in the workplace, it is necessary to provide tools that can address these disparities in access to technology and education.

6. Discussion

6.1. Features of Low-Coding for DEI

This study examines individuals engaging in programming through low-code platforms and the nature of the tasks programmed by them. Not all developers consider low-code tools the optimal programming solution, as indicated by previous research on low-code development, because LCPs have their own templates that limit their functionality and restrict their scalability and flexibility compared with coded software programs [31]. According to interviews with engineers at Company A, those proficient in programming languages expressed dissatisfaction with low-code platforms, citing limitations in functionality and time-consuming processes for tasks that could not be fully implemented using low-code methods. Conversely, interviews with individuals lacking programming skills, such as administrative staff and assistants, revealed positive feedback, with comments such as “I had reservations about programming, but low-code platforms are intuitive to use” and “I never received formal education in programming, but I could still give it a try”. This indicates a lower resistance to technology use among non-technical users.

The implementation of low-code platforms has facilitated the progress of programming in meticulous tasks not previously considered for systemization, akin to the tacit knowledge possessed by administrative staff. Therefore, it can be argued that low-code programming fits well with individuals who possess previously unexpressed knowledge and have brought their tasks into the realm of socialization [46], thus contributing to the improvement in DEI within the organization. This relationship is illustrated in Figure 4. The left circle in Figure 4 represents the technical scope of programming-skilled individuals,

whereas the right circle represents the technical scope of non-programmers. The overlapping areas signify a shared knowledge domain (related to IT and business). Low-code application development fits into area (III) of tasks, in which explicit programming is not feasible owing to unexpressed knowledge.

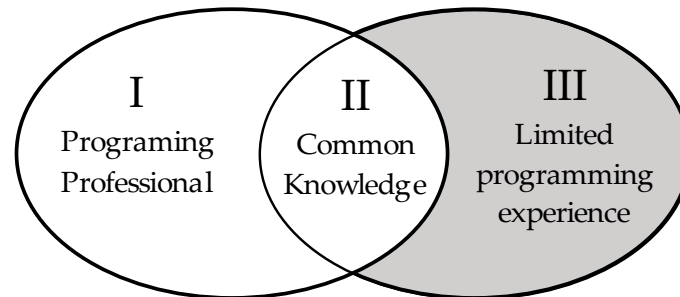


Figure 4. Identify areas where the use of low codes is beneficial.

If we define low-code features as the capability of individuals to program computers without the need for traditional programming languages [34], we can infer that interactive Generative AI tools also exhibit low-code-like functionalities. Therefore, here, we examine the feature as a low-code function that commands an interactive Generative AI tool in natural language to obtain the output needed by the individual.

Similarly, the support provided by Generative AI conversational chatbots fits into areas where advice is required for tasks that have not yet been learned or mastered (Figure 5). The left circle in Figure 5 represents the knowledge domains of skilled individuals in their respective tasks, whereas the right circle represents the knowledge domains of non-skilled individuals. The overlapping area indicates a shared knowledge domain (common-sense and task-related). Generative AI-based advice fits into area (III) of tasks in which knowledge is not yet established, and learning has not yet occurred.

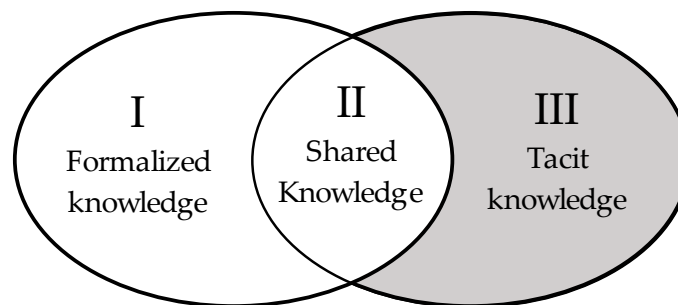


Figure 5. Contents programmed by low-code type tools.

Turning to the areas newly programmed through the introduction of low-code tools, and those where advice from interactive Generative AI proved effective, they coincide with the regions depicted in Figure 5, and both correspond to the shaded areas indicated in Figure 5 (III). In other words, these areas represent previously unarticulated domains of personalized domain knowledge and the knowledge gaps necessary for individuals with limited experience or learning to perform tasks. Given the diverse opportunities and experiences of learning among individuals, disparities can arise, leading to unfairness. However, by individually optimizing inputs and outputs through low-code tools, facilitating the expression of knowledge, complementing knowledge gaps, and promoting fairness in output can be achieved by adopting IT in the workplace.

Therefore, programming tasks that have been shunned by non-IT engineers in the workplace and by the majority of the public because of their aversion to them can now be used to perform complex tasks on computers, such as programming, using the features of low-code tools.

6.2. What Are the Benefits of Low-Coding Perspective of SDGs

This section examines the characteristics of low-coding-type software production, with particular attention paid to the specifications that are the focus of this study based on the results found throughout this project. Some of the benefits of low-coding for the utilization aspect of the SDGs include the following: according to the 2023 Global Gender Gap Report, science, technology, engineering, and mathematics (STEM) occupations are important and pay well, and they are expected to grow in importance and scope in the future. However, the percentage of women in STEM occupations remains significantly under-represented. In the absence of on-the-job training (OJT) for the purpose of learning a programming language, the development of raw code can be intuitive without language training, thereby enabling individuals to utilize it without discrimination. Another challenge is that technology manuals are often written in the majority language, primarily English. Consequently, individuals who are unable to read English are unable to learn it. Furthermore, in regions where English is not widely spoken, self-study of technology, such as programming, may be impeded. In this instance, low-coding policies can be programmed through the sensory manipulation of a graphic interface (GUI) without the necessity to peruse the text.

Typically, individuals seeking to learn programming must first familiarize themselves with technical materials written primarily in English and subsequently receive training in programming through work experience. Nevertheless, it has proven challenging for women who do not meet the eligibility criteria to secure training opportunities through practical work (Ministry of Economy, Trade, and Industry). Conversely, in the case of low-coding, the obstacle of reading English documents and the limited opportunity to be trained through work experience can be circumvented. It can be reasonably assumed that low-coding will facilitate the success of women as IT engineers in countries that exhibit the following characteristics.

- (1) The native language is not English, and there are few English-speaking users.
- (2) Women’s participation in society lags behind that of other countries.

As illustrated in Figure 6, the learning barrier is less pronounced for those with low coding skills on the right side of the spectrum compared to the learning barrier for minority language natives on the far left, who must overcome the challenge of using the program language of English documents.

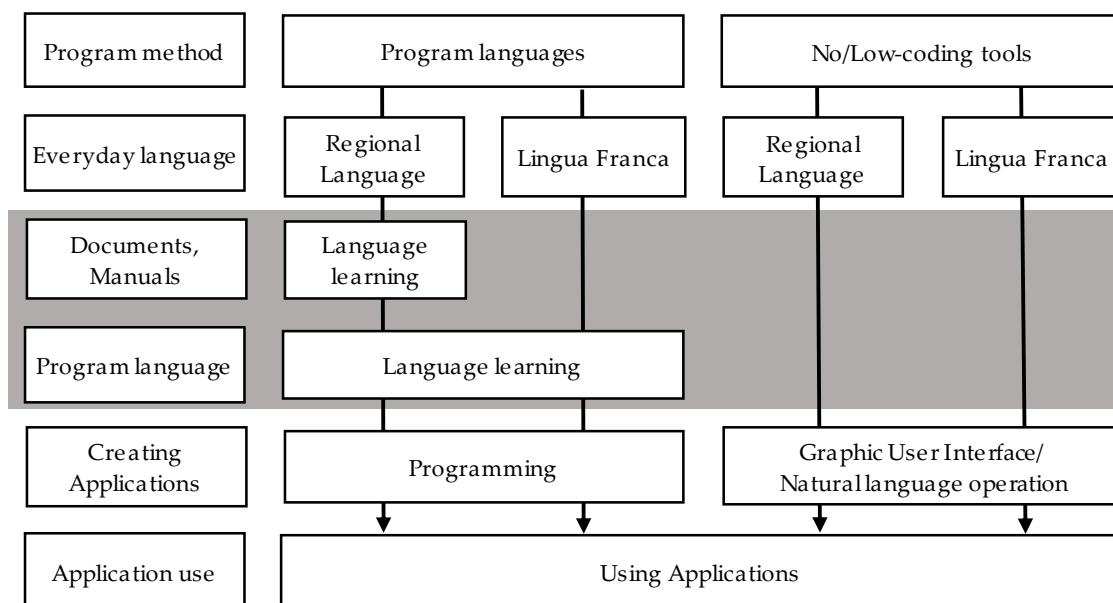


Figure 6. Differences in barriers to language-learning in low-code and programming language.

6.3. Integration of Legacy IT Systems and Low-Code Development

Legacy systems refer to existing software applications and infrastructure that have been in use for a long time and may have outdated technology and architecture. This section discusses the benefits of integrating legacy systems with low-code development. First, existing investments in legacy systems can be leveraged by extending the functionality of legacy systems or integrating them with new low-code applications. This integration helps bridge the gap between the old and new systems, allowing for a smooth transition and reducing the need for a complete system refresh. Secondly, low-code platforms often provide connectors and APIs that facilitate integration with external systems, including legacy systems. These connectors enable data exchange and communication between the low-code application and legacy systems, providing seamless interoperability. Furthermore, by utilizing low-code tools to develop new functionality or user interfaces, organizations can modernize legacy systems without requiring extensive coding or redevelopment [29,30]. In particular, diversity in design occurs because it is highly dependent on individual requirement specifications and preferences. Therefore, with low coding, a diverse group of people can be involved in the production of the interface, thus enabling them to resolve this part of the user's preferences.

It is also important to note that integrating legacy systems with low-code development can present certain challenges. Factors such as compatibility, security, and data integrity must be carefully considered during the integration process. To avoid mistakes due to a lack of understanding of the specifications, it is essential to clearly delineate the roles of the specialized IT team dealing with the legacy systems and the rudimentary tool creation team that is solely involved in low-code development.

In conclusion, the integration of legacy IT systems and low-code development offers an opportunity for organizations to modernize software interfaces, enhance functionality, and improve efficiency. However, this requires careful planning, compatibility considerations, and a thorough understanding of the capabilities of both the legacy system and the selected low-code platform.

7. Answer to the Research Questions

7.1. Answer to RQ1

In response to the research question, the value contributed by low-code tools to the workplace is evident in their ability to reveal previously unseen areas of knowledge and talent, in contrast to traditional ICT utilization in the workplace. First, the accessibility of low-code tools that do not require programming languages has expanded the pool of individuals capable of using ICT and the opportunities available to them. Consequently, the utilization of low-code tools has facilitated the manifestation of diverse knowledge and talents that were previously hidden (diversity), expanded opportunities for collaboration (inclusion), and improved the fairness of talent engagement (equity).

7.2. Answer to RQ2

The following countries are examples of countries with specific cultural backgrounds similar to Japanese company's characteristics: Japan (123rd), Saudi Arabia (130th), Türkiye (133rd), Bangladesh (139th), Egypt (140th), Morocco (141st), Pakistan (143rd), etc. Figures in parentheses indicate ranking positions in the "Economic Participation and Opportunity" section of the Global Gender Gap Report 2023.

These countries are distinguished by the fact that their native language is not English. They tend to lag behind other countries in terms of women's participation in society and in technical professions. Japan (123rd) is a case in point, ranking low in the Global Gender Gap Report. Regardless of ranking, it is also considered effective in other regions where the native language is not English, and the percentage of women engaged in STEM is low. As discussed in Section 6.2, a tool such as the Low-code can support the social activities of women in regions with the above characteristics.

8. Conclusions

In conclusion, low codability was found to contribute to DEI in the workplace. Work experience, including projects and training, is a direct cause of career disparity and inequity as such opportunities are not available to all. However, technologies such as LCPs, which can be used without programming or other education, and interactive Generative AI, which provides information that covers a person's lack of experience, can be effective in realizing DEI in the workplace as they work to correct these gaps. However, when using such technology in the workplace, it is not sufficient to simply introduce the tools; management must fully consider the support environment that will accompany the start of use. To externalize the diverse knowledge of individuals, it is necessary to create a cooperative environment, such as a workshop, where the actions of individuals are supported by those around them [46]. Conducting organizational workshops provides an opportunity for diverse individuals to draw on and express their knowledge and ensure the equity of the approach, which can then be discussed and refined by the organization so that knowledge can be mutually recognized as an organizational asset. The use of new technology tools, such as low-code platforms, has been found to have elements that support the SDG goals of decent work and economic growth, as well as gender equality.

Limitations and Future Development

This study focuses on the results of a large Japanese company. The results are considered versatile enough to be deployed in other organizations; however, the validation of a model that encompasses further diversity should be the subject of future research.

The utilization of low-code tools has demonstrated that less-experienced users can also be engaged in the development of ICTs [29,30]. Conversely, there is a concern that management will need to regulate the involvement of inexperienced users in the creation of functions and the functioning of functions that exceed expectations (automatic generation of advanced algorithms through the use of Generative AI) [37,38]. Consequently, from the perspective of management, it is anticipated that advanced optimization algorithms [47] can be employed not only to assist inexperienced users but also to assess the impact of these users' interventions on large-scale mission-critical systems and to mitigate the risk of disruption. Advanced optimization algorithms have been successfully applied in numerous domains, including online learning, scheduling, multi-objective optimization, transportation, medicine, and data classification. For instance, the self-adaptive fast fire-works algorithm has been offering a robust solution approach that adapts dynamically to the problem landscape [47]. Similarly, hyper-heuristics have demonstrated their effectiveness in complex optimization tasks [48]. Future research may wish to explore the potential application of these advanced optimization techniques in the workplace, with a view to investigating the impact on the workspace environment, particularly in the case of new users with limited experience.

Consequently, future research should also consider the potential application of the following techniques to create a supportive environment for less experienced users and managers in the workplace.

Adaptive and self-adaptive algorithms: It would be beneficial to explore how these algorithms can be tailored to specific user needs and problem contexts, with a particular focus on ease of use for beginners.

Hyper-heuristics: Develop higher-order heuristics that can autonomously generate and adapt low-level heuristics to enhance problem-solving capabilities without extensive domain knowledge.

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References

1. Heeks, R. Do information and communication technologies (ICTs) contribute to development? *J. Int. Dev.* **2010**, *22*, 625–640. [[CrossRef](#)]
2. Christensen, K.; Doblhammer, G.; Rau, R.; Vaupel, J.W. Ageing populations: The challenges ahead. *Lancet* **2009**, *374*, 1196–1208. [[CrossRef](#)] [[PubMed](#)]
3. Kramar, R. Beyond strategic human resource management: Is sustainable human resource management the next approach? *Int. J. Hum. Resour. Manag.* **2014**, *25*, 1069–1089. [[CrossRef](#)]
4. Garg, S.; Sangwan, S. Literature review on diversity and inclusion at workplace, 2010–2017. *Vision* **2021**, *25*, 12–22. [[CrossRef](#)]
5. Cunningham, G.B. The moderating effect of diversity strategy on the relationship between racial diversity and organizational performance. *J. Appl. Soc. Psychol.* **2009**, *39*, 1445–1460. [[CrossRef](#)]
6. Bock, A.C.; Frank, U. Low-code platform. *Bus. Inf. Syst. Eng.* **2021**, *63*, 733–740. [[CrossRef](#)]
7. Budhwar, P.; Chowdhury, S.; Wood, G.; Aguinis, H.; Bamber, G.J.; Beltran, J.R.; Boselie, P.; Lee Cooke, F.; Decker, S.; DeNisi, A.; et al. Human resource management in the age of generative artificial intelligence: Perspectives and research directions on ChatGPT. *Hum. Resour. Manag. J.* **2023**, *33*, 606–659. [[CrossRef](#)]
8. Warschauer, M.; Matuchniak, T. New technology and digital worlds: Analyzing evidence of equity in access, use, and outcomes. *Rev. Res. Educ.* **2010**, *34*, 179–225. [[CrossRef](#)]
9. Day, A.; Paquet, S.; Scott, N.; Hambley, L. Perceived information and communication technology (ICT) demands on employee outcomes: The moderating effect of organizational ICT support. *J. Occup. Health Psychol.* **2012**, *17*, 473–491. [[CrossRef](#)]
10. Klaus, H.; Rosemann, M.; Gable, G.G. What is ERP? *Inf. Syst. Front.* **2000**, *2*, 141–162. [[CrossRef](#)]
11. Ahmad, S.; Schroeder, R.G. The impact of human resource management practices on operational performance: Recognizing country and industry differences. *J. Oper. Manag.* **2003**, *21*, 19–43. [[CrossRef](#)]
12. Anand, R.; Winters, M.F. A retrospective view of corporate diversity training from 1964 to the present. *Acad. Manag. Learn. Educ.* **2008**, *7*, 356–372. [[CrossRef](#)]
13. Shani, A.B.; Noumair, D.A. (Eds.) *Research in Organizational Change and Development*; Emerald Publishing Limited: Bingley, UK, 2021.
14. Diener, E. Subjective well-being. *Psychol. Bull.* **1984**, *95*, 542–575. [[CrossRef](#)] [[PubMed](#)]
15. Oswick, C.; Noon, M. Discourses of diversity, equality, and inclusion: Trenchant formulations or transient fashions? *Br. J. Manag.* **2014**, *25*, 23–39. [[CrossRef](#)]
16. Herring, C. Does diversity pay?: Race, gender, and the business case for diversity. *Am. Sociol. Rev.* **2009**, *74*, 208–224. [[CrossRef](#)]
17. Jackson, S.E.; Joshi, A.; Erhardt, N.L. Recent research on team and organizational diversity: SWOT analysis and implications. *J. Manag.* **2003**, *29*, 801–830. [[CrossRef](#)]
18. Jackson, S.E.; Schuler, R.S. Understanding human resource management in the context of organizations and their environments. *Annu. Rev. Psychol.* **1995**, *46*, 237–264. [[CrossRef](#)] [[PubMed](#)]
19. Jehn, K.A.; Northcraft, G.B.; Neale, M.A. Why differences make a difference: A field study of diversity, conflict, and performance in workgroups. *Admin. Sci. Q.* **1999**, *44*, 741–763. [[CrossRef](#)]
20. Jehn, K.A. Diversity, conflict, and team performances summary of program of research. *Perform. Improv. Q.* **1999**, *12*, 6–19. [[CrossRef](#)]
21. Ely, R.J.; Thomas, D.A. Cultural diversity at work: The effects of diversity perspectives on work group processes and outcomes. *Admin. Sci. Q.* **2001**, *46*, 229–273. [[CrossRef](#)]
22. Jackson, S.E.; Ruderman, M.N. *Diversity in Work Teams: Research Paradigms for a Changing Workplace*; American Psychological Association: Washington, DC, USA, 1995; p. xv–271.
23. Cox, T.H.; Blake, S. Managing cultural diversity: Implications for organizational competitiveness. *Acad. Manag. Perspect.* **1991**, *5*, 45–56. [[CrossRef](#)]
24. Köllen, T. Diversity management: A critical review and agenda for the future. *J. Manag. Inq.* **2021**, *30*, 259–272. [[CrossRef](#)]
25. Arsel, Z.; Crockett, D.; Scott, M.L. Diversity, equity, and inclusion (DEI) in the Journal of Consumer Research: A curation and research agenda. *J. Con. Res.* **2022**, *48*, 920–933. [[CrossRef](#)]
26. Ferraro, C.; Hemsley, A.; Sands, S. Embracing diversity, equity, and inclusion (DEI): Considerations and opportunities for brand managers. *Bus. Horiz.* **2023**, *66*, 463–479. [[CrossRef](#)]
27. Van Dijk, J.; Hacker, K. The digital divide as a complex and dynamic phenomenon. *Inf. Soc.* **2003**, *19*, 315–326. [[CrossRef](#)]

28. Friemel, T.N. The digital divide has grown old: Determinants of a digital divide among seniors. *New Media Soc.* **2016**, *18*, 313–331. [[CrossRef](#)]
29. Sanchis, R.; García-Perales, Ó.; Fraile, F.; Poler, R. Low-code as enabler of digital transformation in manufacturing industry. *Appl. Sci.* **2019**, *10*, 12. [[CrossRef](#)]
30. Waszkowski, R. Low-code platform for automating business processes in manufacturing. *IFAC PapersOnLine* **2019**, *52*, 376–381. [[CrossRef](#)]
31. Wang, S.; Wang, H. A teaching module of no-code business app development. *J. Inf. Syst. Educ.* **2021**, *32*, 1.
32. Bhattacharyya, S.S.; Kumar, S. Study of deployment of “low code no code” applications toward improving digitization of supply chain management. *J. Sci. Technol. Policy Manag.* **2021**, *14*, 271–287. [[CrossRef](#)]
33. Chang, Y.-H.; Ko, C.-B. A study on the design of low-code and no code platform for mobile application development. *Int. J. Adv. Smart Converg.* **2017**, *6*, 50–55.
34. Pinho, D.; Aguiar, A.; Amaral, V. What about the usability in low-code platforms? A systematic literature review. *Comput. Lang.* **2023**, *74*, 101185. [[CrossRef](#)]
35. Lund, B.D.; Wang, T. Chatting about ChatGPT: How may AI and GPT impact academia and libraries? *LHTN* **2023**, *40*, 26–29. [[CrossRef](#)]
36. Baǎldoo-anu, D.; Owusu Ansah, L.O. Education in the era of generative artificial intelligence (AI): Understanding the potential benefits of ChatGPT in promoting teaching and learning. *J. Ai* **2023**, *7*, 52–62. [[CrossRef](#)]
37. Brynjolfsson, E.; Li, D.; Raymond, L.R. Generative AI at work. In *SSRN Journal*; No. w.31161; National Bureau of Economic Research: Cambridge, MA, USA, 2023. [[CrossRef](#)]
38. Noy, S.; Zhang, W. Experimental evidence on the productivity effects of generative artificial intelligence. *Science* **2023**, *381*, 187–192. [[CrossRef](#)]
39. World Economic Forum. *Global Gender Gap Report*; World Economic Forum: New York, NY, USA, 2023.
40. Hislop, D.; Bosua, R.; Helms, R. *Knowledge Management in Organizations: A Critical Introduction*; Oxford University Press: Oxford, UK, 2018.
41. Huber, G.P. A theory of the effects of advanced information technologies on organizational design, intelligence, and decision making. *Acad. Manag. Rev.* **1990**, *15*, 47–71. [[CrossRef](#)]
42. Nonaka, I.; Toyama, R.; Konno, N. SECI, Ba and leadership: A Unified Model of dynamic knowledge creation. *Long Range Plann.* **2000**, *33*, 5–34. [[CrossRef](#)]
43. Alavi, M.; Leidner, D. Knowledge management systems: Issues, challenges, and benefits. *Commun. Assoc. Inf. Syst.* **1999**, *1*, 1–28. [[CrossRef](#)]
44. Rossi, C.; Cricelli, L.; Grimaldi, M.; Greco, M. The strategic assessment of intellectual capital assets: An application within Terradue Srl. *J. Bus. Res.* **2016**, *69*, 1598–1603. [[CrossRef](#)]
45. IPA (Information-Technology Promotion Agency, Japan). *Survey on Skill Transformation in the Digital Age (FY2021)*; IPA: Tokyo, Japan, 2022.
46. Nonaka, I.; Takeuchi, H. *The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation*; Oxford University Press: New York, NY, USA, 1995.
47. Chen, M.; Tan, Y. SF-FWA: A Self-Adaptive Fast Fireworks Algorithm for effective large-scale optimization. *Swarm Evol. Comput.* **2023**, *80*, 101314. [[CrossRef](#)]
48. Singh, E.; Pillay, N. A study of ant-based pheromone spaces for generation constructive hyper-heuristics. *Swarm Evol. Comput.* **2022**, *72*, 101095. [[CrossRef](#)]

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