

6th International Conference on Industry 4.0 and Smart Manufacturing

Mapping the Scientific Landscape of Integrated Scheduling Towards Industry 5.0 with A Bibliometric Analysis

Anak Agung Ayu Putri Ardyanti^{a,b}, Zhiqiang Xie^{a*}, Andrea Stevens Karnyoto^c, Bens Pardamean^{c,d}, Ni Made Estiyanti^{b,e}

^a*School of Computer Science and Technology, Harbin University of Science and Technology, Harbin, 150000, China*

^b*Faculty of Information Technology and Design, Primakara University, Bali, 80226, Indonesia*

^c*Bioinformatics and Data Science Research Center Bina Nusantara University, Jakarta, Indonesia 11480*

^d*Computer Science Department, BINUS Graduate Program - Master of Computer Science Bina Nusantara University Jakarta, Indonesia 11480*

^e*Doctoral School of Management and Business, University of Debrecen, Debrecen, Hungary*

Abstract

The industry is rapidly transitioning from the 4.0 era to the 5.0 era, prompting renewed interest among scholars in scheduling problems. They allow operations to process and assemble various components simultaneously. This bibliometric analysis provides a comprehensive understanding of the diverse research perspectives on the potential challenges of integrated scheduling within the framework. We identified 357 Scopus articles and analysed co-occurrence keyword (CNK) by VOSViewer tools and Global Citation Score (GCS) by Scopus tools. The research data obtained from 1993 to 2023 mainly in the subject areas of Engineering, Computer Science, Maths, and others. CNK identified six cluster keywords, and nine most cited articles based on normalised GCS. These results contribute to our understanding of the development of scheduling algorithms, shifting from an emphasis on manufacturing transfers to contemporary demand-centric research directions. Furthermore, this research provides a valuable perspective for policymakers, plant personnel, and manufacturing managers to make informed decisions.

© 2025 The Authors. Published by Elsevier B.V.

This is an open access article under the CC BY-NC-ND license (<https://creativecommons.org/licenses/by-nc-nd/4.0>)

Peer-review under responsibility of the scientific committee of the 6th International Conference on Industry 4.0 and Smart Manufacturing

Keywords: integrated scheduling; assembly job shop scheduling; heuristic algorithm; genetic algorithm; bibliometric analysis.

* Corresponding author. Tel.: +0-000-000-0000 ; fax: +0-000-000-0000 .

E-mail address: xiezhiqiang@hrbust.edu.cn

1. Introduction

The industrial sector faces significant challenges with scheduling, as there is often a disconnect between utilizing manufacturing resources effectively and optimizing production goals and cost efficiency. Pinedo [1] argues that scheduling issues in manufacturing typically arise when problems occur in the machining process at work centres while assigning order or sequence numbers, leading to busy machines and ineffective prioritization. Common computer scheduling problems include flow shops, job shops, flexible job shops, open shops, single machines, and parallel machines. Efficient scheduling nowadays is important for cutting production expenses, maximizing resource usage, and account production effectiveness [2], [3]. By applying effective scheduling techniques and approaches, maximizing and optimizing resource utilization and efficiently carrying out operations is possible [4]. In modern manufacturing practices, scheduling involves systematically and logically arranging production tasks according to pre-established plans and market requirements [5]. Production scheduling involves determining the timing, product sequence, task priorities, equipment order, and managing human workers [2].

The government must play an active role by conducting strategic research, providing planning guidance, and implementing supportive policies to strengthen the manufacturing sector. There is compelling evidence to suggest how to has evolved significantly from the automated production era, as exemplified by Industry 3.0, to a more human-centric paradigm embodied by Smart Industry 5.0. The knowledge transfer from Industry 3.0, one by one, to Industry 4.0 and rapidly go to Industry 5.0, represents a fundamental shift in how businesses operate, moving away from a purely mechanized approach towards one that emphasizes the role of human workers and their collaboration with advanced technologies [2], [4], [5]. Most contemporary scheduling optimization problems are highly nonlinear and involve variables subject to boundary constraints and multiple functions. Scheduling problems consist are NP-hard or nonlinear programming problems or constrained optimization [6], [7].

Integrated scheduling (IS) is an advanced method derived from job shop scheduling job shop scheduling (JSS). Unlike traditional JSS, which requires all components to be processed before assembly, IS allows for simultaneous processing and assembly, enhancing flexibility and efficiency. Consequently, IS holds significant research and practical value for producing intricate large products, customized small-batch products, and complex components. Xie [8] proposed integrated scheduling (IS) to address the shortcomings of traditional workshop scheduling, which separates processing and assembly. The paper discusses the integrated scheduling problem and algorithms, referring to equipment as devices or machines, and operations as processes, without distinguishing between assembly and machining.

A basic search of research is needed to understand why this research is being done. Based on the connectedness of the literature on the relationship between Integrated Scheduling (IS) OR assembly job shop scheduling (AJSS), three research questions will be answered with scientific reasons: 1) What is the classification based on trend keyword of ISP? 2) What is the model-based solutions for ISP? and 3) What are the challenges and future work directions of ISP?

This bibliometric analysis is intended to support researchers, with a specific focus on integrated scheduling, by examining the progression of research in this area leading up to the peak of Industry 4.0 development and looking towards the broader implications of Industry 5.0.

Our study discusses the significance of visualization analysis and bibliometric review in understanding the research landscape of integrated scheduling. Conducted a comprehensive search and evaluation of published evidence, including build case studies and summary review papers related to integrated scheduling. How to identify trends, research gaps, and patterns knowledge, providing a new comprehensive mapping overview of the subject research. Using CNK and GCS (bibliometric framework Fig.1). This combination of bibliometric analysis review and visualization (BARV) methods emphasizes the importance of understanding integrated scheduling algorithms and manufacturing steps in the development of assembly and manufacturing technologies. Overall, this study highlights the value of these analytical techniques in gaining a clearer and more comprehensive understanding of the research landscape.

In Section 2, we outline our research approach comprehensively, covering materials and methods. Subsequently, the findings are examined and discussed in Section 3. The connection among the most significant technologies is also highlighted concerning the most beneficial 4.0/5.0 technologies, while the solutions are introduced in Section 4. Section 5 provides a detailed conclusion. A diagram illustrating the topics addressed in this study is shown in Fig. 1.

2. Materials and Methods

The Scopus database is widely known for literary research, offering a comprehensive collection of content for academic investigations. It can classify publications by author names and segregate columns based on profiles or sources. Scopus's impact metrics are as effective as or better than WoS's, and less prone to manipulation [7] [8].

In our initial research, 358 articles were found in Scopus, only 9 in WoS. Scopus offers detailed source info, metrics, and author identity. It is preferred for its wide publication range globally. Scopus has more journals than other databases, aiding citation analysis, especially for post-1995 papers. Scopus is valuable due to its broad coverage and accessible data [11], [12], [13].

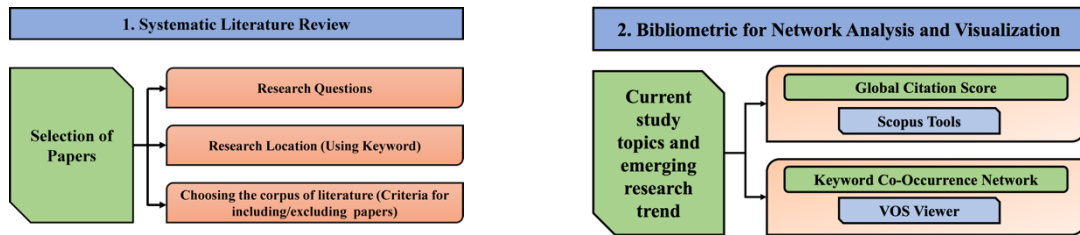


Fig. 1. SLNA Methodology Systematic Literature Review (SLR) (a), Bibliometric for Network Analysis and Visualization (BNAV) (b)

The researchers used a SLNA for literature selection and assessment, comprising two main components. The initial phase involves a bibliometric review prioritizing transparency, inclusivity, and reducing biases. Tools like BNA and Visualization help identify research topics using methods like CNK and GCS, a part of bibliometric analysis, uses citation analysis to link research streams. Network analysis identifies research clusters and field breadth. The study aligns its methodology with reputable review articles on integrated scheduling challenges.

VOSviewer software (VoS 1.6.20) enhances qualitative analysis alongside bibliometrics. It evaluates keywords, titles, and abstracts to reduce biases, improve validity, and enhance construct repeatability. Accessing Scopus data, VoSviewer visualizes item relationships and identifies key elements in research clusters. It introduces CNK, offering insights into authors, journals, and research clusters in academic literature. [14]

3. Results

Systematic literature review

This research undertook a comprehensive literature review using targeted keywords to explore the interrelations of integrated scheduling. We focused on compiling a refined search list to identify relevant publications for the initial bibliographic search. The research query encompassed a range of terms, synonyms, and acronyms related to "Integrated Scheduling," "Assembly Job Shop Scheduling," or "Tree-Structured Products." It incorporated a Genetic Algorithm to develop a novel optimizing algorithm. The primary literature review in Scopus, with the most citations, was analyzed. (Equation 1):

$$\text{TITLE-ABS-KEY} (\text{"integrated scheduling"} \text{ OR } \text{"assembly job shop scheduling"} \text{ OR } \text{"tree-structured products"}) \text{ AND } (\text{"Genetic Algorithm"}) \quad (1)$$

A search conducted on November 20, 2023, using the Scopus search engine yielded 487 articles through searches of titles, keywords, and abstracts. Of these, 443 articles were identified in Engineering, Computer Science, and Mathematics. These articles were categorized as articles, book chapters, conference papers, reviews, conference reviews, and book chapters, totaling 440, with 358 being in English. After removing duplicates, the total number of unique articles available to address research questions was 357 (Table 1). After acquiring clean data, the subject area percentage is calculated as follows: Engineering (29.8%), Computer Science (27.5%), Mathematics (12.7%), Decision

Sciences (9.0%), Business, Management and Accounting (6.3%), Other (10.3%). China (218) is the leader in integrated scheduling research. Regionally, 72.53% of the papers are from Asia, 16.67% from Europe, 8.45% from the Americas, 0.94% from Africa, 0.47% from Australia, New Zealand, and Oceania, and 0.94% from unspecified locations, from data showing how the term "paper" has been searched for from 1993 to 2024.

Tabel 1. procedure and results

Steps	Results
TITLE-ABS-KEY ("integrated scheduling" OR "assembly job shop scheduling" OR "tree structured products") AND ("Genetic Algorithm")	487 articles
Filter by years (1993-2024)	487 articles
Filter by subject area (Engineer, computer science, mathematics)	443 articles
document type (review, article, conference review, book chapter, conference paper)	440 articles
Filter by language (English)	358 articles
Removed duplicate documents based on "author" and "title"	357 articles

Bibliographic network analysis and visualization

Co-occurrence network of keywords (CNK)

Co-occurrence network analysis to analyse selected terms in research publications. This method involves examining how frequently certain words appear together in publications to identify patterns and trends in a particular discipline. Using VOSviewer, researchers can create visual maps of keyword networks based on co-occurrence analysis (Fig. 2).

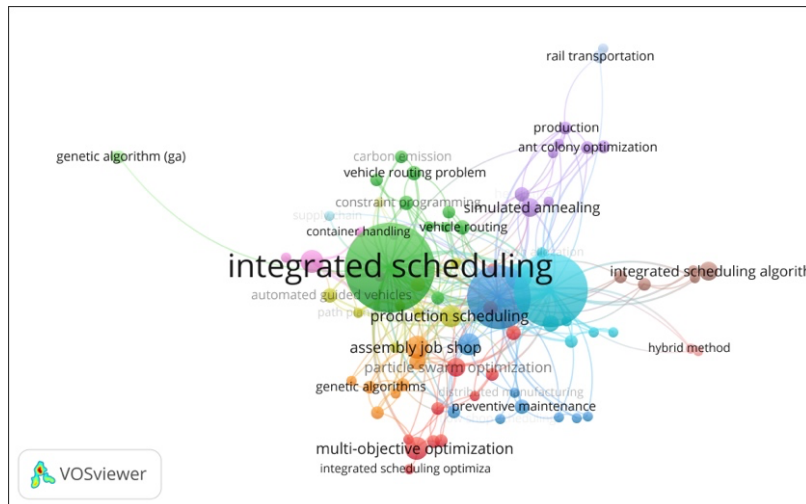


Fig. 2. Co-occurrence of Keywords Network Map

To perform a co-occurrence analysis in VOSviewer, researchers typically follow specific procedures, such as extracting keywords from publications, cleaning the data by combining synonyms and abbreviations and creating a batch file for analysis. It is crucial to emphasize that minimum number of co-occurrences are 3 times to be incorporated into the network analysis. By utilizing co-occurrence analysis and visualizing keyword networks, researchers can gain insights into the relationships between different terms and identify key themes and trends within their research field. This approach can help researchers better understand the literature landscape and inform future research directions. Table 2 provides detailed information on keywords and clusters.

Global citation score analysis

As described in references [15], the GCS analysis is a valuable tool for identifying ground-breaking papers and assessing their impact within the scientific community. The GCS provides a comprehensive measure of a publication's influence by evaluating its citations across the entire database, regardless of its network connections. Table 3 shows that the research articles with the top normalized GCS are those relevant to Co-occurrence Analysis (CoA). Based on the outcomes of the investigation, relevant research can be considered in the most relevant citation coexistence networks.

Table 2. Grouping research subjects according to CNK analysis

C*	Keywords	TLS*	TO*	Main research topics
1	multi-objective optimization, particle swarm optimization, local search, mixed-integer linear programming, assembly, assembly job shop scheduling, evolutionary algorithm, flexible job shop scheduling, cloud manufacturing, integrated scheduling optimization, meta-heuristic, supply chain management	74	55	Single or multi-objective optimization using EA are suggested to address IS or AJSS challenges in manufacturing.
2	integrated scheduling, constraint programming, vehicle routing, vehicle routing problem, carbon emission, dynamic scheduling, integration, mixed integer programming, job shop, material handling	142	111	Single/multi-objective FISA with tree-structure
3	scheduling, optimization, preventive maintenance, production and transportation, distributed manufacturing, low shop scheduling, meta-heuristics, multi-objective optimization, time window	106	77	Integrated distributed scheduling optimization
4	production scheduling, automated guided vehicles, flexible, manufacturing system, agv, automated guided vehicle, hybrid genetic algorithm, makespan, path planning	70	34	IS optimization based on intelligent manufacturing and AGV
5	simulated annealing, heuristics, ant colony optimization, production, tt&c, distribution, flexible manufacturing systems, inventory	54	33	Heuristic methods for manufacturing system
6	genetic algorithm, container terminal, integrated scheduling problem, maintenance, metaheuristic, quay crane, berth allocation, project scheduling	137	137	Evolution of Genetics Algorithm

C*: Cluster; TLS*: Total link strength; TO*: Total Occurrence

Table 3. Ranking of the 9 most cited articles based on normalized GCS

Rank	Topic	Authors	Publication Year	Journal	Appearance in Cluster	GCS	Normalized GCS*
1	AGV	Zhong [16]	2020	CIE	1,2,3,4,6	133	12,5
2	Satellite imaging & data transmission	Zhang J., Xing L.[18]	2022	COR	2 and 6	22	8
3	A constraint-based scheduling system	Ham [19]	2018	TR	2 and 3	166	7,3
4	Blockchain	Zeng [20]	2023	IJPR	2,3, and 6	8	7
5	AGV	Liang [21]	2023	Mathematics	6	7	7
6	AGV	Yang [22]	2018	CIE	2,3,4,6	119	5,8
7	Hybrid flow shop	Li [23]	2022	CJME	2,3,4,5	16	5,5
8	Autonomous CT	Xu [24]	2021	CIE	1,2,3,4,6	29	5,3
9	Integrate scheduling	Wang [17]	2021	AEI	1,2,3,4,5,6	27	5,3

Nevertheless, there are some research papers with significantly larger normalized GCS values [16], and some with lower normalized GCS values [17]. Despite the fact that the paper by Zhong et al [16] was published in 2020, it has received a great deal of citations. It has been observed that papers tend to attract more citations in the immediate post-publication period. As a result, we can conclude that these articles constitute pioneering research and provide a roadmap for future research.

4. Discussion

Classification integrated scheduling based on keywords trend

This research was conducted to investigate the effectiveness of the ISP and introduce a novel scheduling approach for complex and small-batch manufacturing. This bibliometric review aims to provide a thorough understanding and visual representation of different research viewpoints on the ISP challenge within the framework of Industry 5.0. The

articles explained the evolution of scheduling algorithms from AJSP to IS from 1993 to 2023. The key innovation of the paper lies in its sophisticated research methodologies, which facilitate a deep understanding and visualization of various approaches to integrated scheduling problems. In addition, the data visualization analysis delivered an unprecedented viewpoint on the interconnectedness as well as the evolving ideas for classifying integrated scheduling problems based on the keywords (Table 2), the most cited article (Table 3) and over a period of 10 years and mapping by detail area (Table 4).

Table 4. Classification of integrated scheduling problems

Detail Area/Research Stream	Type of IS applied and references
Integrated Scheduling for Manufacturing and Assembly	Multi-flexible ISP [25], in Hybrid Flowshop and AS/RS with GA-MBO [26], ABC algorithm [27], with no-wait constraints [28], complex products with tree structure [29], Ant Colony Algorithm [30], mixed integer linear programming (MILP) [31].
Planning Scheduling	Hybrid genetic algorithm and tabu search [32], for production and preventive maintenance [33], design of loop layout [34].
Assembly job shop scheduling	Ensure that the completion cost, the early arrival of workers, and the training costs are as minimal as possible [35], for complex mechanical and electronic products assembly line [36][36], PSO and artificial immune [37], multi-objective dynamic, operation, and tree-structure [38].
Production and distribution	Unrelated for parallel machines and delivery trucks [39], review [40], single products (40), multistage stochastic (47), Job Shop with Ant Colony Algorithm [41], MTO supply chain [42]. 1/12/25 2:24:00 PM
Control/ robotics	GA ISP Low-Carbon Op. Perspective [43].
AVG and Machine	Flexible manufacturing combine transportation and production [44], an ISP for single machines and multi-vehicle routes [45].
Automated Container Terminal	The Three-Stage and Improved Genetic Algorithm [46], time windows [47], Adaptive Autotuning [48], Hybrid GA, PSO base Fuzzy system [49], Wharf Apron [50].
Logistics	Memetic algorithms [51], metaheuristic routing with large neighbourhood searching algorithm [52].
Supply chain	Storm optimisation algorithm [20].
Energy and Carbon	The EMTLBO algorithm is a multi-objective optimization algorithm by utilizing teaching and learning [53], vehicle [45].
Security Systems	NSGA II [54].
Health	Monitoring and predict failure [55], predictive maintenance [56]. Home healthcare [57], MOIPs [58].

Solution for integrated scheduling

From Gao 2020 [29] and 2021 [59] introduce the process structure of the product studied by integrated scheduling is generally tree-like, usually called process tree. As it shown in (Fig. 4), the process structure in Fig. 4(a) is a flat structure, of which the production process only has single layer assembly operation. The process structure in Fig. 4(b) is a tall structure. This structure has a multi-layer assembly operation, and each layer has only one assembly operation. Several tall structures and flat structures form the complex structure shown in Fig. 4(c). The products in integrated scheduling problem are usually with complex structures.

The square leaf node is the material or purchased parts. The square node is the assembly or component. The square root node is the final assembly or product. The circular node represents the operation. A process tree can only contain circular nodes for operations. The process tree in Fig. 4(c) contains only operation nodes for complex products. Nodes have arrows showing priority constraints between operations. Arrows point from high to low-priority operations. Low-priority operations can only be done after high priority ones. The known information contained in each operation in the process tree can be represented in three elements group $\alpha/\beta/\gamma$, where α indicate the name of the operation, β indicate the name of the machine, and γ indicate the processing information (processing time). For example, $A_1/M_3/5$ means that it takes A_1 about 5 units of processing time to be processed on machine M_3 .

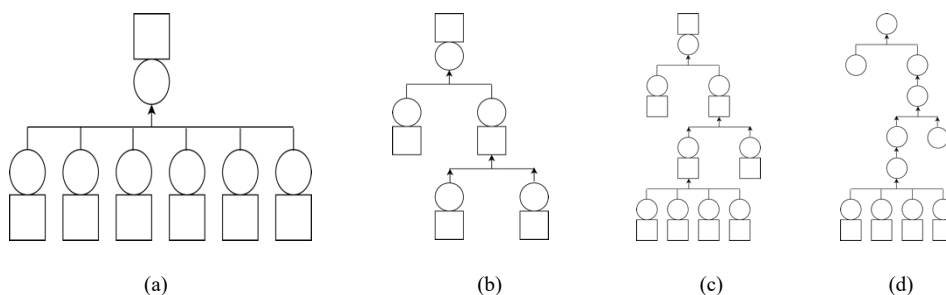


Fig. 3. Diagram of process structure a) flat structure, (b) tall structure, (c) complex structure, (d) Process tree corresponding to complex structure in figure (a), (b), (c) [59] [29]

Future Research Direction

These results contribute to our comprehension of the progression of the Scheduling Algorithm, shifting from an emphasis on manufacturing transfer to contemporary research directions centered around demand. The integrated scheduling problem's next work direction is combining multi-objective problems and adding more encoding layers. Additionally, this research provides valuable perspectives for policymakers, factory personnel, and manufacturing managers to make well-informed decisions (Table 5).

Table 5. Future Research Direction

Research Stream	Future Research Direction
Production and distribution	The Multi Flexible Integrated Scheduling Algorithm (MFISA) can be combined with strategies for multiple workshops or other constraints to address an extension of the MFISP, and it can be further adapted to dynamic settings [22] [26], including GA, ACO, PSO, and others, while creating more effective and efficient solutions for the issue[31], [32], [40].
Control/ robotics	Additional practical limitations will be factored in to finalize the P_QYY model, including YT/YS conflicts, storage space allocation, and the due date or readiness time of containers [43].
AVG and Machine	A complex distribution factor, namely, taking into account the travel speed as a variable for decision-making or the traffic state of a roadway system, could be intriguing [45].
Automated Container Terminal	The processing duration of HGA-PSO remains quite extensive when addressing large-scale experiments, dynamic real-time scheduling issues [48], AI [49]
Logistics	Adding one or more heuristics to tackle larger cases, as the complexity of these issues renders exact methods ineffective [52].
Supply chain	Sustainable SCS decision-making framework based on multi-supplier, multi-manufacturer, and multi-distributor across three echelons, along with the SBSO algorithm, offers an innovative approach for supply chain scheduling [20].
Energy and Carbon	Taking into account the speed of travel as a variable in decision-making or the traffic state of a roadway system could be intriguing [45].
Security Systems	Taking into account the addition of diverse nodes [54]
Health	A deeper analysis of the data needed to implement the suggested model in industry operations and predictive maintenance could facilitate a dynamic production scheduling process that integrates maintenance [55], [56], [57].

5. Conclusion

This study aimed to bring a fresh perspective on the advancements and existing status of integrated scheduling research. Moreover, we can better understand and describe various research viewpoints on the complex issues of IS in the framework of Industry 5.0. Six key themes and trends in integrated scheduling research were identified:

manufacturing and assembly integrated scheduling, AGV, supply chain scheduling, energy and carbon, security systems, and health production. Moreover, this analysis offered a unique viewpoint concept to interconnect the literature and newly highlighted areas for further investigation. In recent years, manufacturing, IoT, and Artificial Intelligence based on optimization algorithms have been the primary areas of research interest. It can also deepen our perception of the organization's contribution to advancing manufacturing toward Industry 5.0.

References

- [1] M. L. Pinedo, *Scheduling*, vol. 29. Springer, 2016.
- [2] B. Wang et al., “Human Digital Twin in the context of Industry 5.0,” *Robotics and Computer-Integrated Manufacturing*, vol. 85, p. 102626, 2024.
- [3] D. Ariansyah, B. Pardamean, and G. Caruso, “The effect of visual advanced driver assistance systems on a following human driver in a mixed-traffic condition,” *Procedia Computer Science*, vol. 216, pp. 221–229, 2023, doi: 10.1016/j.procs.2022.12.130.
- [4] T. Mraih, O. B. Driss, and H. B. El-Haouzi, “Distributed permutation flow shop scheduling problem with worker flexibility: Review, trends and model proposition,” *Expert Systems with Applications*, p. 121947, 2023.
- [5] C. Destouet, H. Tlahig, B. Bettayeb, and B. Mazari, “Flexible job shop scheduling problem under Industry 5.0: A survey on human reintegration, environmental consideration and resilience improvement,” *Journal of Manufacturing Systems*, vol. 67, pp. 155–173, 2023.
- [6] K. Deb, “An efficient constraint handling method for genetic algorithms,” *Computer methods in applied mechanics and engineering*, vol. 186, no. 2–4, pp. 311–338, 2000.
- [7] D. Ariansyah, B. Pardamean, E. Barbaro, and J. A. Erkoyuncu, “Augmented reality training for improved learnability,” *CIRP Journal of Manufacturing Science and Technology*, vol. 48, pp. 19–27, Feb. 2024, doi: 10.1016/j.cirpj.2023.11.003.
- [8] Z. Xie, P. Wang, N. Chang, and X. Shao, “Flexible integrated scheduling algorithm base on static processing time,” in *2011 International Conference on Computer Science and Service System (CSSS)*, IEEE, 2011, pp. 1279–1282.
- [9] D. Máté, N. M. Estiyanti, and A. Novotny, “How to support innovative small firms? Bibliometric analysis and visualization of start-up incubation,” *Journal of Innovation and Entrepreneurship*, vol. 13, no. 1, p. 5, 2024.
- [10] K. R. Powell and S. R. Peterson, “Coverage and quality: A comparison of Web of Science and Scopus databases for reporting faculty nursing publication metrics,” *Nursing outlook*, vol. 65, no. 5, pp. 572–578, 2017.
- [11] M. E. Falagas, V. D. Kouranos, R. Arencibia-Jorge, and D. E. Karageorgopoulos, “Comparison of SCImago journal rank indicator with journal impact factor,” *The FASEB journal*, vol. 22, no. 8, pp. 2623–2628, 2008.
- [12] M. E. Falagas, E. I. Pitsouni, G. A. Malietzis, and G. Pappas, “Comparison of PubMed, Scopus, web of science, and Google scholar: strengths and weaknesses,” *The FASEB journal*, vol. 22, no. 2, pp. 338–342, 2008.
- [13] D. Ariansyah, G. Colombo, and B. Pardamean, “Toward Learning Factory for Industry 4.0: Virtual Reality (VR) for Learning Human–Robot Collaboration,” in *Innovative Technologies in Intelligent Systems and Industrial Applications*, vol. 1029, S. C. Mukhopadhyay, S. M. N. A. Senanayake, and P. W. C. Withana, Eds., in Lecture Notes in Electrical Engineering, vol. 1029, Cham: Springer Nature Switzerland, 2023, pp. 101–111. doi: 10.1007/978-3-031-29078-7_10.
- [14] C. J. Waaijer, C. A. van Bochove, and N. J. van Eck, “On the map: Nature and Science editorials,” *Scientometrics*, vol. 86, no. 1, pp. 99–112, 2011.
- [15] F. Strozzi, C. Colicchia, A. Creazza, and C. Noè, “Literature review on the ‘Smart Factory’ concept using bibliometric tools,” *International Journal of Production Research*, vol. 55, no. 22, pp. 6572–6591, Nov. 2017, doi: 10.1080/00207543.2017.1326643.
- [16] M. Zhong, Y. Yang, Y. Dessouky, and O. Postolache, “Multi-AGV scheduling for conflict-free path planning in automated container terminals,” *Comput Ind Eng*, vol. 142, 2020, doi: 10.1016/j.cie.2020.106371.
- [17] H. Wang, Q. Yan, and S. Zhang, “Integrated scheduling and flexible maintenance in deteriorating multi-state single machine system using a reinforcement learning approach,” *Adv. Eng. Inf.*, vol. 49, 2021, doi: 10.1016/j.aei.2021.101339.
- [18] J. Zhang and L. Xing, “An improved genetic algorithm for the integrated satellite imaging and data transmission scheduling problem,” *Comp. Oper. Res.*, vol. 139, 2022, doi: 10.1016/j.cor.2021.105626.
- [19] A. M. Ham, “Integrated scheduling of m-truck, m-drone, and m-depot constrained by time-window, drop-pickup, and m-visit using constraint programming,” *Transp. Res. Part C Emerg. Technol.*, vol. 91, pp. 1–14, 2018, doi: 10.1016/j.trc.2018.03.025.
- [20] M. Zeng, K. Sadeghzadeh, and T. Xiong, “A three-echelon based sustainable supply chain scheduling decision-making framework under the blockchain environment,” *Int J Prod Res*, vol. 61, no. 14, pp. 4951–4971, 2023, doi: 10.1080/00207543.2022.2059719.
- [21] C. Liang, Y. Zhang, and L. Dong, “A Three Stage Optimal Scheduling Algorithm for AGV Route Planning Considering Collision Avoidance under Speed Control Strategy,” *Mathematics*, vol. 11, no. 1, 2023, doi: 10.3390/math11010138.
- [22] Y. Yang, M. Zhong, Y. Dessouky, and O. Postolache, “An integrated scheduling method for AGV routing in automated container terminals,” *Comput Ind Eng*, vol. 126, pp. 482–493, 2018, doi: 10.1016/j.cie.2018.10.007.
- [23] W. Li, D. Han, L. Gao, X. Li, and Y. Li, “Integrated Production and Transportation Scheduling Method in Hybrid Flow Shop,” *Chin J Mech Eng Engl Ed*, vol. 35, no. 1, 2022, doi: 10.1186/s10033-022-00683-7.
- [24] B. Xu, D. Jie, J. Li, Y. Yang, F. Wen, and H. Song, “Integrated scheduling optimization of U-shaped automated container terminal under loading and unloading mode,” *Comput Ind Eng*, vol. 162, 2021, doi: 10.1016/j.cie.2021.107695.
- [25] D. Yang, Z. Xie, and C. Zhang, “Multi-flexible integrated scheduling algorithm for multi-flexible integrated scheduling problem with setup times,” *Math. Biosci. Eng.*, vol. 20, no. 6, pp. 9781–9817, 2023, doi: 10.3934/mbe.2023429.
- [26] J. Lu, L. Xu, J. Jin, and Y. Shao, “A Mixed Algorithm for Integrated Scheduling Optimization in AS/RS and Hybrid Flowshop,” *Energies*, vol. 15, no. 20, 2022, doi: 10.3390/en15207558.
- [27] X. Li, J. Lu, C. Yang, and J. Wang, “Research of Flexible Assembly Job-Shop Batch-Scheduling Problem Based on Improved Artificial Bee Colony,” *Front. Bioeng. Biotechnol.*, vol. 10, 2022, doi: 10.3389/fbioe.2022.909548.
- [28] Z. Xiaowei, X. Zhiqiang, S. Xia, and X. Yingchun, “An integrated scheduling method for personalized products with no-wait constraints,”

- Int J Adv Manuf Technol*, 2022, doi: 10.1007/s00170-022-09394-8.
- [29] Y. Gao, Z. Xie, and X. Yu, "A hybrid algorithm for integrated scheduling problem of complex products with tree structure," *Multimedia Tools and Applications*, vol. 79, pp. 32285–32304, 2020.
- [30] B.-Y. Cheng, J. Y.-T. Leung, and K. Li, "Integrated scheduling of production and distribution to minimize total cost using an improved ant colony optimization method," *Comput Ind Eng*, vol. 83, pp. 217–225, 2015, doi: 10.1016/j.cie.2015.02.017.
- [31] S. Zhang and S. Wang, "Flexible assembly job-shop scheduling with sequence-dependent setup times and part sharing in a dynamic environment: Constraint programming model, mixed-integer programming model, and dispatching rules," *IEEE Trans Eng Manage*, vol. 65, no. 3, pp. 487–504, 2018, doi: 10.1109/TEM.2017.2785774.
- [32] Y. Yang, X. Zhu, and A. Haghani, "Multiple Equipment Integrated Scheduling and Storage Space Allocation in Rail–Water Intermodal Container Terminals Considering Energy Efficiency," *Transp Res Rec*, vol. 2673, no. 3, pp. 199–209, 2019, doi: 10.1177/0361198118825474.
- [33] S. Chansombat, P. Pongcharoen, and C. Hicks, "A mixed-integer linear programming model for integrated production and preventive maintenance scheduling in the capital goods industry," *Int J Prod Res*, vol. 57, no. 1, pp. 61–82, 2019, doi: 10.1080/00207543.2018.1459923.
- [34] K. Mallikarjuna, V. Veeranna, and K. H. Reddy, "A new meta-heuristics for optimum design of loop layout in flexible manufacturing system with integrated scheduling," *Int J Adv Manuf Technol*, vol. 84, no. 9–12, pp. 1841–1860, 2016, doi: 10.1007/s00170-015-7715-9.
- [35] X.-Q. Wan and H.-S. Yan, "Integrated scheduling and self-reconfiguration for assembly job shop in knowledgeable manufacturing," *Int J Prod Res*, vol. 53, no. 6, pp. 1746–1760, 2015, doi: 10.1080/00207543.2014.958595.
- [36] L. Yabo, W. Yang, and Z. Feng, "Optimization algorithm for balancing and sequencing mixed assembly line," in *Lect. Notes Comput. Sci.*, Springer Verlag, 2014, pp. 422–431. doi: 10.1007/978-3-319-09265-2_43.
- [37] H. Du, D. Liu, and M.-H. Zhang, "A hybrid algorithm based on particle swarm optimization and artificial immune for an assembly job shop scheduling problem," *Math. Probl. Eng.*, vol. 2016, 2016, doi: 10.1155/2016/3938679.
- [38] Q. Lei, W. Guo, and Y. Song, "Integrated scheduling algorithm based on an operation relationship matrix table for tree-structured products," *International Journal of Production Research*, vol. 56, no. 16, pp. 5437–5456, 2018.
- [39] D.-Y. Wang, O. Grunder, and A. El Moudni, "Integrated scheduling of production and distribution operations: A review," *Int. J. Ind. Syst. Eng.*, vol. 19, no. 1, pp. 94–122, 2015, doi: 10.1504/IJISE.2015.065949.
- [40] B.-Y. Cheng, J. Y.-T. Leung, and K. Li, "Integrated scheduling on a batch machine to minimize production, inventory and distribution costs," *Eur J Oper Res*, vol. 258, no. 1, pp. 104–112, 2017, doi: 10.1016/j.ejor.2016.09.009.
- [41] Z.-H. Jia, S.-Y. Huo, K. Li, and H.-P. Chen, "Integrated scheduling on parallel batch processing machines with non-identical capacities," *Eng Optim*, vol. 52, no. 4, pp. 715–730, 2020, doi: 10.1080/0305215X.2019.1613388.
- [42] Z. He, Z. Guo, and J. Wang, "Integrated scheduling of production and distribution operations in a global MTO supply chain," *Enterp. Inf. Syst.*, vol. 13, no. 4, pp. 490–514, 2019, doi: 10.1080/17517575.2018.1428770.
- [43] Y. Zheng, M. Xu, Z. Wang, and Y. Xiao, "A Genetic Algorithm for Integrated Scheduling of Container Handling Systems at Container Terminals from a Low-Carbon Operations Perspective," *Sustainability*, vol. 15, no. 7, 2023, doi: 10.3390/su15076035.
- [44] D. B. M. Fontes and S. M. Homayouni, "Joint production and transportation scheduling in flexible manufacturing systems," *J of Global Optim*, vol. 74, no. 4, pp. 879–908, 2019, doi: 10.1007/s10898-018-0681-7.
- [45] J. Wang, S. Yao, J. Sheng, and H. Yang, "Minimizing total carbon emissions in an integrated machine scheduling and vehicle routing problem," *J. Clean. Prod.*, vol. 229, pp. 1004–1017, 2019, doi: 10.1016/j.jclepro.2019.04.344.
- [46] Y. Lu, "The Three-Stage Integrated Optimization of Automated Container Terminal Scheduling Based on Improved Genetic Algorithm," *Math. Probl. Eng.*, vol. 2021, 2021, doi: 10.1155/2021/6792137.
- [47] C. Low, R.-K. Li, and C.-M. Chang, "Integrated scheduling of production and delivery with time windows," *Int J Prod Res*, vol. 51, no. 3, pp. 897–909, 2013, doi: 10.1080/00207543.2012.677071.
- [48] M. Zhong, Y. Yang, Y. Zhou, and O. Postolache, "Adaptive Autotuning Mathematical Approaches for Integrated Optimization of Automated Container Terminal," *Math. Probl. Eng.*, vol. 2019, 2019, doi: 10.1155/2019/7641670.
- [49] M. Zhong, Y. Yang, Y. Zhou, and O. Postolache, "Application of hybrid GA-PSO based on intelligent control fuzzy system in the integrated scheduling in automated container terminal," *J. Intelligent Fuzzy Syst.*, vol. 39, no. 2, pp. 1525–1538, 2020, doi: 10.3233/JIFS-179926.
- [50] M. Zhu, C. Zhou, and A. Che, "Simulation-Optimization Approach for Integrated Scheduling at Wharf Apron in Container Terminals," in *Proc. Winter Simul. Conf.*, Feng B., Pedrielli G., Peng Y., Shashaani S., Song E., Corlu C.G., Lee L.H., Chew E.P., Roeder T., and Lendermann P., Eds., Institute of Electrical and Electronics Engineers Inc., 2022, pp. 1944–1955. doi: 10.1109/WSC57314.2022.10015248.
- [51] F. Qiu, N. Geng, and H. Wang, "An improved memetic algorithm for integrated production scheduling and vehicle routing decisions," *Comp. Oper. Res.*, vol. 152, 2023, doi: 10.1016/j.cor.2022.106127.
- [52] L. Berghman, Y. Kergosien, and J.-C. Billaut, "A review on integrated scheduling and outbound vehicle routing problems," *Eur J Oper Res*, vol. 311, no. 1, pp. 1–23, 2023, doi: 10.1016/j.ejor.2022.12.036.
- [53] W. Tan, X. Yuan, J. Wang, H. Xu, and L. Wu, "Multi-objective teaching–learning-based optimization algorithm for carbon-efficient integrated scheduling of distributed production and distribution considering shared transportation resource," *J. Clean. Prod.*, vol. 406, 2023, doi: 10.1016/j.jclepro.2023.137061.
- [54] S. Huang, C. Zhou, N. Xiong, S.-H. Yang, Y. Qin, and Q. Zhang, "A general real-time control approach of intrusion response for industrial automation systems," *IEEE Trans. Syst. Man Cybern. Syst.*, vol. 46, no. 8, pp. 1021–1035, 2016, doi: 10.1109/TSMC.2015.2469688.
- [55] S. Zhai, A. Riess, and G. Reinhart, "Formulation and solution for the predictive maintenance integrated job shop scheduling problem," in *IEEE Int. Conf. Progn. Health Manag., ICPHM*, Institute of Electrical and Electronics Engineers Inc., 2019. doi: 10.1109/ICPHM.2019.8819397.
- [56] A. Ladj, F. B.-S. Tayeb, and C. Varnier, "Tailored Genetic Algorithm for Scheduling Jobs and Predictive Maintenance in a Permutation Flowshop," in *IEEE Int. Conf. Emerging Technol. Factory Autom., ETFA*, Institute of Electrical and Electronics Engineers Inc., 2018, pp. 524–531. doi: 10.1109/ETFA.2018.8502462.
- [57] N. Yadav and A. Tanksale, "An integrated routing and scheduling problem for home healthcare delivery with limited person-to-person contact," *Eur J Oper Res*, vol. 303, no. 3, pp. 1100–1125, 2022, doi: 10.1016/j.ejor.2022.03.022.
- [58] C. Di Martinelly, A. Duenas, and D. Pham, "Integration of operating room advance scheduling and allocation scheduling while considering

- the resource constraints: A multiobjective genetic algorithm approach,” in *ILS - Inf. Syst., Logist. Supply Chain, Proc.*, INSA Lyon, 2018, pp. 714–724. [Online]. Available: <https://www-scopus-com-s.webvpn.nefu.edu.cn/inward/record.uri?eid=2-s2.0-85050966197&partnerID=40&md5=8709cc7c3ff0d5100ed53230475ff0f7>
- [59] Y. Gao, Z. Xie, Q. Jia, and X. Yu, “An Effective Memetic Algorithm for the Distributed Integrated Scheduling of Tree-Structured Products,” *Int. J. Coop. Inf. Syst.*, vol. 30, no. 1–4, 2021, doi: 10.1142/S0218843021500015.