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Multiobjective Optimization in Distributed Industry and Environmental Sustainability: a Systematic Literature Review

Otimização Multiobjetivo na Indústria Distribuída e a Sustentabilidade Ambiental: uma Revisão Sistemática da Literatura

La Optimización Multiobjetivo en la Industria Distribuida y la Sostenibilidad Medioambiental: una Revisión Bibliográfica Sistemática

Francisco dos Santos[1]
https://orcid.org/0000-0001-8621-615X

Lino Costa[2]
https://orcid.org/0000-0003-4772-4404

Leonilde Varela [3]
https://orcid.org/0000-0002-2299-1859

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ABSTRACT

With the growth of industrialization, researchers have also become increasingly concerned about environmental protection. Environmental issues have been one of the problems and one of the objectives to consider when it comes to production scaling problems, mainly minimizing energy consumption, and minimizing carbon emissions, as well as various other objectives to optimize. Measures that put pressure on organizations to pay more attention to the environment have been created, along with other measures, not only economic but also social. Good production scheduling allows organizations to be more successful in business, as it contributes to a better environment and society. Therefore, the search for processes that allow for more effective and efficient decision-making is becoming a subject of paramount importance to study. Sustainability is currently an urgent challenge for engineering and organizations. One of the ways to contribute to more sustainable manufacturing systems is the development of intelligent technologies and the sharing of

[1] MSc., ALGORITMI Research Centre / LASI, University of Minho, Braga, Portugal and Polytechnic Institute, Kimpa Vita University, Uíge, Angola. francisco_dos_santos@outlook.pt
[2] PhD, ALGORITMI Research Centre / LASI, University of Minho, Braga, Portugal and Department of Production and Systems, University of Minho, Braga, Portugal. lac@dps.uminho.pt
[3] PhD, ALGORITMI Research Centre / LASI, University of Minho, Braga, Portugal and Department of Production and Systems, University of Minho, Braga, Portugal. leonilde@dps.uminho.pt

manufacturing systems. This paper studies the literature on production scheduling approaches in distributed companies and their potential benefits for the environment and society, in addition to the economic benefits. In this way, the optimization of environmental, social, and economic measures in the planning and scheduling of production in extended company contexts, using approaches based on multiobjective optimization, is a primary focus of this work.

Keywords: Multiobjective optimization; Distributed industry; Environmental Pollution; Sustainability

RESUMO

Com o crescimento da industrialização, os investigadores têm-se preocupado cada vez mais com a proteção do ambiente. As questões ambientais têm sido um dos problemas e um dos objectivos a considerar quando se trata de problemas de escala de produção, principalmente a minimização do consumo de energia e a minimização das emissões de carbono, bem como vários outros objectivos a otimizar. Foram criadas medidas que pressionam as organizações a prestar mais atenção ao ambiente, a par de outras medidas, não só económicas, mas também sociais. Uma boa programação da produção permite que as organizações tenham mais sucesso nos negócios, pois contribui para um melhor ambiente e sociedade. Por isso, a procura de processos que permitam uma tomada de decisão mais eficaz e eficiente está a tornar-se um assunto de extrema importância a estudar. A sustentabilidade é atualmente um desafio urgente para a engenharia e para as organizações. Uma das formas de contribuir para sistemas de produção mais sustentáveis é o desenvolvimento de tecnologias inteligentes e a partilha de sistemas de produção. Este artigo estuda a literatura sobre abordagens de programação da produção em empresas distribuídas e os seus potenciais benefícios para o ambiente e para a sociedade, para além dos benefícios económicos. Desta forma, a otimização de medidas ambientais, sociais e económicas no planeamento e programação da produção em contextos de empresas alargadas, utilizando abordagens baseadas na otimização multiobjectivo, é o foco principal deste trabalho.

Palavras-chave: Otimização multiobjetivo; Indústria Distribuída; Poluição ambiental; Sustentabilidade

RESUMEN

Con el crecimiento de la industrialización, los investigadores también se han preocupado cada vez más por la protección del medio ambiente. Las cuestiones medioambientales han sido uno de los problemas y uno de los objetivos a considerar cuando se trata de problemas de escalado de la producción, principalmente la minimización del consumo de energía, y la minimización de las emisiones de carbono, así como otros varios objetivos a optimizar. Se han creado medidas que presionan a las organizaciones para que presten más atención al medio ambiente, junto con otras medidas, no sólo económicas, sino también sociales. Una buena programación de la producción permite a las organizaciones tener más éxito en los negocios, ya que contribuye a mejorar el medio ambiente y la sociedad. Por ello, la búsqueda de procesos que permitan una toma de decisiones más eficaz y eficiente se está convirtiendo en un tema de estudio de suma importancia. La sostenibilidad es actualmente un reto urgente para la ingeniería y las organizaciones. Una de las formas de contribuir a sistemas de fabricación más sostenibles es el desarrollo de tecnologías inteligentes y la puesta en común de los sistemas de fabricación. Este artículo estudia la bibliografía sobre los enfoques de programación de la producción en empresas distribuidas y sus posibles beneficios para el medio ambiente y la sociedad, además de

los económicos. De este modo, la optimización de medidas medioambientales, sociales y económicas en la planificación y programación de la producción en contextos de empresas extendidas, utilizando enfoques basados en la optimización multiobjetivo, es un objetivo principal de este trabajo.

Palabras clave: Optimización multiobjetivo; Industria Distribuida; Contaminación Medioambiental; Sostenibilidad

INTRODUCTION

The traditional single-objective production scheduling method has become increasingly unable to meet the requirements of business models over time, and a multiobjective scheduling solution is needed (Liu, Chen, & Chou, 2014), since in many situations there are many objectives to optimize simultaneously, and the objective of minimizing environmental pollution has been one of the objectives that industries are increasingly considering. It has been difficult for companies facing community and competitive pressures to ignore the fundamental role of green principles in balancing environmental and economic development (Entezaminia, Heydari, & Rahmani, 2016).

The concept of sustainability involves meeting the needs of current generations in a responsible way, while considering similar conditions for future generations to preserve natural resources, maintaining a balance between economic development, respecting the environment and social well-being.

Nature provides us with all the raw materials or natural resources to use, but these natural resources are scarce and limited, and as well as being important for companies, they are also important for communities and economic growth itself. Therefore, not wasting them is necessary to better protect these scarce resources. Distributed companies can help in this process of not wasting these resources.

Today, there are significant and rapidly growing problems related to the environment, which have often not been properly addressed. Environmental pollution problems have also long been attributed largely to industrial production (Przewozniczek, Dziurzanski, Zhao, & Indrusiak, 2021). In the context of concern for environmental protection in production systems, there are some limitations in order to ensure that natural resources are used at a constant rate that does not exceed the renewal rate of the same resources, as well as not ignoring the capacity of the environment to absorb this waste, it is necessary to turn the focus to renewable natural resources as an alternative to non-renewable ones (Oláh et al., 2020).

In this work, a systematic literature review (SLR) is carried out to study the progress of research related to minimizing the effects of industrialization on the environment in distributed production scheduling problems with many objectives, to find out what the level of prioritization of environmental protection in industrial processes is. The literature review is an important research methodology that not only investigates texts, but also makes it possible to answer research questions by selecting and evaluating different contributions (dos Santos, Costa, & Varela, 2022). To conclude the study, a discussion was made of 14 selected articles which were used as a basis for answering the research questions.

METHODOLOGY / SETUP/ ARCHITECTURE

In general, academic contributions are placed in the context of previously researched and published work, and the number of research publications has grown in recent years (Borrego, Foster, & Froyd, 2014). Therefore, it is often difficult to search for all the research that has been done on a particular subject when you want to answer your own questions on a particular research topic, so a systematic literature review is used to help synthesize previous research and answer the research questions.

A SLR is also defined as a resource for identifying, evaluating, and interpreting all relevant and available research into a particular research question, subject area or phenomenon of interest (Budgen & Brereton, 2006).

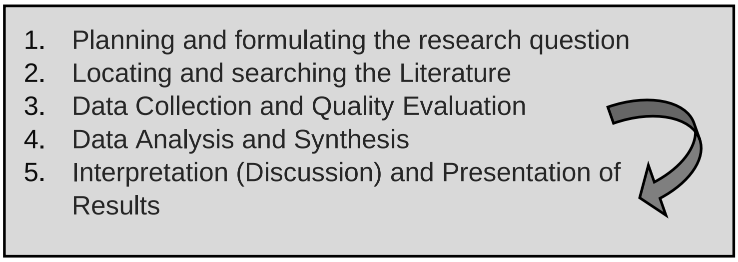
In this work, the SLR methodology is adopted. This is a method that allows us, among other things, to survey studies that have already been carried out and answer some research questions. This methodology must be comprehensive to identify and systematize the best results, with little or no complexity (dos Santos et al., 2022).

As for the research questions, since SLR is an important methodology in research, using pre-planned research strategies to answer the research questions, for this work we intend to answer the following research questions:

- Q1. What are the main studies carried out when it comes to scaling production?
- Q2. Environmental objectives are considered when scaling production in distributed companies?
- Q3. What environmental advantages can distribute companies have?

In order to answer the research questions, RSL was used, adopting the proposal of (Thomé, Scavarda, & Scavarda, 2016) and (Okoli, 2015) consisting of 5 main phases of SLR processing, shown in Figure 1:

Figure 1- Phases of the Systematic Literature Review (Adapted from (dos Santos et al., (2022))



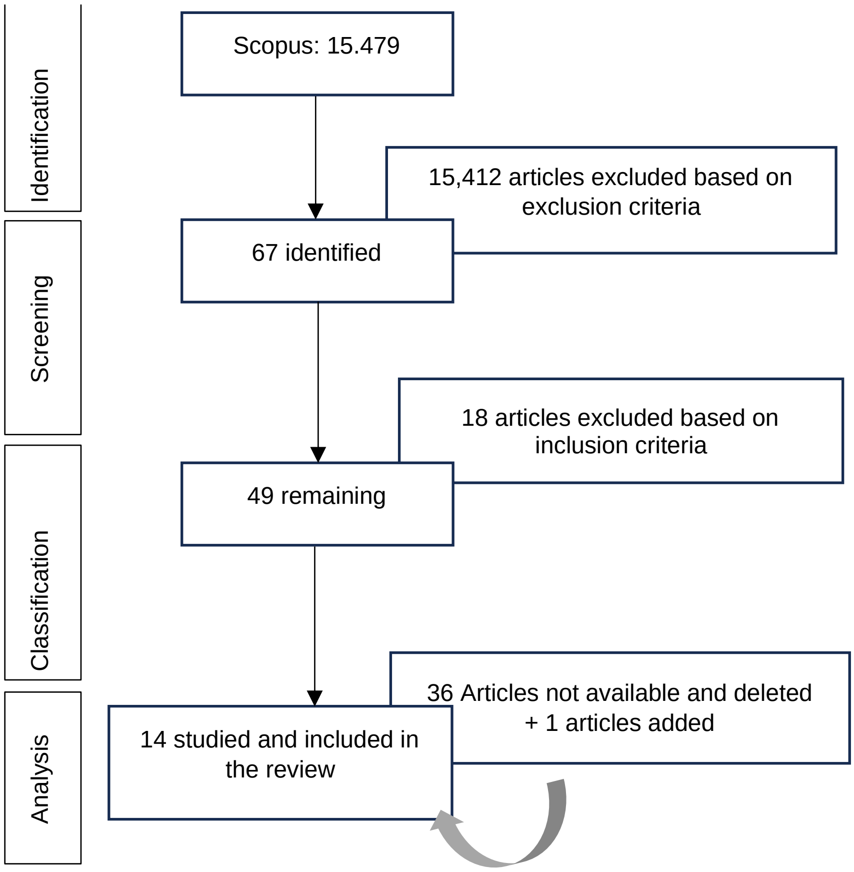
The first stage is the planning and formulation of the research questions, i.e., the problem is identified and through this the questions to be answered with the proposed research are formulated, for this work, three research questions Q1, Q2 and Q3 were presented above. In the second stage, the platforms to be used for collecting the literature are defined, in this case, where the materials related to the topic under research will be collected, using the keywords of the research (search terms presented in Table 1), for this investigation only Scopus was used, since it is a database that has coverage of several indexed scientific journals. In the third stage, the necessary materials were collected through the chosen platform. The fourth stage is where the materials collected are synthesized and grouped into areas of study. And the last stage, the interpretation and presentation of results, is the final stage, where the discussion of the materials presented is made, in a succinct way the results of the different materials found are presented Table 1 shows the platform, the search terms, the search options such as limiters and the search form, and finally the result found by applying all the search options.

This table does not detail how the initial results were obtained without the limiters, but Figure 2 shows the results of each step applied in the search for material. After applying only, the search term, 15,479 articles were found, then only 67 articles remained after applying the exclusion criteria and when applying the inclusion criteria, 49 articles remained, as illustrated in Table 1. But as these criteria alone may not be enough to classify the articles that may be important to our research, an analysis was finally carried out based on reading the abstracts and more than half of the remaining articles were excluded, leaving only 14 articles, in which case only these 14 articles were used to answer the research questions.

Table 1- Search terms

Platform	Search Terms	Search Options		Results
		Limiters	**Search**	
Scopus	(TITLE-ABS-KEY (Multi-objective OR Multiobjective AND Optimization AND Distributed AND Industry OR Manufacture AND Sustainability OR Environment))	Search terms applied to: Article Title, Abstract and Keywords; Years: 2010-2022; Language: English; Publication; Stage: Final	Advanced Search	49

Figure 2- Steps applied to the systematic literature review (adapted de dos Santos et al., 2022)

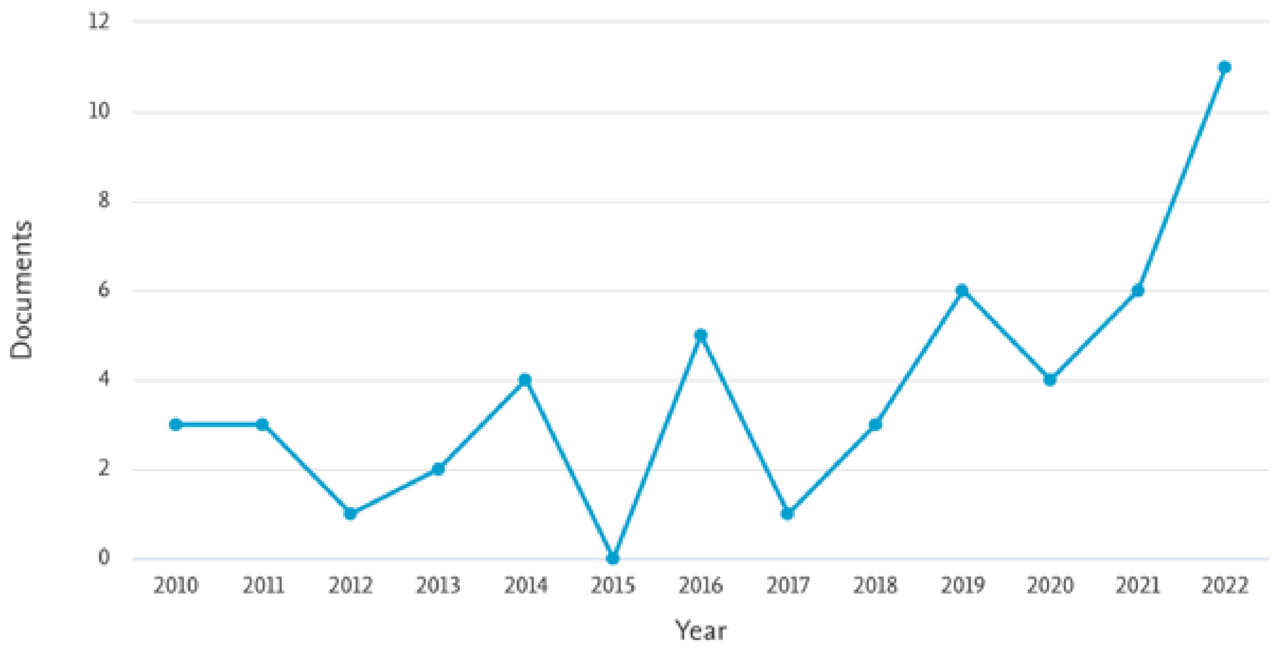


RESULTS

The year range of the selected study is from 2010 to 2022, and Figure 3a shows the evolution of publications on subjects related to the environment in distributed industries with the application of multiobjective optimization methods. It can be seen in the figure that the number of publications has always fluctuated, but from 2019 onwards the number of publications began to grow, although in the following year there was a slight drop, being recovered in the following year and reaching a peak in the year 2022, which is the limit year of the study, this indicates that there is a greater interest from researchers in adding environmental concerns to their studies. And Figure 3b shows a graph with the areas where these issues are most addressed, with engineering and computer science having the highest number of publications.

Figure 3- Year of publication and publication by research area.

(a)



(b)

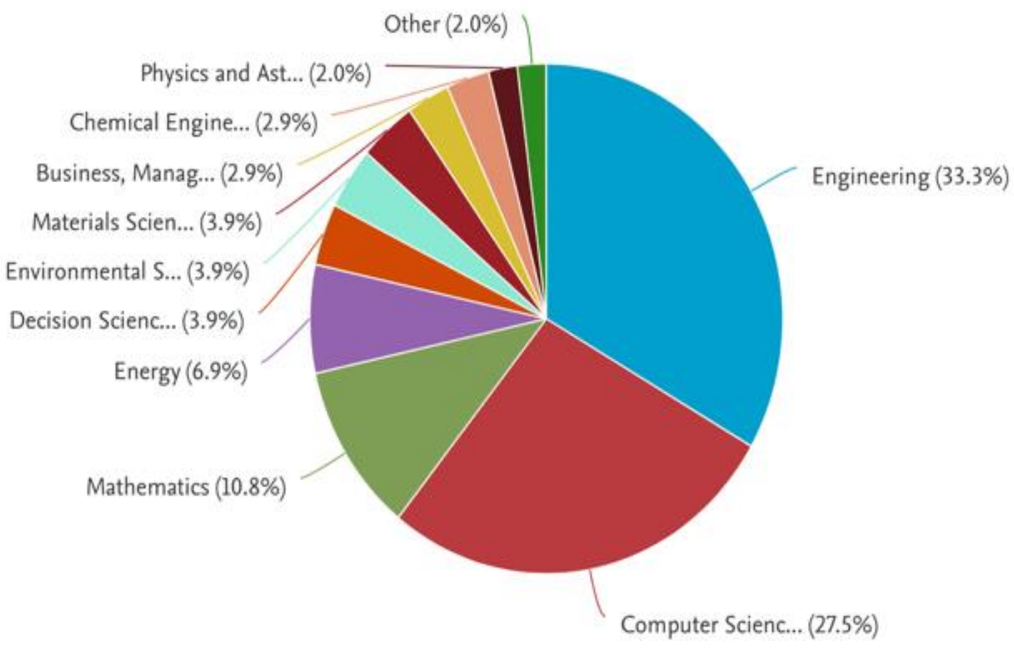


Table 2 shows the articles that were discussed, where they were organized by topic in relation to the keywords defined for the study. The topics refer to the keywords used in the search string, and the references are the references of the articles. The intersection between them indicates that the topic was used as a keyword or in the title of the referenced article. In this sense, the topics *multiobjective* and *distributed* were the keywords found in most articles.

Table 2- Summary of articles discussed.

Topics	References
Optimization	[Starkey et al., 2016];[Gao et al., 2019]; [Chen & Hung, 2014];[Wang et al., 2022];[Yuan, 2019];[Liu et al., 2014];
Multiobjective	[Starkey et al., 2016];[Ramakurthi et al., 2021]; [Gao et al., 2019];[Chen & Hung, 2014];[Wang et al., 2022];[Kaur et al., 2020];[Shao et al., 2019];[Liu et al., 2014];[Entezaminia et al., 2016]
Energy	[Lu et al., 2021];[Kaur et al., 2020];[Yuan, 2019]
Distributed	[Ramakurthi et al., 2021]; [W. Y. Zhang et al., 2011]; [Zhang et al., 2022]; [Wang et al., 2022];[Lu et al., 2021];[Ibrahim et al., 2020];[Shao et al., 2019];[Zhao et al., 2011]
Industry/Manufacturing	[Ramakurthi et al., 2021], [Zhang et al., 2011]; [Lu et al., 2021];[Liu et al., 2014];[Entezaminia et al., 2016]
Sustainability/Environment	[Chen & Hung, 2014];[Entezaminia et al., 2016]

Figure 4 shows a word cloud made up of the keywords of the 14 articles used to conduct this research and answer the research questions. The words that appear largest are the ones that were used the most in the keywords of these articles. The words Distributed, optimization and multiobjective appear the most because they are the words that served as the basis for the construction of the search string. The word Algorithm is also very prominent, because most of the problems dealt with in these articles used different algorithms in their investigations, one of the most widely used algorithms being the Genetic algorithm, which also appears in the word clouds. The word Energy also appears the most, because in a large part of the problems linked to the environment, one of the subjects that has been dealt with the most is energy consumption.

Production technologies and other topics

Optimization problems in the real world are usually very complex and require the satisfaction of many simultaneous objectives, which usually conflict with each other (dos Santos, Costa, & Varela, 2023). As such, distributed manufacturing has become a common mode of production due to the influence of economic globalization (Shao, Pi, & Shao, 2019). This applies to industries that employ large mobile workforces in the field.

Allocating resources to different geographical locations can lead to higher transportation costs and consequently more pollution of the environment with the production of polluting gases. One solution to these problems is to create different geographical areas to meet production needs, although this can have disadvantages when it comes to protecting the environment (Starkey et al., 2016). Therefore, Starkey et al., (2016) present a proposal using multiobjective genetic algorithms, transferring this system to the cloud, where the available computing resources are greater than locally. The proposed system showed that using cloud computing helps reduce optimization time. The advance of the Internet of Things (IoT) is expected to soon create a tsunami of large volumes of data, which in turn will require real-time data analysis and processing from cloud computing platforms. An important part of this infrastructure is supported by geographically distributed grid-scale data centers. These data centers therefore impose a considerable cost on energy consumption, which in turn affects the environment (Kaur, Garg, Kaddoum, Bou-Harb, & Choo, 2020).

Figure 4- Word cloud with the keywords of all 14 articles

Considering that the efficient use of resources can be seen as a potential candidate to minimize energy use and thus decrease the load on the energy sector, Kaur et al., (2020) propose a solution to minimize energy use levels by taking advantage of data centers. In recent years, the application of distributed production technology has grown due to its flexible and environmentally friendly nature (Gao, Ji, Li, & Wu, 2019). In this sense, distributed production systems have competitive advantages related to the level of optimization in general and in their supply chain (Zhang et al., 2011). Zhang et al., (2011) present a new resource allocation method using the extended genetic algorithm to optimize multiobjective decision-making in the context of supply chain implementation. However, Entezaminia et al., (2016) present a multiobjective, multi-period, multi-product and multi-location aggregate production planning model in a green supply chain. In this proposal, products are scored in terms of environmental criteria, such as recycling, biodegradability, energy consumption, applying the analytic hierarchy process (AHP), which in general terms is used to obtain a single indicator that describes the environmental impact of various product alternatives.

Increased competition has worried many manufacturers of time-sensitive products such as clothing, expanding their production in different parts of the world. The concern of manufacturers is to be able to aggregate orders from all over the world, assigning them to the most adapted factories (Chen & Hung, 2014). In this sense, Chen & Hung, (2014) propose an efficient method, using multiobjective genetic algorithm to find viable solutions in order allocation. This solution of several factories distributed around the world is more efficient in terms of meeting deadlines for delivering orders to customers, but on the other hand, can be more harmful to the environment if the transportation of goods from one country to another is done by means that pollute less.

Energy in the industry

Manufacturing processes in general require energy to function, so there has been growing concern about energy-efficient production scheduling, with strict environmental regimes increasing the pressure on the contemporary industrial environment. Another problem linked to the energy sector in industry is related to suppliers supplying other sectors using the same infrastructure (Ibrahim et al., 2020). The construction of distributed multi-energy flow cogeneration systems is inevitable for the development of the energy industry (Yuan, 2019). Some studies show the need to improve distribution performance, in this sense, a new approach is presented by Ibrahim et al., (2020), considering a synchronized optimal process between all categories of consumers.

One of the main forces that has promoted the diversification of the main body of the modern energy industry is photovoltaic power generation and it has played an important role in electricity demand (Zhang et al., 2022). When studying optimal energy storage scheduling, Zhang et al., (2022) consider the cost of the power generation system and the impact of the environment. The global energy industry has been restructured, introducing a number of challenges, such as conflicting planning objectives and growing uncertainties for transportation networks. Very recently, several distributed generation technologies have reached a stage where they can be implemented on a large scale, which could influence the energy sector (Zhao, Foster, Dong, & Wong, 2011). Therefore, Zhao et al., (2011) use a method based on market simulation to evaluate the economic activity of different production technologies, based on which future scenarios for the expansion of production can be formulated.

Although production systems have been influenced by the decentralization of the supply chain, finding a supplier from a set of several suppliers according to customer requirements, and improving process planning and scheduling functions, there are situations that still need to be addressed (Ramakurthi et al., 2021). Accordingly, Ramakurthi et al., 2021, considering a set of gear manufacturing industries located in India, propose an integrated multiobjective evolutionary approach to solve the objectives of makespan, energy consumption and increasing the utilization rate. (Wang et al., 2022), point out that a number of actions are needed in various sectors of industry to achieve carbon neutrality, with electrical systems and electric vehicles being two of the main contributors to decarbonization in the energy and transport sectors. Although Lu et al., (2021), also point out that in the context of factories, environmental criteria such as energy consumption and carbon emissions are unavoidable due to the demands of production and the practical life of the industries themselves.

CONCLUSIONS

Increased competition has led many manufacturers of various products to turn to distributed industry models. This industry model has several advantages in terms of reducing environmental pollution, as industries share their manufacturing environments to meet their commitments to customers, but indirectly there can be less environmental pollution when industries share the same factories. When it comes to multiobjective optimization problems in distributed production scheduling, many environmental problems are considered, and the number of studies linked to the environment has grown, especially when it comes to energy problems in industry.

This article presents a systematic review of the literature, to identify the concern of industries to minimize the problems linked to the environment, in this sense, 14 articles were found to answer three research questions. It can be said that the research questions have been answered, as industries are concerned about environmental problems. In production scheduling problems with many objectives, environmental issues are considered, although the greatest concern is more related to energy. On the other hand, distributed industry in general helps to better protect the environment because industries can share their resources.

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REFERENCES

Borrego, M., Foster, M. J., & Froyd, J. E. (2014). Systematic literature reviews in engineering education and other developing interdisciplinary fields. *Journal of Engineering Education*, 103(1), 45–76. https://doi.org/10.1002/jee.20038

Budgen, D., & Brereton, P. (2006). Performing systematic literature reviews in software engineering. Proceedings - *International Conference on Software Engineering*, 2006, 1051–1052. https://doi.org/10.1145/1134285.1134500

Chen, R., & Hung, P. (2014). Multiobjective Order Assignment Optimization in a Global Multiple-Factory Environment. *Mathematical Problems in Engineering*, 2014, 1–14. https://doi.org/10.1155/2014/673209

dos Santos, F., Costa, L. A., & Varela, L. (2022). A Systematic Literature Review About Multi-objective Optimization for Distributed Manufacturing Scheduling in the Industry 4.0. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 13378 LNCS, 157–173. https://doi.org/10.1007/978-3-031-10562-3_12

dos Santos, F., Costa, L., & Varela, L. (2023). Multi-objective Optimization of the Job Shop Scheduling Problem on Unrelated Parallel Machines with Sequence-Dependent Setup Times. *In International Conference on Computational Science and Its Applications* (pp. 495–507). Springer. https://doi.org/10.1007/978-3-031-37108-0_32

Entezaminia, A., Heydari, M., & Rahmani, D. (2016). A multi-objective model for multi-product multi-site aggregate production planning in a green supply chain: Considering collection and recycling centers. *Journal of Manufacturing Systems*, 40, 63–75. https://doi.org/10.1016/j.jmsy.2016.06.004

Gao, H., Ji, X., Li, K., & Wu, N. (2019). Multi-objective Comprehensive Optimization of Distribution Network considering the randomness of DG. *IOP Conference Series: Materials Science and Engineering*, 569(4), 1–10. https://doi.org/10.1088/1757-899X/569/4/042050

Ibrahim, C., Mougharbel, I., Kanaan, H. Y., Georges, S. W., Daher, N. abou, & Saad, M. (2020). Industrial Loads Used as Virtual Resources for a Cost-Effective Optimized Power Distribution. *IEEE* Access, 8, 14901–14916. https://doi.org/10.1109/aCCESS.2020.2966736

Kaur, K., Garg, S., Kaddoum, G., Bou-Harb, E., & Choo, K. K. R. (2020). A Big Data-Enabled Consolidated Framework for Energy Efficient Software Defined Data Centers in IoT Setups. *IEEE Transactions on Industrial Informatics*, 16(4), 2687–2697. https://doi.org/10.1109/TII.2019.2939573

Liu, T. K., Chen, Y. P., & Chou, J. H. (2014). Developing a multiobjective optimization scheduling system for a screw manufacturer: A refined genetic algorithm approach. *IEEE* Access, 2, 356–364. https://doi.org/10.1109/ACCESS.2014.2319351

Lu, C., Gao, L., Yi, J., & Li, X. (2021). Energy-Efficient Scheduling of Distributed Flow Shop with Heterogeneous Factories: A Real-World Case from Automobile Industry in China. *IEEE Transactions on Industrial Informatics*, 17(10), 6687–6696. https://doi.org/10.1109/TII.2020.3043734

Okoli, C. (2015). A guide to conducting a standalone systematic literature review. *Communications of the Association for Information Systems*, 37(1), 879–910. https://doi.org/10.17705/1cais.03743

Oláh, J., Aburumman, N., Popp, J., Khan, M. A., Haddad, H., & Kitukutha, N. (2020). Impact of industry 4.0 on environmental sustainability. *Sustainability (Switzerland)*, 12(11), 1–21. https://doi.org/10.3390/su12114674

Przewozniczek, M. W., Dziurzanski, P., Zhao, S., & Indrusiak, L. S. (2021). Multi-Objective parameter-less population pyramid for solving industrial process planning problems. *Swarm and Evolutionary Computation*, 60(September 2020). https://doi.org/10.1016/j.swevo.2020.100773

Ramakurthi, V. B., Manupati, V. K., Machado, J., & Varela, L. (2021). A hybrid multi-objective evolutionary algorithm-based semantic foundation for sustainable distributed manufacturing systems. *Applied Sciences (Switzerland)*, 11(14). https://doi.org/10.3390/app11146314

Shao, W., Pi, D., & Shao, Z. (2019). A Pareto-Based Estimation of Distribution Algorithm for Solving Multiobjective Distributed No-Wait Flow-Shop Scheduling Problem with Sequence-Dependent Setup Time. *IEEE Transactions on Automation Science and Engineering*, 16(3), 1344–1360. https://doi.org/10.1109/TASE.2018.2886303

Starkey, A., Hagras, H., Shakya, S., Owusu, G., Mohamed, A., & Alghazzawi, D. (2016). A cloud computing based many objective type-2 fuzzy logic system for mobile field workforce area optimization. *Memetic Computing*, 8(4), 269–286. https://doi.org/10.1007/s12293-016-0206-1

Thomé, A. M. T., Scavarda, L. F., & Scavarda, A. J. (2016). Conducting systematic literature review in operations management. *Production Planning and Control*, 27(5), 408–420. https://doi.org/10.1080/09537287.2015.1129464

Wang, B., Yu, X., Wu, Q., Li, Z., Jiang, R., Qian, G., & Huang, R. (2022). Case studies of a distributed building energy system incorporating with EVs considering effects of random charging behaviors and time-of-use pricing in electricity. *Case Studies in Thermal Engineering*, 38(May), 102297. https://doi.org/10.1016/j.csite.2022.102297

Yuan, L. (2019). Optimization Operation of Multi-energy Complementary System based on Interval Model. *IEEE PES Innovative Smart Grid Technologies Asia*, ISGT 2019, 3837–3842. https://doi.org/10.1109/ISGT-Asia.2019.8881325

Zhang, W. Y., Zhang, S., Cai, M., & Huang, J. X. (2011). A new manufacturing resource allocation method for supply chain optimization using extended genetic algorithm. *International Journal of Advanced Manufacturing Technology*, 53(9–12), 1247–1260. https://doi.org/10.1007/s00170-010-2900-3

Zhang, X., Fang, J., Zou, J., Chen, Q., Chen, S., Hong, J., & Wang, S. (2022). Optimal Scheduling of Distributed Resources in Multi area and Multi-station Optical Storage System Based on Improved Genetic Algorithm. *IMCEC 2022 - IEEE 5th Advanced Information Management, Communicates, Electronic and Automation Control Conference*, 5, 1302–1307. https://doi.org/10.1109/IMCEC55388.2022.10020044

Zhao, J. H., Foster, J., Dong, Z. Y., & Wong, K. P. (2011). Flexible transmission network planning considering distributed generation impacts. *IEEE Transactions on Power Systems*, 26(3), 1434–1443. https://doi.org/10.1109/TPWRS.2010.2089994