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A scientometrics survey on project scheduling

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A B S T R A C T

In project management, a schedule is considered as a list a project's milestones, activities, and deliverables, normally with some start and finish time schedule, which are estimated by some information incorporated in the project schedule including resource allocation, budget, task duration, and linkages of dependencies and scheduled events. This paper presents a comprehensive review of the studies associated with project scheduling. The study uses Scopus database as a primary search engine and covers 3370 records over the period 1963-2019. The records are statistically analyzed and categorized in terms of different criteria. Based on the survey, "decision support systems" is the keyword which has carried the highest densities followed by heuristics methods. Among the most cited articles, papers published by researchers in Germany have received the highest citations (9084), followed by United States (7058) and Belgium with 4853 citations.

1. Introduction

In project management, a schedule is considered as list a project's milestones, activities, and deliverables, normally with some start and finish time schedule, which are estimated by some information incorporated in the project schedule including resource allocation, budget, task duration, and linkages of dependencies and scheduled events. Any schedule is normally implemented in the project planning and project portfolio management as parts of project management. Elements on a schedule are associated with different issues such as the work breakdown structure (WBS) terminal elements, the statement of work, etc. Project scheduling has been used in the literature for years (Krauss, 1963; Moshman et al., 1963; Betzig, 1964). The object of project scheduling and management is to produce a complete project by considering the client's desires. In several cases, the primary object of project management is to change the client's brief to address the client's objectives. When the client's targets become transparent, they ought to influence all decisions made by other parties involved in the project such as project managers, designers, contractors, etc. This paper presents an overview on studies associated with project scheduling. The study uses Scopus database as a primary search engine and analyzes the data over the period 1963-2019.

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2. The most common keywords

Table 1 demonstrates some of the mostly cited references associated with project scheduling. As we can observe from the results of Table 1, Scheduling, Project scheduling and Project management are three well recognized keywords used in the literature. Fig. 1 shows the most important words used over times.

Table 1
The most popular keywords used in studies associated with project scheduling

Terms	Frequency	Terms	Frequency
scheduling	1210	activity duration	50
project scheduling	674	combinatorial optimization	49
project management	446	makespan	48
optimization	394	project duration	48
problem solving	319	computer software	47
algorithms	316	critical path analysis	47
resource-constrained project scheduling problem	298	iterative methods	46
genetic algorithms	258	precedence constraints	45
resource allocation	241	tabu search	44
heuristic methods	236	uncertainty analysis	44
constraint theory	194	random processes	43
scheduling algorithms	182	production control	42
mathematical models	171	decision support systems	40
project scheduling problem	167	priority rules	40
resource constrained project scheduling	156	resource constraints	40
costs	128	local search	39
integer programming	122	mathematical programming	38
heuristic algorithms	100	resource-constrained project scheduling	37
constrained optimization	99	construction management	36
decision making	99	critical chain	36
computational complexity	93	rcpsp	36
construction industry	92	managers	35
artificial intelligence	91	production engineering	35
resource constraint	84	strategic planning	35
evolutionary algorithms	83	heuristics	34
operations research	82	construction	33
resource-constrained	82	critical path method	32
computer simulation	81	economic and social effects	32
computational results	80	precedence relations	32
multi-project scheduling	79	project activities	32
construction projects	76	heuristic programming	31
computational experiment	74	software engineering	31
benchmarking	66	dynamic programming	30
particle swarm optimization (pso)	63	flow measurement	30
scheduling problem	63	industrial engineering	30
computer programming	62	product development	30
simulated annealing	62	constraint programming	29
multiobjective optimization	61	graph theory	29
linear programming	60	meta heuristics	29
stochastic systems	59	np-hard	29
fuzzy sets	58	objective functions	29
computational methods	57	optimization problems	29
pert	57	multi agent systems	28
multi-mode resource-constrained project scheduling problem	54	project managers	28
net present value	54	project planning	28
multimodes	52	uncertainty	28
planning	52	optimal solutions	27

3. Contributions of countries

Our survey demonstrates that European countries have maintained the most contribution in the field of project scheduling. Table 2 shows details of our survey.

Table 2
The summary of the contributions of different countries

Country	Total Citations	Average Article Citations
GERMANY	9084	63.52
USA	7058	29.05
BELGIUM	4853	55.15
CHINA	2816	10.71
SPAIN	1919	35.54
IRAN	1829	15.12
FRANCE	1618	24.15
POLAND	1348	18.99
TURKEY	1110	27.75
TAIWAN	1100	21.57
CANADA	1070	23.26
UNITED KINGDOM	794	30.54
ITALY	723	21.26
INDIA	682	14.51
HONG KONG	667	37.06
AUSTRALIA	646	16.56
JAPAN	637	19.91
ISRAEL	513	21.38
KOREA	460	21.90
GREECE	448	23.58
SINGAPORE	437	23.00
PORTUGAL	262	18.71
THAILAND	246	22.36
AUSTRIA	232	23.20
BRAZIL	232	15.47
SOUTH AFRICA	190	95.00
CZECH REPUBLIC	176	22.00
TUNISIA	172	17.20
NETHERLANDS	167	12.85
LEBANON	163	81.50
SAUDI ARABIA	149	37.25
HUNGARY	138	9.20
COLOMBIA	119	17.00
QATAR	109	54.50
SWITZERLAND	108	12.00
CHILE	84	9.33
ARMENIA	80	40.00
ARGENTINA	69	17.25
EGYPT	66	9.43
NEW ZEALAND	56	11.20
MALAYSIA	45	9.00
NORWAY	44	14.67
SWEDEN	38	38.00
NIGERIA	29	7.25
CYPRUS	28	5.60
FINLAND	19	9.50
SLOVENIA	17	5.67
CAMEROON	14	4.67
DENMARK	14	14.00
LITHUANIA	11	5.50
IRELAND	10	5.00
BELARUS	9	9.00
CROATIA	9	2.25
MEXICO	8	8.00
PAKISTAN	7	3.50
LUXEMBOURG	6	6.00
INDONESIA	2	2.00
KUWAIT	2	2.00
VENEZUELA	2	2.00

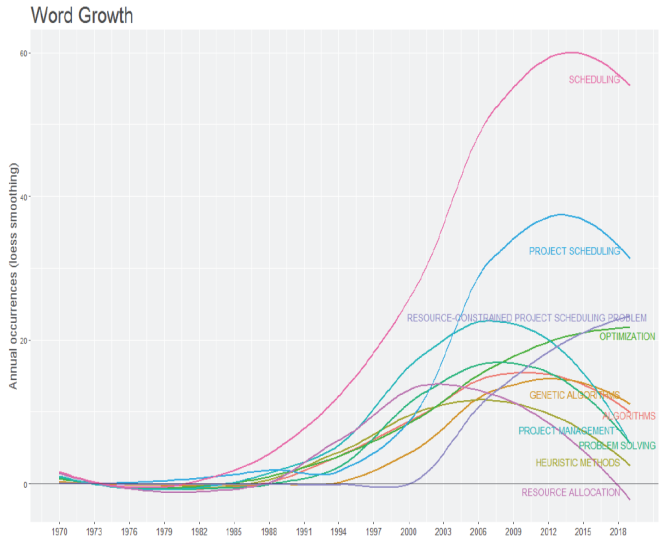

Fig. 1. The summary of the most popular keywords used in project scheduling

According to Table 2, researchers from Germany have published 9084 papers followed by United States with 7058 papers and Belgium with 4853 papers. In terms of the average citation, papers published by researchers in Germany and Belgium have maintained the highest citations. Fig. 3 shows the results of the collaborations among various countries.

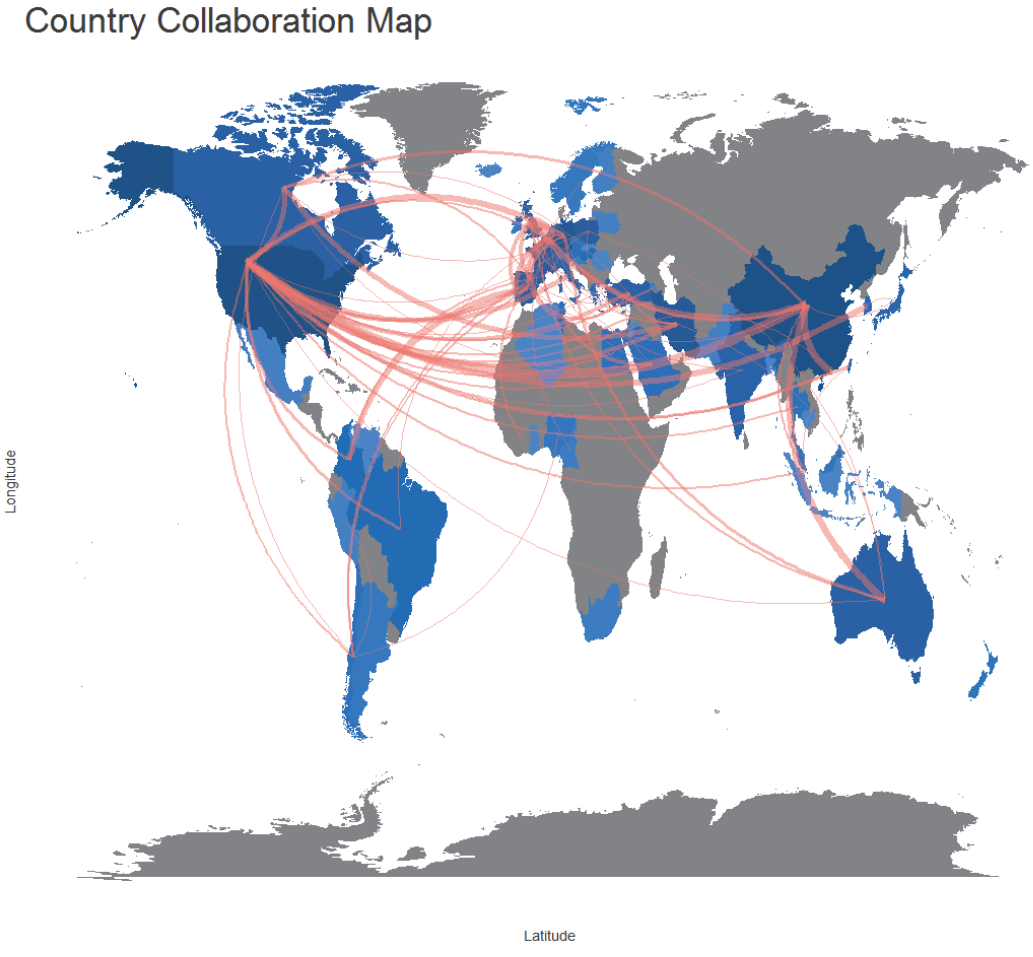

Fig. 3. Country collaboration map

As we can observe from the results of Fig. 3, there were strong collaboration from the researchers in United States from one side and other countries.

4. Highly cited papers

Table 3 shows the summary of the most cited articles. As we can observe from the results of Table 3, the study by Brucker et al. (1999) has received the highest citations. In their study, they provided a classification scheme, i.e. an explanation for the resource environment, the activity characteristics, and the objective function, respectively, which is consistent with machine scheduling and helps classify the most important models. They also proposed a unifying notation to review some of the recent developments such as exact and heuristic algorithms for the single-mode and the multi-mode case, for the time–cost tradeoff problem, etc. The second highly cited work is associated with Kolisch and Drexl (1997) where they provided a local search for non-preemptive multi-mode resource-constrained project scheduling. They proposed a general class of non-preemptive resource-constrained project scheduling problems where activity durations were discrete functions of committed renewable and nonrenewable resources. They obtained a 0-1 problem formulation and explained the model by applying applications within production and operations management. In addition, they proved that the feasibility problem which is NP-complete and could hardly deal with some shortcomings. Thus, they proposed a new local search method that initially attempt to locate a feasible solution and then executed a single-neighborhood search on the set of feasible mode assignments. They also performed a computational study on two benchmark sets where the experiment included a comparison of the procedure with other heuristics. The third highly cited work belongs to Herroelen and Leus (2005) where they investigated a project scheduling under uncertainty. The other highly cited paper was accomplished by Merkle et al. (2002) which was a meta-heuristics method named ant colony optimization for resource-constrained project scheduling. Hartmann (2010) in his remarkable work provided a competitive genetic algorithm for resource-constrained project scheduling. This work is one of the well-known non-review paper which has received a high citation and the average citation per year was also the highest for this item. A close look at the highly cited works listed in Table 3 reveals that many of them were associated with meta-heuristics methods ((Boctor, 1990, 1993; Boctor, 1996; Bouleimen & Lecocq, 2003; Debels et al., 2006; Debels & Vanhoucke, 2007; Gonçalves et al., 2008; Hartmann, 1998; Hartmann, 2001; Hartmann, 2002; Józefowska et al., 2001). This can be also verified in Fig. 4 where genetic algorithm has been used significantly.

Table 3
The summary of the most cited articles

Paper	Total Citations	TC per Year
BRUCKER P, 1999, EUR J OPER RES	952	47.6
KOLISCH R, 1997, EUR J OPER RES	692	31.4545
HERROELEN W, 2005, EUR J OPER RES	562	40.1429
MERKLE D, 2002, IEEE TRANS EVOL COMPUT	483	28.4118
KOLISCH R, 2006, EUR J OPER RES	467	35.9231
HARTMANN S, 2010, EUR J OPER RES	428	47.5556
KOLISCH R, 1996, EUR J OPER RES	422	18.3478
HARTMANN S, 1998, NAV RES LOGIST	372	17.7143
HERROELEN W, 1998, COMPUT OPER RES	359	17.0952
BOULEIMEN K, 2003, EUR J OPER RES	341	21.3125
HARTMANN S, 2000, EUR J OPER RES	327	17.2105
MUSA JD, 1975, IEEE TRANS SOFTWARE ENG	316	7.1818
DAVIS EW, 1975, MANAGE SCI	315	7.1591
KOO B, 2000, J CONSTR ENG MANAGE	301	15.8421
KOLISCH R, 2001, OMEGA	295	16.3889
TALBOT FBRIAN, 1982, MANAGE SCI	262	7.0811
PATTERSON JH, 1984, MANAGE SCI	261	7.4571
CHO SH, 2005, IEEE TRANS ENG MANAGE	241	17.2143
BAKER KR, 2009, PRINC OF SEQUENCING AND SCHEDULING	225	22.5
CHRISTOFIDES N, 1987, EUR J OPER RES	221	6.9062
DEBELS D, 2006, EUR J OPER RES	215	16.5385
JARBOUI B, 2008, APPL MATH COMPUT	213	19.3636
MINGOZZI A, 1998, MANAGE SCI	211	10.0476

ÖZDAMAR L, 1995, IIE TRANS	211	8.7917
BRUCKER P, 1998, EUR J OPER RES	196	9.3333
VALLS V, 2005, EUR J OPER RES	184	13.1429
HARTMANN S, 2002, NAV RES LOGIST	184	10.8235
GONÇALVES JF, 2008, EUR J OPER RES	182	16.5455
KOLISCH R, 1996, J OPER MANAGE	176	7.6522
IP WH, 2003, COMP OPER RES	173	10.8125
LI KY, 1992, EUR J OPER RES	173	6.4074
PETEGHEM VV, 2010, EUR J OPER RES	171	19
ALCARAZ J, 2001, ANN OPER RES	171	9.5
BOCTOR FF, 1990, EUR J OPER RES	171	5.8966
KURTULUS I, 1982, MANAGE SCI	171	4.6216
HARTMANN S, 2001, ANN OPER RES	170	9.4444
ZHOU X, 2007, TRANSP RES PART B METHODOL	158	13.1667
DEMEULEMEESTER EL, 1997, MANAGE SCI	157	7.1364
RODAMMER FA, 1988, IEEE TRANS SYST MAN CYBERN	154	4.9677
WGLARZ J, 2011, EUR J OPER RES	153	19.125
VALLS V, 2008, EUR J OPER RES	152	13.8182
HERROELEN W, 2004, INT J PROD RES	152	10.1333
MENDES JJM, 2009, COMP OPER RES	151	15.1
CESTA A, 2002, J HEURISTICS	151	8.8824
ALBA E, 2007, INF SCI	149	12.4167
SPRECHER A, 1998, EUR J OPER RES	148	7.0476
ZHANG H, 2005, AUTOM CONSTR	147	10.5
ADELI H, 1997, J CONSTR ENG MANAGE	146	6.6364
SPRECHER A, 1995, EUR J OPER RES	146	6.0833
DAVIS EW, 1973, AIIE TRANS	145	3.1522
KHANZODE A, 2008, ELECTRON J INF TECHNOL CONSTR	142	12.9091
DEMEULEMEESTER E, 2003, J SCHEDULING	142	8.875
ALCARAZ J, 2003, J OPER RES SOC	137	8.5625
AL-FAWZAN MA, 2005, INT J PROD ECON	133	9.5
ARTIGUES C, 2003, EUR J OPER RES	132	8.25
ÖZDAMAR L, 1999, IEEE TRANS SYST MAN CYBERN PT C APPL	128	6.4
SPRECHER A, 1997, OR SPECTRUM	128	5.8182
SAIDI-MEHRABAD M, 2007, INT J ADV MANUF TECHNOL	127	10.5833
ZHOU X, 2005, EUR J OPER RES	125	8.9286
TUKEL OI, 2006, EUR J OPER RES	124	9.5385
VAN DE VONDER S, 2005, INT J PROD ECON	124	8.8571
MORI M, 1997, EUR J OPER RES	123	5.5909
MOORTHY R, 2006, OR SPECTRUM	120	9.2308
MIKA M, 2005, EUR J OPER RES	120	8.5714
TORMOS P, 2001, ANN OPER RES	120	6.6667
KOLISCH R, 1997, IIE TRANS	118	5.3636
ZHANG H, 2006, INT J PROJ MANAGE	117	9
MÖHRING RH, 2003, MANAGE SCI	117	7.3125
LEE JK, 1996, J OPER RES SOC	115	5
LEVNER E, 2010, COMPUT IND ENG	114	12.6667
LONG LD, 2008, INT J PROJ MANAGE	114	10.3636
WANG D, 2001, IEEE TRANS SYST MAN CYBERN PT C APPL REV	113	6.2778
HERROELEN WS, 1997, EUR J OPER RES	112	5.0909
VAN DE VONDER S, 2008, EUR J OPER RES	109	9.9091
BOCTOR FF, 1993, INT J PROD RES	109	4.1923
BOCTOR FF, 1996, INT J PROD RES	108	4.6957
YANG XS, 2011, COMMUN COMPUT INFO SCI	107	13.375
BROWNING TR, 2010, INT J PROD ECON	107	11.8889
LOVA A, 2009, INT J PROD ECON	107	10.7
DREXL A, 1991, MANAGE SCI	106	3.7857
NONOBE K, 2002, OPER RES COMPUT SCI INTERFACES SER	105	6.1765
DOERSCH RH, 1977, MANAGE SCI	105	2.5
SENOUCI AB, 2001, J CONSTR ENG MANAGE	103	5.7222
DE REYCK B, 1998, EUR J OPER RES	103	4.9048
DEBELS D, 2007, OPER RES	102	8.5
JÓZEFOWSKA J, 2001, ANN OPER RES	102	5.6667
STEYN H, 2001, INT J PROJ MANAGE	102	5.6667
KATEHAKIS MN, 1987, MATH OPER RES	102	3.1875

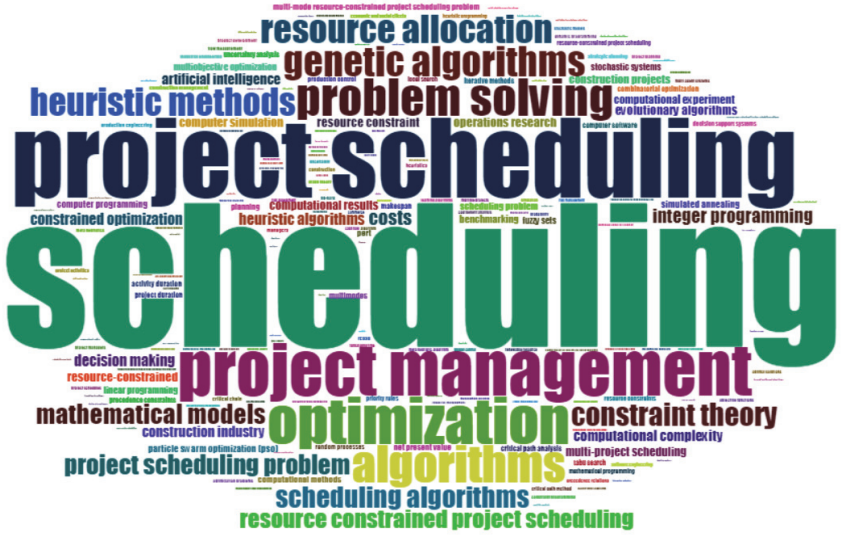

Fig. 4. The frequency of the keywords used in different project scheduling studies

5. Contribution of the countries

One of the interesting areas of the interest is to learn more about the contribution of different countries in project scheduling. As we can observe from the results of Fig. 5, researchers from China (537 papers), United States (487 papers), Iran (257 papers) and Germany (215) have contributed the most on project scheduling.

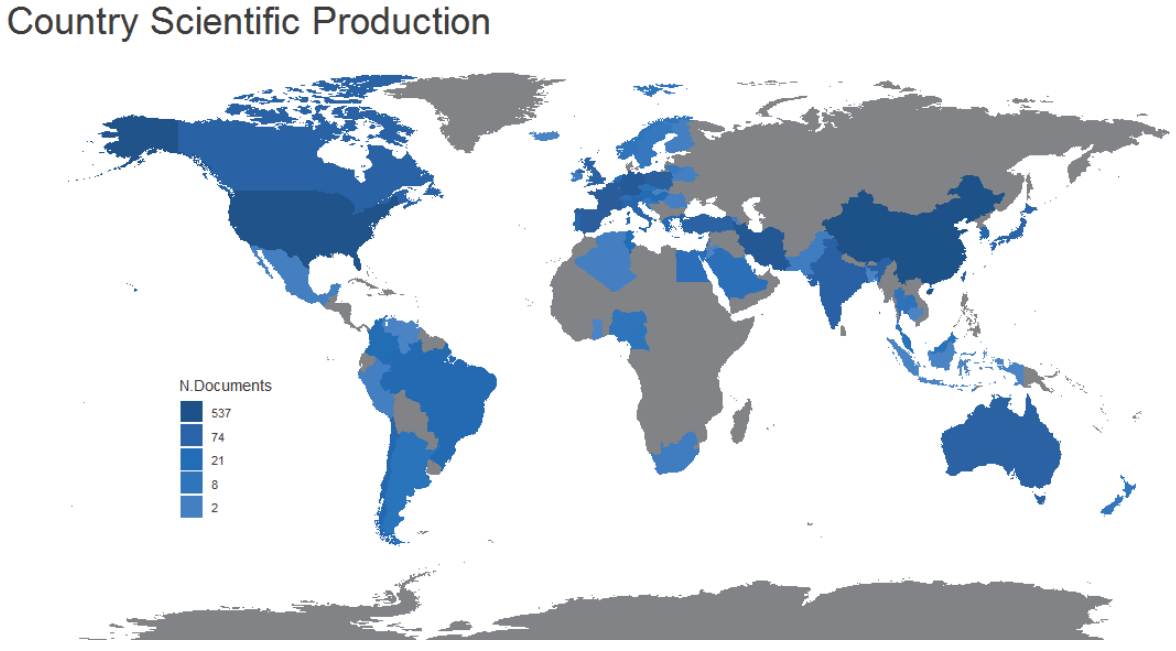

Fig. 5. The frequency of the keywords used in different project scheduling studies

6. Conclusion

This study has tried to provide a comprehensive review of the studies published in the literature associated with project scheduling. The study has indicated that this field has been popular mostly among researchers in United States, China, Germany and Iran. The study has also indicated that while researchers from Germany published a relatively high number of papers, they were also suc-

cessful to publish highly cited papers. Many project scheduling studies have dealt with combinatorial optimization techniques and our survey has concluded that meta-heuristics methods have been popular among researchers to locate the near-optimal solutions. We hope this study could guide other researchers find important research gaps.

References

Adeli, H., & Karim, A. (1997). Scheduling/cost optimization and neural dynamics model for construction. *Journal of Construction Engineering and Management*, *123*(4), 450-458.

Alba, E., & Chicano, J. F. (2007). Software project management with GAs. *Information Sciences*, *177*(11), 2380-2401.

Alcaraz, J., & Maroto, C. (2001). A robust genetic algorithm for resource allocation in project scheduling. *Annals of operations Research*, *102*(1-4), 83-109.

Alcaraz, J., Maroto, C., & Ruiz, R. (2003). Solving the multi-mode resource-constrained project scheduling problem with genetic algorithms. *Journal of the Operational Research Society*, *54*(6), 614-626.

Al-Fawzan, M. A., & Haouari, M. (2005). A bi-objective model for robust resource-constrained project scheduling. *International Journal of production economics*, *96*(2), 175-187.

Artigues, C., Michelon, P., & Reusser, S. (2003). Insertion techniques for static and dynamic resource-constrained project scheduling. *European Journal of Operational Research*, *149*(2), 249-267.

Baker, K. R., & Trietsch, D. (2013). *Principles of sequencing and scheduling*. John Wiley & Sons.

Brucker, P., Drexl, A., Möhring, R., Neumann, K., & Pesch, E. (1999). Resource-constrained project scheduling: Notation, classification, models, and methods. *European journal of operational research*, *112*(1), 3-41.

Betzig, H. M. (1964). Earlier payout through tight project scheduling and control. *Journal of the American Oil Chemists' Society*, *41*(3), 58-58.

Boctor, F. F. (1990). Some efficient multi-heuristic procedures for resource-constrained project scheduling. *European journal of operational research*, *49*(1), 3-13.

Boctor, F. F. (1993). Heuristics for scheduling projects with resource restrictions and several resource-duration modes. *The international journal of production research*, *31*(11), 2547-2558.

Boctor, F. F. (1996). Resource-constrained project scheduling by simulated annealing. *International Journal of Production Research*, *34*(8), 2335-2351.

Bouleimen, K. L. E. I. N., & Lecocq, H. O. U. S. N. I. (2003). A new efficient simulated annealing algorithm for the resource-constrained project scheduling problem and its multiple mode version. *European Journal of Operational Research*, *149*(2), 268-281.

Brucker, P., Knust, S., Schoo, A., & Thiele, O. (1998). A branch and bound algorithm for the resource-constrained project scheduling problem1. *European Journal of Operational Research*, *107*(2), 272-288.

Browning, T. R., & Yassine, A. A. (2010). Resource-constrained multi-project scheduling: Priority rule performance revisited. *International Journal of Production Economics*, *126*(2), 212-228.

Cho, S. H., & Eppinger, S. D. (2005). A simulation-based process model for managing complex design projects. *IEEE Transactions on engineering management*, *52*(3), 316-328.

Christofides, N., Alvarez-Valdés, R., & Tamarit, J. M. (1987). Project scheduling with resource constraints: A branch and bound approach. *European Journal of Operational Research*, *29*(3), 262-273.

Cesta, A., Oddi, A., & Smith, S. F. (2002). A constraint-based method for project scheduling with time windows. *Journal of Heuristics*, *8*(1), 109-136.

Damak, N., Jarboui, B., Siarry, P., & Loukil, T. (2009). Differential evolution for solving multi-mode resource-constrained project scheduling problems. *Computers & Operations Research*, *36*(9), 2653-2659.

Davis, E. W. (1973). Project scheduling under resource constraints—historical review and categorization of procedures. *AIIE Transactions*, *5*(4), 297-313.

Davis, E. W., & Patterson, J. H. (1975). A comparison of heuristic and optimum solutions in resource-constrained project scheduling. *Management science*, *21*(8), 944-955.

Debels, D., De Reyck, B., Leus, R., & Vanhoucke, M. (2006). A hybrid scatter search/electromagnetism meta-heuristic for project scheduling. *European Journal of Operational Research*, *169*(2), 638-653.

Debels, D., & Vanhoucke, M. (2007). A decomposition-based genetic algorithm for the resource-constrained project-scheduling problem. *Operations Research*, *55*(3), 457-469.

Demeulemeester, E. L., & Herroelen, W. S. (1997). New benchmark results for the resource-constrained project scheduling problem. *Management Science*, *43*(11), 1485-1492.

Demeulemeester, E., Vanhoucke, M., & Herroelen, W. (2003). RanGen: A random network generator for activity-on-the-node networks. *Journal of scheduling*, *6*(1), 17-38.

De Reyck, B. (1998). A branch-and-bound procedure for the resource-constrained project scheduling problem with generalized precedence relations. *European Journal of Operational Research*, *111*(1), 152-174.

Doersch, R. H., & Patterson, J. H. (1977). Scheduling a project to maximize its present value: A zero-one programming approach. *Management Science*, *23*(8), 882-889.

Drexl, A. (1991). Scheduling of project networks by job assignment. *Management Science*, *37*(12), 1590-1602.

Fleszar, K., & Hindi, K. S. (2004). Solving the resource-constrained project scheduling problem by a variable neighbourhood search. *European Journal of Operational Research*, *155*(2), 402-413.

Gonçalves, J. F., Mendes, J. J., & Resende, M. G. (2008). A genetic algorithm for the resource constrained multi-project scheduling problem. *European Journal of Operational Research*, *189*(3), 1171-1190.

Hartmann, S. (1998). A competitive genetic algorithm for resource-constrained project scheduling. *Naval Research Logistics (NRL)*, *45*(7), 733-750.

Hartmann, S., & Kolisch, R. (2000). Experimental evaluation of state-of-the-art heuristics for the resource-constrained project scheduling problem. *European Journal of Operational Research*, *127*(2), 394-407.

Hartmann, S. (2001). Project scheduling with multiple modes: a genetic algorithm. *Annals of Operations Research*, *102*(1-4), 111-135.

Hartmann, S. (2002). A self-adapting genetic algorithm for project scheduling under resource constraints. *Naval Research Logistics (NRL)*, *49*(5), 433-448.

Hartmann, S., & Briskorn, D. (2010). A survey of variants and extensions of the resource-constrained project scheduling problem. *European Journal of operational research*, *207*(1), 1-14.

Herroelen, W. S., Van Dommelen, P., & Demeulemeester, E. L. (1997). Project network models with discounted cash flows a guided tour through recent developments. *European Journal of Operational Research*, *100*(1), 97-121.

Herroelen, W., De Reyck, B., & Demeulemeester, E. (1998). Resource-constrained project scheduling: a survey of recent developments. *Computers & Operations Research*, *25*(4), 279-302.

Herroelen, W., & Leus, R. (2004). Robust and reactive project scheduling: a review and classification of procedures. *International Journal of Production Research*, *42*(8), 1599-1620.

Herroelen, W., & Leus, R. (2005). Project scheduling under uncertainty: Survey and research potentials. *European journal of operational research*, *165*(2), 289-306.

Ip, W. H., Huang, M., Yung, K. L., & Wang, D. (2003). Genetic algorithm solution for a risk-based partner selection problem in a virtual enterprise. *Computers & Operations Research*, *30*(2), 213-231.

Józefowska, J., Mika, M., Różycki, R., Waligóra, G., & Węglarz, J. (2001). Simulated annealing for multi-mode resource-constrained project scheduling. *Annals of Operations Research*, *102*(1-4), 137-155.

Levner, E., Kats, V., de Pablo, D. A. L., & Cheng, T. E. (2010). Complexity of cyclic scheduling problems: A state-of-the-art survey. *Computers & Industrial Engineering*, *59*(2), 352-361.

Lee, J. K., & Kim, Y. D. (1996). Search heuristics for resource constrained project scheduling. *Journal of the Operational Research Society*, *47*(5), 678-689.

Li, K. Y., & Willis, R. J. (1992). An iterative scheduling technique for resource-constrained project scheduling. *European Journal of Operational Research*, *56*(3), 370-379.

Long, L. D., & Ohsato, A. (2008). Fuzzy critical chain method for project scheduling under resource constraints and uncertainty. *International Journal of Project Management*, *26*(6), 688-698.

Lova, A., Tormos, P., Cervantes, M., & Barber, F. (2009). An efficient hybrid genetic algorithm for scheduling projects with resource constraints and multiple execution modes. *International Journal of Production Economics*, *117*(2), 302-316.

Jarboui, B., Damak, N., Siarry, P., & Rebai, A. (2008). A combinatorial particle swarm optimization for solving multi-mode resource-constrained project scheduling problems. *Applied Mathematics and Computation*, *195*(1), 299-308.

Katehakis, M. N., & Veinott Jr, A. F. (1987). The multi-armed bandit problem: decomposition and computation. *Mathematics of Operations Research*, *12*(2), 262-268.

Kolisch, R. (1996). Serial and parallel resource-constrained project scheduling methods revisited: Theory and computation. *European Journal of Operational Research*, *90*(2), 320-333.

Kolisch, R. (1996). Efficient priority rules for the resource-constrained project scheduling problem. *Journal of Operations Management*, *14*(3), 179-192.

Kolisch, R., & Drexl, A. (1997). Local search for nonpreemptive multi-mode resource-constrained project scheduling. *IIE transactions*, *29*(11), 987-999.

Kolisch, R., & Sprecher, A. (1997). PSPLIB-a project scheduling problem library: OR software-ORSEP operations research software exchange program. *European journal of operational research*, *96*(1), 205-216.

Kolisch, R., & Padman, R. (2001). An integrated survey of deterministic project scheduling. *Omega*, *29*(3), 249-272.

Kolisch, R., & Hartmann, S. (2006). Experimental investigation of heuristics for resource-constrained project scheduling: An update. *European journal of operational research*, *174*(1), 23-37.

Koo, B., & Fischer, M. (2000). Feasibility study of 4D CAD in commercial construction. *Journal of construction engineering and management*, *126*(4), 251-260.

Krauss, W. (1963). Über die Terminplanung großer Entwicklungsvorhaben. *Unternehmensforschung*, *7*(4), 151-168.

Kurtulus, I. B. R. A. H. I. M. S., & Davis, E. W. (1982). Multi-project scheduling: Categorization of heuristic rules performance. *Management Science*, *28*(2), 161-172.

Merkle, D., Middendorf, M., & Schmeck, H. (2002). Ant colony optimization for resource-constrained project scheduling. *IEEE transactions on evolutionary computation*, *6*(4), 333-346.

Mendes, J. J. D. M., Gonçalves, J. F., & Resende, M. G. (2009). A random key based genetic algorithm for the resource constrained project scheduling problem. *Computers & Operations Research*, *36*(1), 92-109.

Mika, M., Waligóra, G., & Węglarz, J. (2005). Simulated annealing and tabu search for multi-mode resource-constrained project scheduling with positive discounted cash flows and different payment models. *European Journal of Operational Research*, *164*(3), 639-668.

Mingozzi, A., Maniezzo, V., Ricciardelli, S., & Bianco, L. (1998). An exact algorithm for the resource-constrained project scheduling problem based on a new mathematical formulation. *Management science*, *44*(5), 714-729.

Moorthy, R., & Teo, C. P. (2007). Berth management in container terminal: the template design problem. In *Container Terminals and Cargo Systems* (pp. 63-86). Springer, Berlin, Heidelberg.

Mori, M., & Tseng, C. C. (1997). A genetic algorithm for multi-mode resource constrained project scheduling problem. *European Journal of Operational Research*, *100*(1), 134-141.

Moshman, J., Johnson, J., & Larsen, M. (1963, May). RAMPS: a technique for resource allocation and multi-project scheduling. In *Proceedings of the May 21-23, 1963, spring joint computer conference* (pp. 17-27). ACM.

Möhring, R. H., Schulz, A. S., Stork, F., & Uetz, M. (2003). Solving project scheduling problems by minimum cut computations. *Management Science*, *49*(3), 330-350.

Musa, J. D. (1975). A theory of software reliability and its application. *IEEE transactions on software engineering*, (3), 312-327.

Nonobe, K., & Ibaraki, T. (2002). Formulation and tabu search algorithm for the resource constrained project scheduling problem. In *Essays and surveys in metaheuristics* (pp. 557-588). Springer, Boston, MA.

Olofsson, T., Lee, G., Eastman, C., & Reed, D. (2007). Benefits and lessons learned of implementing building virtual design and construction (VDC) technologies for coordination of mechanical, electrical, and plumbing.

Özdamar, L., & Ulusoy, G. (1995). A survey on the resource-constrained project scheduling problem. *IIE transactions*, *27*(5), 574-586.

Ozdamar, L. (1999). A genetic algorithm approach to a general category project scheduling problem. *IEEE Transactions on Systems, Man, and Cybernetics, Part C (Applications and Reviews)*, *29*(1), 44-59.

Patterson, J. H. (1984). A comparison of exact approaches for solving the multiple constrained resource, project scheduling problem. *Management science*, *30*(7), 854-867.

Rodammer, F. A., & White, K. P. (1988). A recent survey of production scheduling. *IEEE transactions on systems, man, and cybernetics*, *18*(6), 841-851.

Saidi-Mehrabad, M., & Fattahi, P. (2007). Flexible job shop scheduling with tabu search algorithms. *The International Journal of Advanced Manufacturing Technology*, *32*(5-6), 563-570.

Senouci, A. B., & Adeli, H. (2001). Resource scheduling using neural dynamics model of Adeli and Park. *Journal of Construction Engineering and Management*, *127*(1), 28-34.

Sprecher, A., Hartmann, S., & Drexl, A. (1997). An exact algorithm for project scheduling with multiple modes. *Operations-Research-Spektrum*, *19*(3), 195-203.

Sprecher, A., & Drexl, A. (1998). Multi-mode resource-constrained project scheduling by a simple, general and powerful sequencing algorithm1. *European Journal of Operational Research*, *107*(2), 431-450.

Steyn, H. (2002). Project management applications of the theory of constraints beyond critical chain scheduling. *International Journal of Project Management*, *20*(1), 75-80.

Talbot, F. B. (1982). Resource-constrained project scheduling with time-resource tradeoffs: The nonpreemptive case. *Management science*, *28*(10), 1197-1210.

Tormos, P., & Lova, A. (2001). A competitive heuristic solution technique for resource-constrained project scheduling. *Annals of Operations Research*, *102*(1-4), 65-81.

Tukel, O. I., Rom, W. O., & Eksioglu, S. D. (2006). An investigation of buffer sizing techniques in critical chain scheduling. *European Journal of Operational Research*, *172*(2), 401-416.

Valls, V., Ballestín, F., & Quintanilla, S. (2005). Justification and RCPSP: A technique that pays. *European Journal of Operational Research*, *165*(2), 375-386.

Valls, V., Ballestin, F., & Quintanilla, S. (2008). A hybrid genetic algorithm for the resource-constrained project scheduling problem. *European Journal of Operational Research*, *185*(2), 495-508.

Van Peteghem, V., & Vanhoucke, M. (2010). A genetic algorithm for the preemptive and non-preemptive multi-mode resource-constrained project scheduling problem. *European Journal of Operational Research*, *201*(2), 409-418.

Van de Vonder, S., Demeulemeester, E., Herroelen, W., & Leus, R. (2005). The use of buffers in project management: The trade-off between stability and makespan. *International Journal of production economics*, *97*(2), 227-240.

Van de Vonder, S., Demeulemeester, E., & Herroelen, W. (2008). Proactive heuristic procedures for robust project scheduling: An experimental analysis. *European Journal of Operational Research*, *189*(3), 723-733.

Wang, D., Yung, K. L., & Ip, W. H. (2001). A heuristic genetic algorithm for subcontractor selection in a global manufacturing environment. *IEEE Transactions on Systems, Man, and Cybernetics, Part C (Applications and Reviews)*, *31*(2), 189-198.

Węglarz, J., Józefowska, J., Mika, M., & Waligóra, G. (2011). Project scheduling with finite or infinite number of activity processing modes–A survey. *European Journal of operational research*, *208*(3), 177-205.

Yang, X. S., Deb, S., & Fong, S. (2011, July). Accelerated particle swarm optimization and support vector machine for business optimization and applications. In *International Conference on Networked Digital Technologies* (pp. 53-66). Springer, Berlin, Heidelberg.

Zhang, H., Li, X., Li, H., & Huang, F. (2005). Particle swarm optimization-based schemes for resource-constrained project scheduling. *Automation in Construction*, *14*(3), 393-404.

Zhang, H., Li, H., & Tam, C. M. (2006). Particle swarm optimization for resource-constrained project scheduling. *International Journal of Project Management*, *24*(1), 83-92.

Zhou, X., & Zhong, M. (2005). Bicriteria train scheduling for high-speed passenger railroad planning applications. *European Journal of Operational Research*, *167*(3), 752-771.

Zhou, X., & Zhong, M. (2007). Single-track train timetabling with guaranteed optimality: Branch-and-bound algorithms with enhanced lower bounds. *Transportation Research Part B: Methodological*, *41*(3), 320-341.