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Development of PSO algorithm to increase the operation of port attraction

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ABSTRACT: Marine transportation system nowadays has special importance in international trade because of easy access and relative low costs. Ports as part of this system also play main role inmarine transportation process. Purpose of this research is to provide an algorithm for increasingoperation of port attraction. To make a model, variables whether dependent or independent should be determined. Dependent variable, here is operation of port in separation of goods. Studies show that physical specifications of ports such as length of jetty, number of jetty, number of cranes in jetty and beach, area of store, etc are the most important factors in operation of port. Therefore, these parameters are considered as independent parameters. At first, by using available information and statistics, operation of port in separation of goods is determined and then by referring to site of considered ports,we will extract physical specifications of ports. Modeling will be done by SPSS software and linear multivariable regression. Optimization of models is done by aforesaid software and using PSO algorithm. Finally, we analyze the models sensitively by using excelsoftware in order to study way and amount of effect of every parameter on objective functions.

Keywords: operation of port attraction,multivariable regression,PSO algorithm, analysis of sensitivity

INTRODUCTION

Measuring efficiency of port has a special importance because ports are vital for economic of a country and cause welfare and success of people. There are many reasons formeasuring efficiency of a port or terminal:

- First, we need to know how its operational efficiencyis.How many goods is transported everyday? How many customers are serviced every week?
- Second, what sources (including human sources, machineries and area of store) are used for doing port activities? How many goods are transported by every operator? How much is the cost of transporting every tone goods?
- It is necessary to measure amount of present efficiency of port than before. Are transported more goods than last year by operator of machineries? Whether there is any progress inefficiency?
- It is necessary for ports and terminals to compare their efficiency with their competitors especially model ports?

Now, following models are used:

1. Urban model: transportation activities are done around great cities and changetransportation models from trucks to smaller vehicles.
2. Italian model: it is a model that incorporates multilateral terminals with rail transportation.
3. Model of transporting goods of next port with other areas of the port.
4. Simultaneous impressionity model in which all parameters are effective inmultilateral terminalsimultaneously.

For calculating these effects on amount of total attraction of port, simultaneous impressionity model has been used. Simultaneous impressionity models have three famous mathematical models as follows[1]:

1- Linear model which is as follows: $y = a.x_1 + b.x_2 + ... + c$

2- craft model: $y = a.x_1{}^b.x_2{}^c....$

3- index model: $y = a.b^{x_1}.c^{x_2}....$

Where Y: is dependent variable which is sum of operation of port in separation of goods.
X_1, x_2: independent variables which include specifications of port such as area, capacity, number of crane,
A, b, c: calibration ratio of model

It is necessary to mention that linear model has priority toward other models because of having sensible elasticity ratio and in case of being different statistical tests unsuitable, other types are used.
Process of modeling has been done like this that structure of different variables in model has been evaluated based on statistical tests such as R^2, t and f and evaluation of model and finally the best structure has been proposed as desirable model.

After modeling, we consider to optimization of models. Purpose of optimization is to find the best acceptable answer considering to limits and needs of problem. There may be different answers for a problem and a function named objective function is defined for their comparison and selects an optimized answer. Definedobjective function is same calibrated model in separation of goods. Different problems of optimization are divided into following groups:

a) Unlimited optimization problems: the purpose is to minimize or maximizeobjective function without any limitation on design variables.
b) Limitedoptimizationproblems: optimization is done in most applied problems considering to some limitations; the limitations in the filed of behavior or operation of a system is named behavioral limitations and limitations in physic and geometry of problem is named as numerical or laterallimitations.

MATERIALS AND METHODS

During last 50 years, development of computer has caused some developments in methods ofoptimization so that many constructions have been codified during this time. In this part, we review somemethods ofoptimization. Figure 1 shows methods ofoptimization schematically.

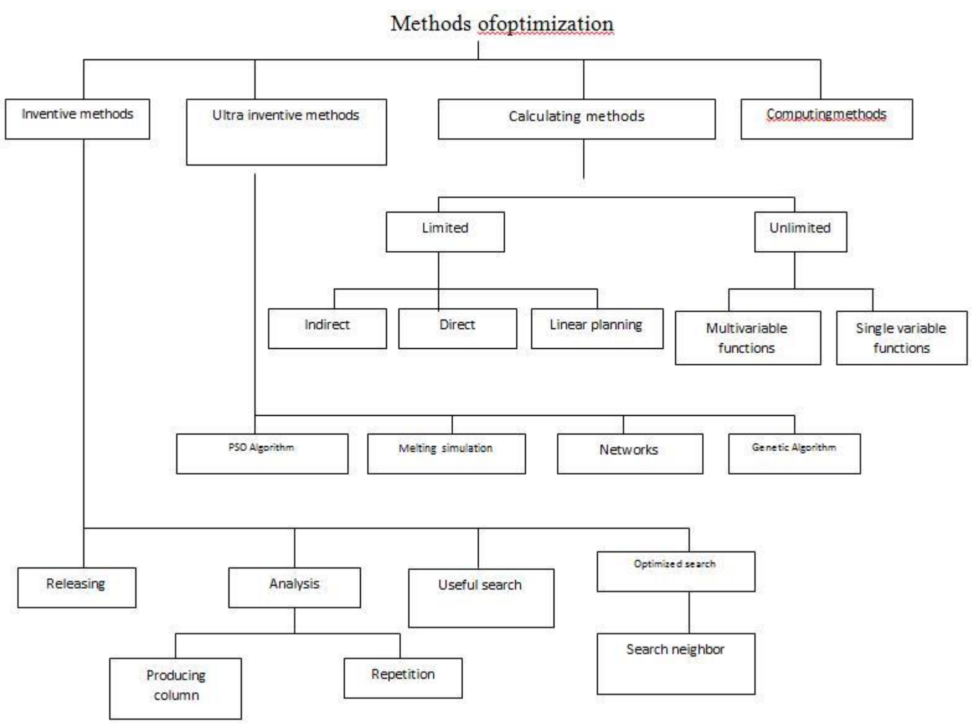

Figure 1. classification of methods of optimization

PSO algorithm has been used for optimizing models in this article.
2-1- introduction ofPSO algorithm

On 1995, Eberhart and Kennedy introduced PSO as indefinite search method for function optimization. This algorithm has inspired from group movement of birds for reaching food.

PSO is equal to a bird in group movement of birds. Every solution is named a particle and every particle has some sufficiency which is calculated bysufficiency function.The more particle closer to object, the more it hassufficiency.Also, every particle has a speed which leads movement of particle. Every particle continues to its movement by following particles. In this way, a group of PSO particles create randomly and try to find a solution for optimization by updating generations. In every step, every particle is updated by two best amounts. The first case is the best situation that the particle has reached. The aforesaid is determined and maintained. Another best amount namely pbest is used by algorithm and is the best situation which is gained by population of particles. This situation is shown by gbest.

After finding the best amounts, speed and place of every particle is updated by using equations (4) and (5).

v[] = v[] +
c1 * rand() * (pbest[] - position []) +c2 * rand() * (gbest[] - position[] (4)

position[] = position[] + v[] (5)

Right side of equation 4 constitutes from three parts which first part is present speed of particle and second and third part is change of speed and its turn toward best personal experience and groupexperience. If we don't consider to first part, then, speed of particles is determined by considering to current situation andbest personal experience and groupexperience. In this way, the best group particle is fixed in its place and others move toward that particle. In fact, group movementof particles without part 1 of equations 4 will be process in which space of search becomes small gradually and a local search is done for the best particle. In contrast, if we just consider to first part of equations 4, particles continue their normal way until to reach to wall of area and they do a throughout search.

Literature of review

A. Mansour Khaki, Sh. Afandizadeh and R.Moayedfar (2008) studied about total operation of port attraction. Their purpose was to estimate and foresee total operation of multilateral transportation terminals and Shahid Rajaei Port as case study[3]. Zhuoyi Wang (2008) studied about total modeling of Jebel Ali port and provided a total plan for it. His purpose was to develop total plan forJebel Ali port on 2030 including environmental changes, evaluation of possible choices, and evaluation of costs and simulation of computer model[4]. Writer of this thesis provided a computer simulation model based on Monte Carlo to analyze behavior of container jetty and determine length of jetty considering to number of cranes.

Shih and Lai (1992) provided law of topology of firstentry-first service with an inventive algorithm for analyzing berth devotion modeling . Brown (1994, 1997) proposed mathematical models of berth devotion modeling for maximizing benefit in ports . Eimay (1997) analyzed berth devotion. In this problem, devotion and row of ships for every berth have been considered for the least waiting time and offset of ships. Park and Kim (2004) studied about planning for crane of jetty with activities in ship considering to interference of cranes and priority law between activities. The writers proposed restriction and divergence method and inventive algorithm for solving problem of planning for crane of berth . Bierwirth and Meisel (2009) revised model of Sammarra (2008) and modeled and developed it according torestriction and divergence method. Their proposed solution includes objective function and calculating time.

RESULTS AND DISCUSSION

Modeling

Modeling was done by using SPSS software, volume 20. The models have been calibrated for modeling based on available specifications and information and statistics of port. Types of parameters used in modeling have been shown in table 1 and calibrated models in table 2. Synthetic parameters have been used in some models such as proportion of total length of jetty to number of available jetti

Table 1. variabale used in modeling process

Types of variables used in modeling			
Description	Mark	Title of variable	Type of variable
----	L.A	Area of terminal	
----	N.C	Total number of crane (container & ship to beach)	
----	N.B	Number of jetty	
----	B.L	Length of jetty	
---	P.A	Area of influence range	single
---	P.C	Capacity of pipe line	
---	Ca	Capacity of ship acceptance	
NC/A. B.L	NCU	Number of cranes in medium length of every jetty	Synthetic
B.L / N.B	A.B.L	medium length of every jetty	
----	CCO	Total operation of containers	
----	OCO	Total oil operations	Operational
----	GCO	Total operation of general goods	

Table 2. calibrated models according to separation of goods

General goods	$Gco = 5063.5+ 578.7\times(N.C)+ 31.1\times(L.A)+ 523.3\times(N.B) - 31.8\times(\frac{B.L}{N.B})- 90040.4\times(\frac{N.C\times N.B}{B.L})$				R2	F test	Percent of test error
					0.98	good	---
T test	Fixed amount	First variable	Second variable	Thirdvariable	Fourth variable	Fifth variable	
	0.046	0.00	0.049	0.00	*0.013*	*0.00*	
Container goods	$Cco=2835.1+ 319.3\times(N.C)+ 6.7\times(L.A)-642.8\times(N.B) + 0.5\times(B.L)- 8.2\times(\frac{B.L}{N.B})$				R2	F test	Percent of test error
					0.98	good	---
T test	Fixed amount	First variable	Second variable	Thirdvariable	Fourth variable	Fifth variable	
	0.02	0.00	0.002	0.00	*0.169*	*0.024*	
Oil cargo	$Oco = -761143+178.7\times(P.A)-2099.8\times(B.L) +17.2\times(Ca)+2804.7\times(P.C)$				R2	F test	Percent of test error
					0.922	good	---
T test	Fixed amount	First variable	Second variable	Thirdvariable	Fourth variable		
	0.066	0.045	0.032	0.01	*0.016*		

Considering to table 2, R2 is between 0.92 to 0.98 which shows suitable correlation between dependent variable namely total operation of ports and independent variables (specifications of port). Amount of t test and f test in all models is suitable in case of meaningful level of independent variables and correlation of everyindependent variable with dependent variable.Figures 3 to5 show total operation of ports according to model and observe schematically.

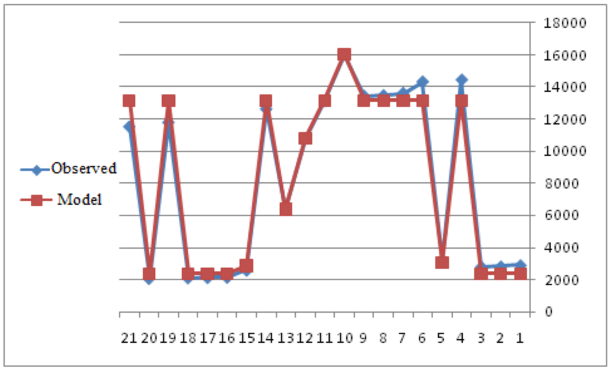

Figure 2. total operation of ports for cargo goods based on model and observe

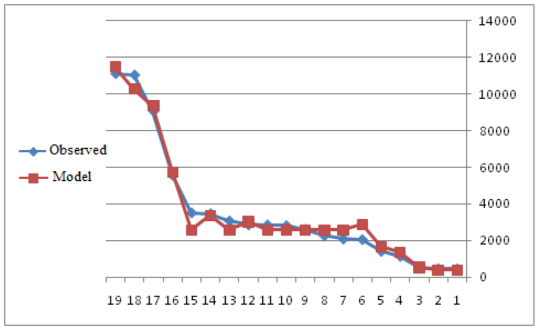

Figure 3. total operation of ports for container goods based on model and observe

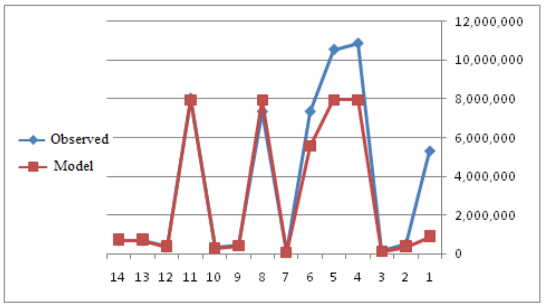

Figure 4. total operation of ports for oil goods based on model and observe

Reliability evaluation of model

For evaluating reliability of models, we will use statistics and information that don't interfere in modeling process. We estimate operation of port by using proposed models and compare them with statistics provided by ports and determine estimated error of model. The results ofreliability evaluation of model are shown in tables 3 to 5. Equation 6 is used for evaluating error.

6) 100 * (operation based on observed - operation based on model) / (operation based on observed) ≤ 15 %

Table 3. results gained by reliability evaluation of proposed model for general goods

Port	operation (thousands tons)	Number of crane	Terminalarea (Hectar)	Berth length (meter)	Number of berth	Operation based on model	%error
Dubai 1) (991	14524	25	175.00	3000	10	13160	-9.39
Damam (1998)	2126	6	50.00	950	4	2354	10.72
Dubai (1997)	11299	25	175.00	3000	10	13160	16.47
Mersin (2010)	4046	17	61.41	708	3	4388	8.45

Table 4. results gained by reliability evaluation of proposed model for container goods

Port	operation (thousands TEUs)	Number of crane	Terminal area (Hectare)	Berth length (meter)	Number of berth	Operation based on model	% error
Tanzania (2010)	342	3	18	725	3	335	-2.11
Khorfekan (1993)	359	5	30	1060	4	372	3.60
Alexandra (2010)	543	2	19	510	2	458	-15.66
Salaleh Port (2001)	1761	7	120	1236	4	1331	-24.42

Table 5. results gained by reliability evaluation of proposed model for oil goods

Port	Operation (thousands TEUs)	Number of crane	Terminal area (Hectare)	Berth length (meter)	Number of berth	Operation based on model	%error
ShahidRajaei 13) (87	8,637,690	740	160,000	1,134	28,600	8,728,354	1.05
ShahidRajaei 13) (82	9,344,308	740	160,000	1,134	28,600	8,728,354	-6.60
ShahidRajaei 13) (88	8,499,420	740	160,000	1,134	28,600	8,728,354	2.62
ShahidRajaei 13) (89	6,604,658	740	160,000	1,134	28,600	8,728,354	24.05
Neka (1386)	278,146	750	6,000	144	11,400	208,263	-18.22

Optimization the models

Optimization is an important and determinant activity in planning. Plannerswill be able to produce better plans when they can save time and cost of planning by optimization methods. Purpose ofoptimization is to determine variables of planning so that objective function is minimized or maximized and our purpose is to maximizeobjective function. The algorithm used in this essay is PSO algorithm for optimizing models. 3 statuses have been considered foroptimizing general and container goods considering to nature of models. At first, we didn't consider to any limit for providing relation between cranes and number of berths in algorithms but we intended this relation to be 1 and 2 in next steps. Results of optimization are shown in tables 6 to 8.

Table 6. results of optimization by PSO for general goods

Gbest	Number of crane	Terminal area (Hectare)	number of berth	berth length /number of berth	Number of crane/ (berth length /number of berth)
1.92E+04	17	167.025	25	204.07	0.0833
General goods (number of crane=number of berth)					
Gbest	Number of crane	Terminal area (Hectare)	number of berth	berth length /number of berth	Number of crane/ (berth length /number of berth)
1.63E+04	20	151.08	20	193.674	0.1033
General goods (number of crane=twice number of berth)					
Gbest	Number of crane	Terminal area (Hectare)	number of berth	berth length /number of berth	Number of crane/ (berth length /number of berth)
1.08E+04	20	134.9428	10	266.9981	0.0749

Table 7. results of optimization by PSO for container goods

Gbest	Number of crane	Terminal area (Hectare)	number of berth	berth length (meter)	berth length /number of berth
1.50E+03	20	20	6	809	134.833
General goods (number of crane=number of berth)					
Gbest	Number of crane	Terminal area (Hectare)	number of berth	berth length (meter)	berth length /number of berth
2.22E+03	11	470	11	839.3	76.3494
General goods (number of crane=twice number of berth)					
Gbest	Number of crane	Terminal area (Hectare)	number of berth	berth length (meter)	berth length /number of berth
1.4E+03	8	260.5381	4	800	200

Table 8. results of optimization by PSO for oil goods

Gbest	Area of influence (square kilometer)	Length of oil berth (meter)	Portage (tone)	Quality of pipe (inch-Kilometer)
+06E9.37	41,493	259	16,000	1,065

Analysis of sensitivity

Calibrated models are analyzed forsensitivity to study percent of effect of mentioned parameters on sum of operation. For this work, at first, specifications of 5 ports is selected and change of operation of ports considering to parameters are studied by using excel software. Tables 9 to12 show the results of analyzing sensitivity. Similar evaluations have been done for container and oil goods which are shown in appendix “A”. A parameter named “rate of change” is used for evaluating effect of change on operation which is shown as percent. Equation (7) shows way of evaluating rate of change.

7) Rate of change= ((operation of port based on model- operation of port in return for 10% increase or decrease of berth length)/(operation of port based on provided model) * 100

Parameters that are used in analyzing sensitivity are as follows:

Turnover= operation of port in separation of goods

Berth length= total length of berths available in port

L/N= ratio of total berth length of port to berth numbers

C/(L/N)= number of cranes in return to every (meter/inch) of berth length

L + 0.1 * L=berth length plus 10% increase of berth length for studying effect on total operation of port

L - 0.1 * L=berth length plus 10% decrease of berth length for studying effect on total operation of port

Model (L + 0.1 * L)= amounts gained for operation in return for10% increase of berth length

Model (L - 0.1 * L) = amounts gained for operation in return for10% decrease of berth length

Model= operation of port based on provided model

%change= change of operation of port in return for10% increase or decrease of berth length

Table 9. results of 10% decrease or increase of berth length on operation of port for general goods

Port	Turnover	Berth Length	L/N	L+0.1*L	Model (L+0.1*L)	Model	%Change
Damam *(1992)*	2884	950	261.25	1045	1805	2354	-23.32
Dubai *(1993)*	13629	3000	330.00	3300	12887	13160	-2.07
Jebel Ali *(2010)*	10795	7475	373.75	8222.5	9830	10790	-8.90
Imam Khomeini *(1999)*	2568	1037	228.14	1140.7	2517	2861	
Port	Turnover	Berth Length	L/N	L-01*L	Model (L-0.1*L)	Model	%Change
Damam *(1992)*	2884	950	213.750	855	2857	2354	21.35
Dubai *(1993)*	13629	3000	270.000	2700	13280	13160	0.91
Jebel Ali *(2010)*	10795	7475	305.795	6727.5	11724	10790	8.65
Imam Khomeini *(1999)*	2568	1037	186.660	933.3	3134	2861	9.56

Table10. results of increase or decrease of 1 crane for operation of port for general goods

Port	Turnover	Crane	L/N	C/(L/N)	C+1	Model(C-1)	Model	%Change
Damam *(1992)*	2884	6	237.500	0.02947	7	2553	2354	8.47
Dubai *(1993)*	13629	25	300.000	0.08667	26	13438	13160	2.11
Jebel Ali *(2010)*	10795	5	339.773	0.01766	6	11104	10790	2.91
Imam Khomeini *(1999)*	2568	8	207.400	0.04339	9	3005	2861	5.04
Port	Turnover	Crane	L/N	C/(L/N)	C-1	Model(C-1)	Model	%Change
Damam *(1992)*	2884	6	237.500	0.02947	5	2154	2354	-8.49
Dubai *(1993)*	13629	25	300.000	0.08667	24	12881	13160	-2.12
Jebel Ali *(2010)*	10795	5	339.773	0.01766	4	10476	10790	-2.91
Imam Khomeini *(1999)*	2568	8	207.400	0.04339	7	2716	2861	-5.07

Table 11. results of increase or decrease of 10% area of terminal on operation of port for general goods

Port	Turnover	Land Area	Berth length	L.A+0.1*L.A	Model (L.A+0.1*L.A)	Model	%Change
Damam *(1992)*	2884	50.00	950	55.00	2509	2354	6.60
Dubai *(1993)*	13629	175.00	3000	192.50	13704	13160	4.13
Jebel Ali *(2010)*	10795	111.09	7475	122.19	11136	10790	3.20
Imam Khomeini *(1999)*	2568	20.00	1037	22.00	2923	2861	2.16
Port	Turnover	Land Area	Berth length	L.A-0.1*L.A	Model (L.A-0.1*L.A)	Model	%Change
Damam *(1992)*	2884	50.00	950	45.00	2198	2354	-6.61
Dubai *(1993)*	13629	175.00	3000	157.50	12615	13160	-4.14
Jebel Ali *(2010)*	10795	111.09	7475	99.98	10445	10790	-3.20
Imam Khomeini *(1999)*	2568	20.00	1037	18.00	2798	2861	-2.19

Table 12. results of increase or decrease of 1 berth for operation of port for general goods

Port	Turnover	N.berth	L/N	C/(L/N)	N+1	Model(N+1)	Model	%Change
Damam *(1992)*	2884	4	190.000	0.03158	5	3819	2354	62.25
Dubai *(1993)*	13629	10	272.727	0.09167	11	13800	13160	4.86
Jebel Ali *(2010)*	10795	22	325.000	0.01538	23	11723	10790	8.65
Imam Khomeini *(1999)*	2568	5	172.833	0.04629	6	3789	2861	32.43
Port	Turnover	N.berth	B/N	C/(B/N)	N-1	Model(N-1)	Model	%Change
Damam *(1992)*	2884	4	316.667	0.01895	3	-119	2354	-105.07
Dubai *(1993)*	13629	10	333.333	0.07500	9	12326	13160	-6.34
Jebel Ali *(2010)*	10795	22	355.952	0.01405	21	9812	10790	-9.06
Imam Khomeini *(1999)*	2568	5	259.250	0.03086	4	1382	2861	-51.68

According to the above tables, it can be said that operation of port for general goods decreases by increase of jetty length and decrease of cranes and it shows that in case of unbalance betweenjetty length and number of cranes, operation of port will be decreased. Results of above table show that increase of terminal area cause to increase operation of port.While it has some costs for facilities and equipments of ports and the best and the most economical choice should be chosen.

CONCULSION

According to the above tables, it can be said that operation of port for general goods decreases by increase of jetty length and decrease of cranes and it shows that in case of unbalance betweenjetty length and number of cranes, operation of port will be decreased. Results of above table show that increase of terminal area cause to increase operation of port.While it has some costs for facilities and equipments of ports and the best and the most economical choice should be chosen.

REFERENCES

Conclusion & Recommendations. 1999. Mr. Gilberto Galloni Managing Director Interporto Bologna S.P.A. Fv-2000 Project Co – ordinator: "Fv- 2000 International Conference Barcelona", 17th June.
Kennedy J, Eberhart R and Shi Y. 2001. Swarm Intelligence, Morgan Kaufman Publishers.
Mansour Khaki A, Afandizadeh SH, Moayedfar R. 2004. "An Estimation of the Total Turnover of a Multimodal Transportation Terminals (case study of Shahid Rajayi Port)", The 5th International Congress on Civil Engineering, Tarbiat Modarres University.
Zhuoyi W. 2008. "Master plan of Jebel Ali Port", TU Delf, pp.38-58, 91, 96-106.
Lai KK, Shih K. 1992. "A study of container berth allocation; Journal of Advanced Transportation" 26; 45–60.
Brown GG, Cormican KJ, Lawphongpanich S, Widdis DB. 1997. Optimizing submarine berthing with a persistence incentive; Naval Research Logistics 44; 301–318.
Imai A, Nagaiwa K, Chan WT. 1997. Efficient planning of berth allocation for container terminals in Asia; *Journal of Advanced Transportation* 31; 75–94.
Kim KH and Park YM. 2004. A crane scheduling method for port container terminals. In European Journal of Operational Research, 156, pp. 752-768.
Bierwirth C, Meisel FA. 2009. fast heuristic for quay crane scheduling with interference constraints. Journal of Scheduling, Vol. 12, 2009, pp. 345-360.