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Egypt – Japan University of Science and Technology
Innovative Design Engineering
Industrial Engineering and Systems management

The Container Pre-marshalling Problem

Special Session on
Modeling and Analysis of Container Terminal Operations

MARLOG 4

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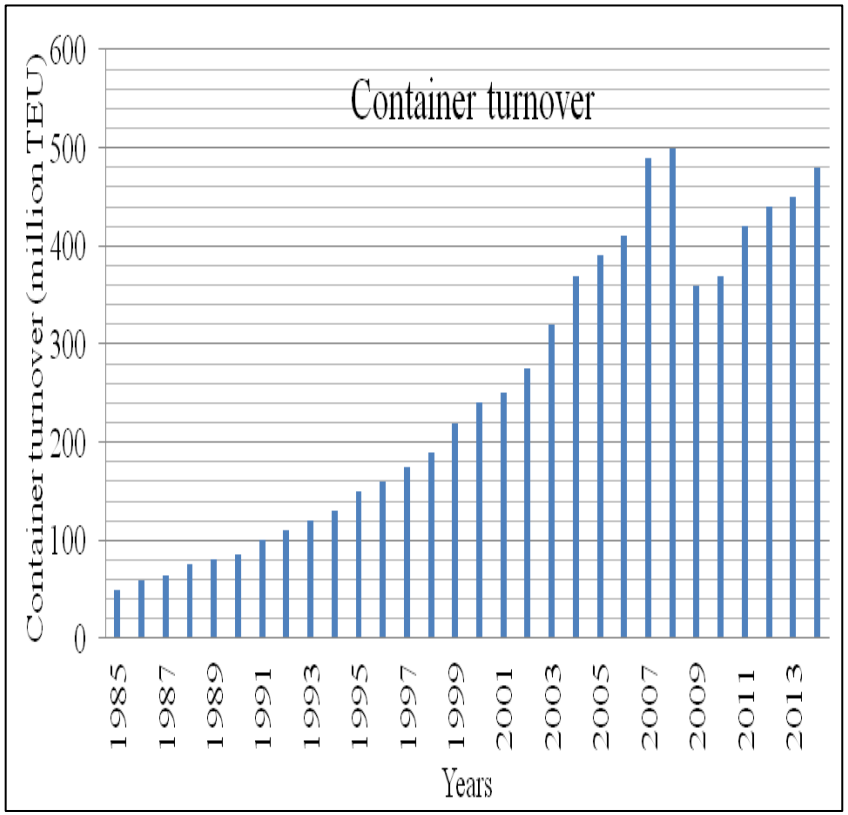
Introduction

- 85% of the world trade is via container terminals
- Increase the competition between container terminals
- Increase interest of research in different operations in container terminals to find optimum solutions for the problems found
- one of these problems is the container pre-marshalling

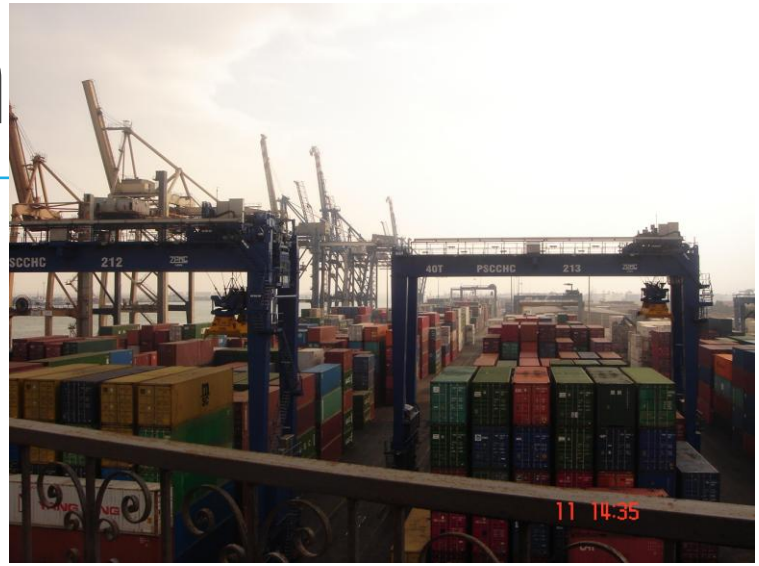


Introduction Con

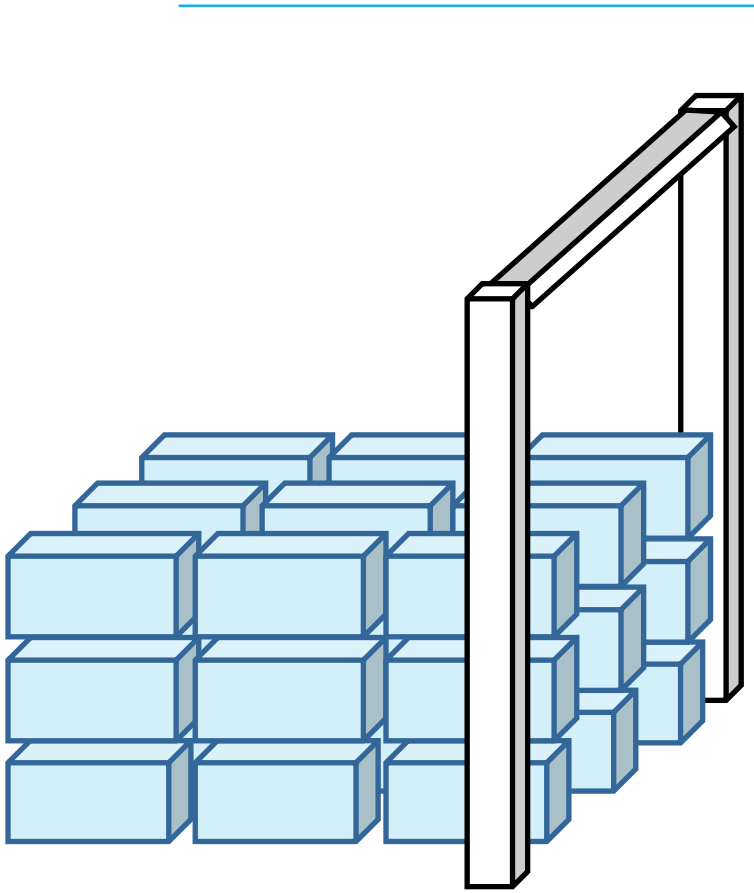
Performance Indicators of the container terminal efficiency are:

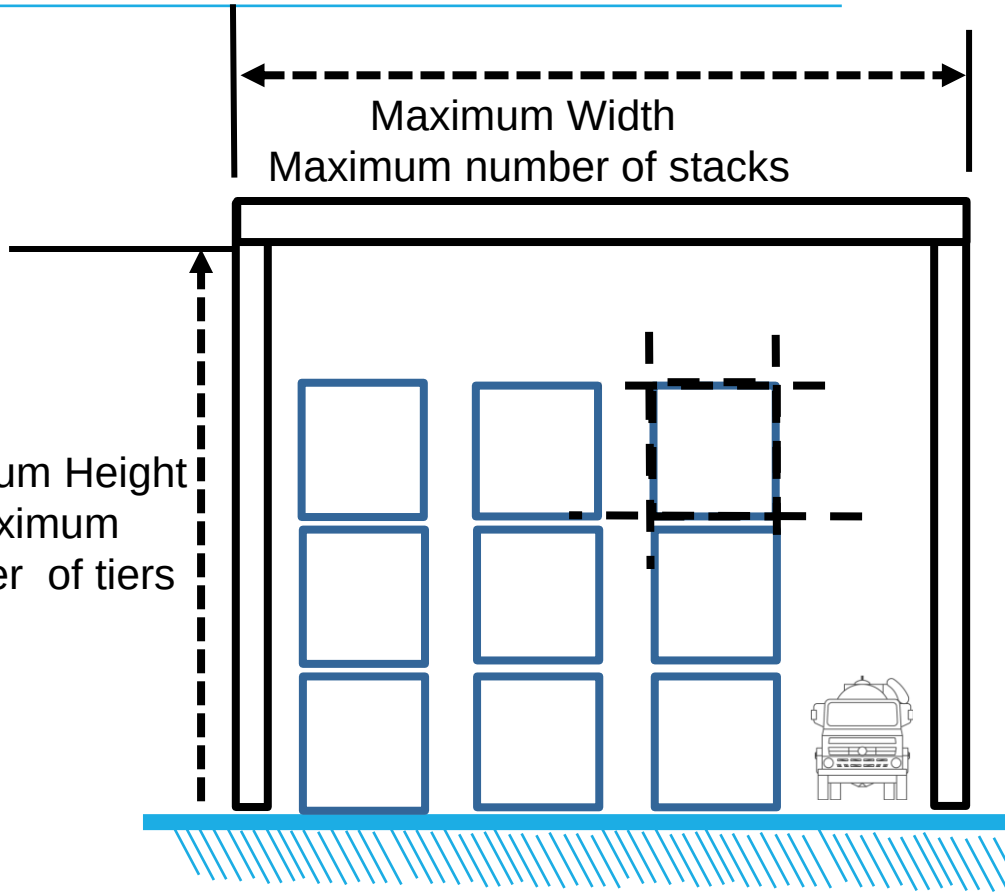
- Vessel berthing time: the time that taken by a vessel waiting until leaving the quay
- Throughput of the quay cranes: the efficiency of unloading/loading containers from/to vessels

These indicators are influenced by the work rate of the yard crane



Yard layout





Bay

Stack

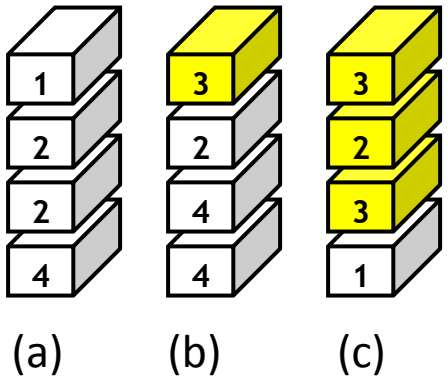
Tier

The Mis-overlay Concept (Lee & Hsu 2007)

Mis-overlays, is a situation were two or more containers are stacked in the wrong order

The mis-overlay index, is the maximum depth of the mis-overlays in the stack

- (a) no mis-overlays
- (b) mis-overlay index = 1
- (c) mis-overlay index = 3

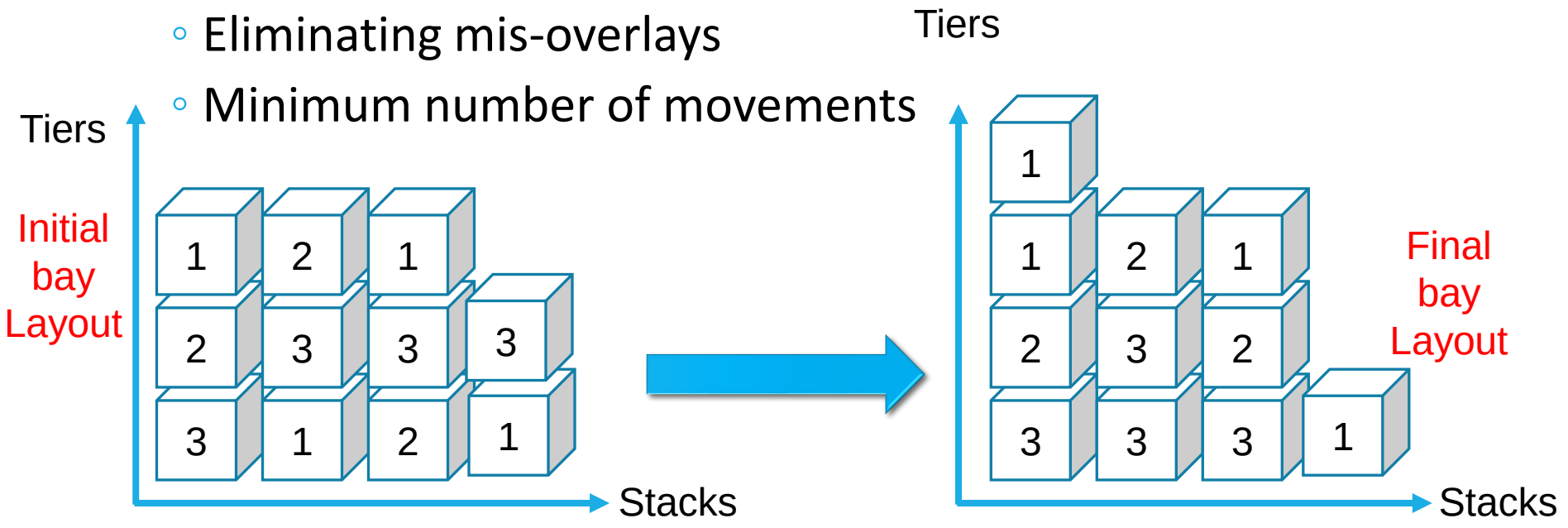


The Container Pre-marshalling Problem

In the container pre-marshalling problem, an initial layout of a bay is converted to a final desired layout.

Objectives

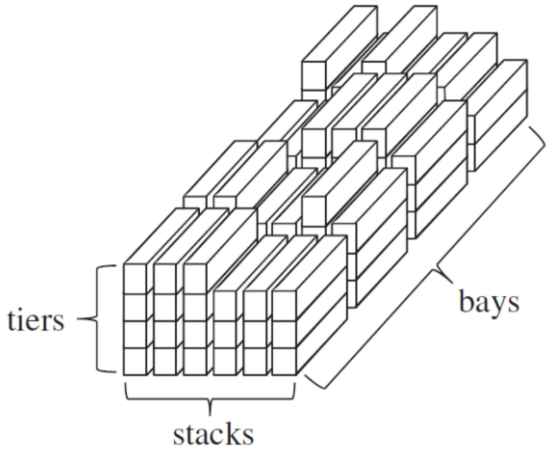
- Eliminating mis-overlays
- Minimum number of movements



Related Problems

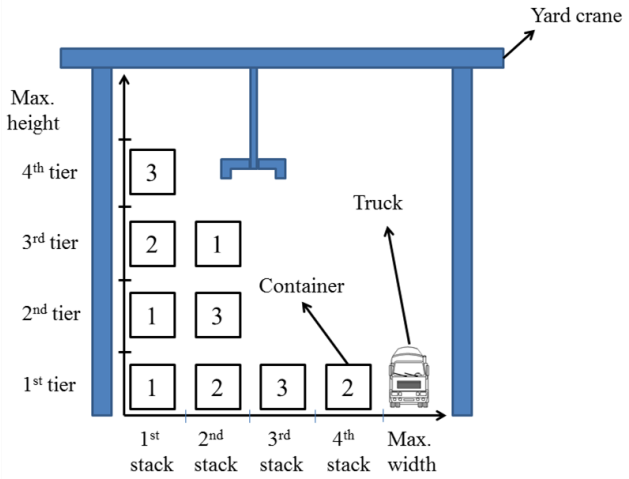
The container remarshaling problem

It is a general case from the container pre-marshalling within which containers are rearranged within a block with minimum number of container movements.



The container retrieval (relocation) problem

It is desired to fetch a container from the bay with minimum number of reshuffles, and then remove another container and so on till the bay is empty.



Proposed solution methods

There are many solution methods which are able to solve the container pre-marshalling problem

Exact method

Approximate method

$$y_{ii}^{c1} \le 1, \qquad \forall c \in Cont, i \in Slots \qquad [1]$$

$$\sum_c y_{ij}^{ct} + \sum_c \sum_{j \ne i} x_{ij}^{ct} \le 1, \qquad \forall t \in Time \backslash \{1, T\}, i \in Slots \qquad [2]$$

$$\sum_c y_{ij}^{ct} + \sum_c \sum_{i \ne j} x_{ij}^{ct} \le 1, \qquad \forall t \in Time \backslash \{1, T\}, j \in Slots \qquad [3]$$

$nt, j \in Slots$ [4]

$nt, j \in Slots$ [5]

[6]

$ne \backslash \{1, T\}$ [7]

$x_{ij}^{ct} \ge 0,$
$1, \ldots, (n-1)H + 1\}$ [8]

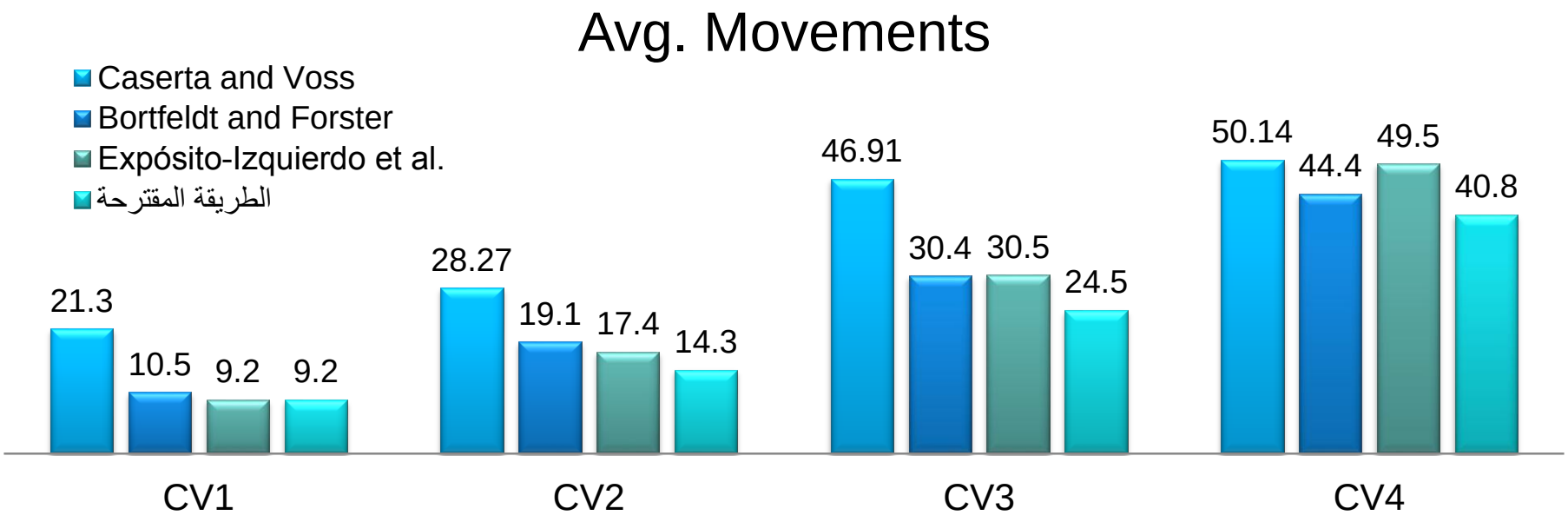
```
16.  for z =1 to (length(cr)-1) step 2 do
17.      for R=1 to a-1 do
18.          if ILC(R,cr(z)) equal to 0 and ILC(R+1,cr(z)) equal to 0 then
19.            if R+1equal to a then
20.              cr← [cr(z) cr(z+1)]
21.              NAMcount1C3← NAMcount1C+1
22.            else continue
23.            end if
24.          elseif ILC(R,cr(z)) equal to 0 and  ILC(R+1,cr(z)) not equal to 0 then
25.                for B=1to a-1 do
26.                    if ILC(B,cr(z+1)) equal to 0 and ILC(B+1,cr(z+1)) equal to 0 then
27.                      if B+1equal to a then
28.                        ILC(B+1,cr(z+1)) ← ILC(R+1,cr(z))
29.                        ILC(R+1,cr(z)) ← 0
30.                        Count ← Count+1
31.                      else continue
32.                      end if
```

Proposed solution methods cont.

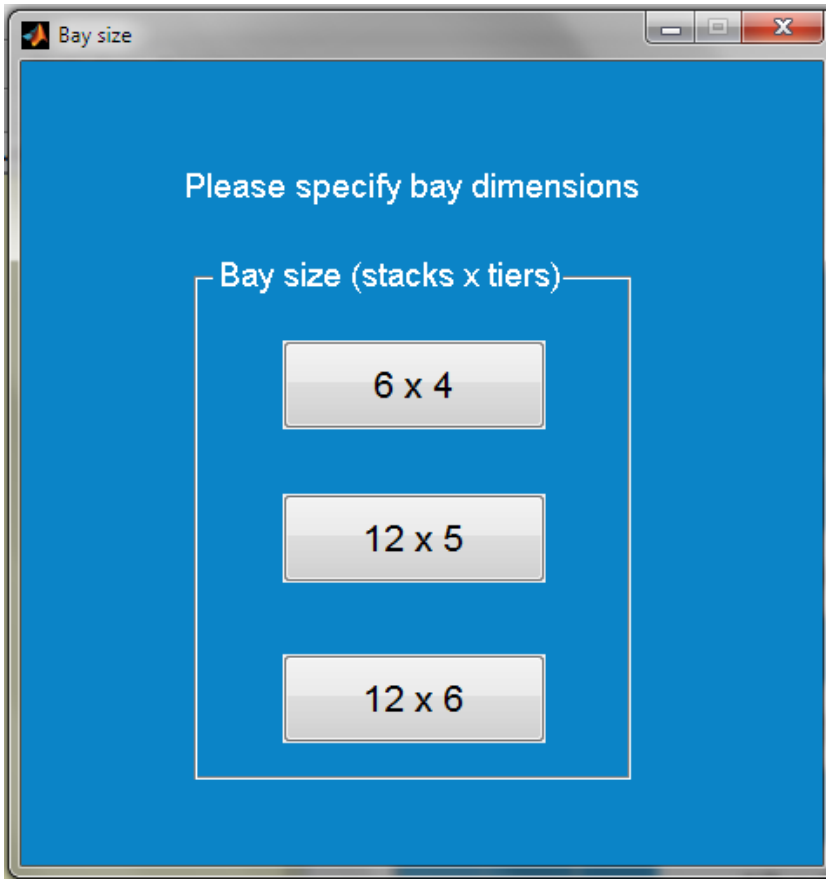
A Proposed method based on Genetic algorithm was used to solve the problem

The proposed method was tested on 80 randomly generated instances

A software was developed based on the proposed method to solve the problem



Software interface

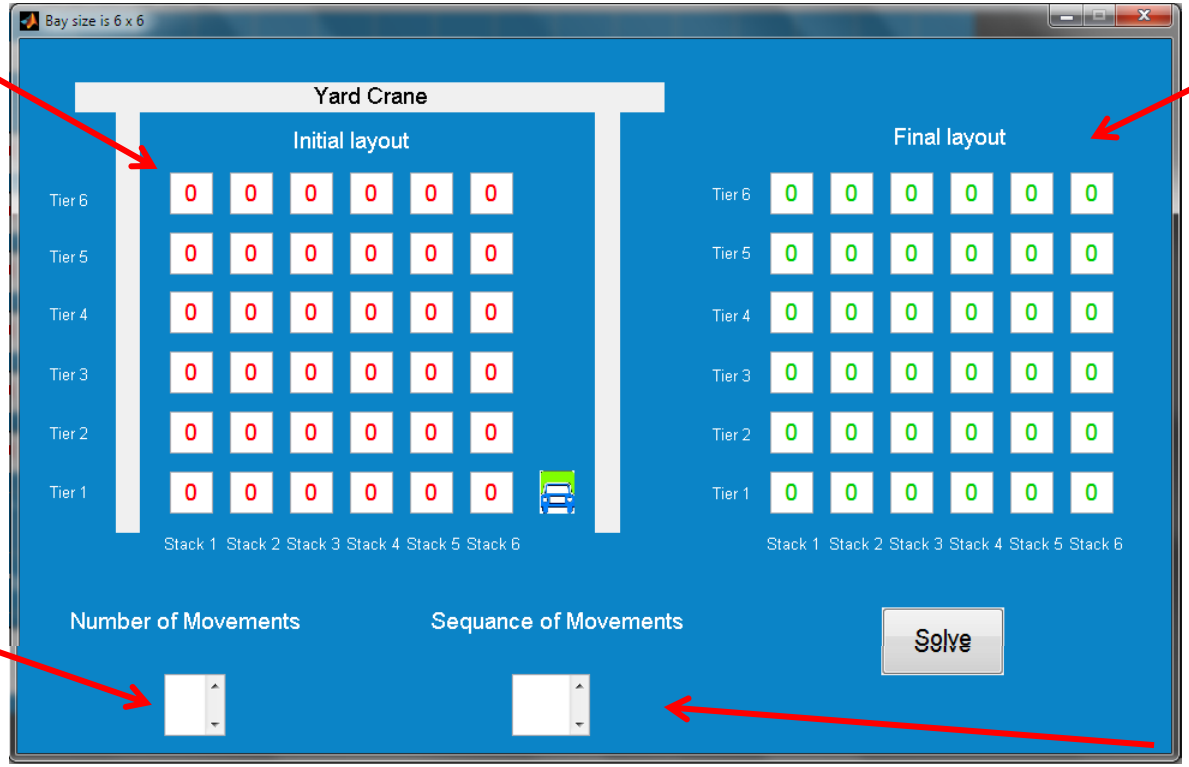


Bay dimension

Software interface

Initial layout of the bay

Final layout of the bay

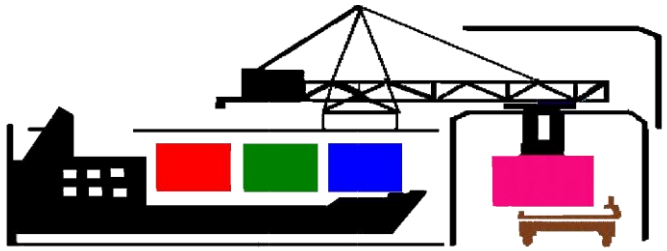


No. of Movements

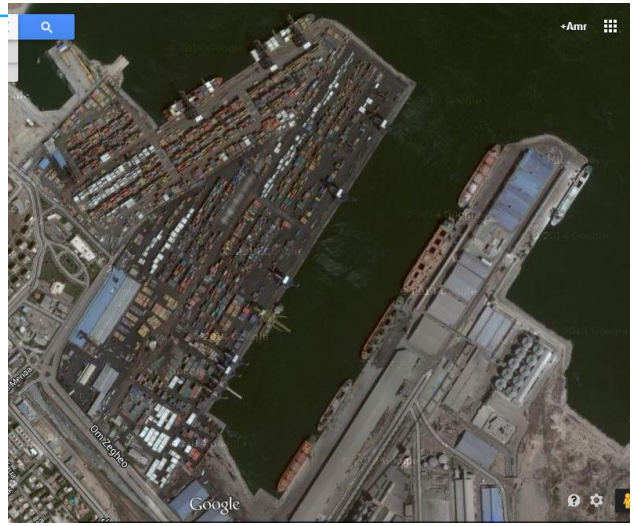
Sequence of movements

Container & Cargo Handling Company (ACCHC)

Alexandria Container & Cargo Handling Company (ACCHC)



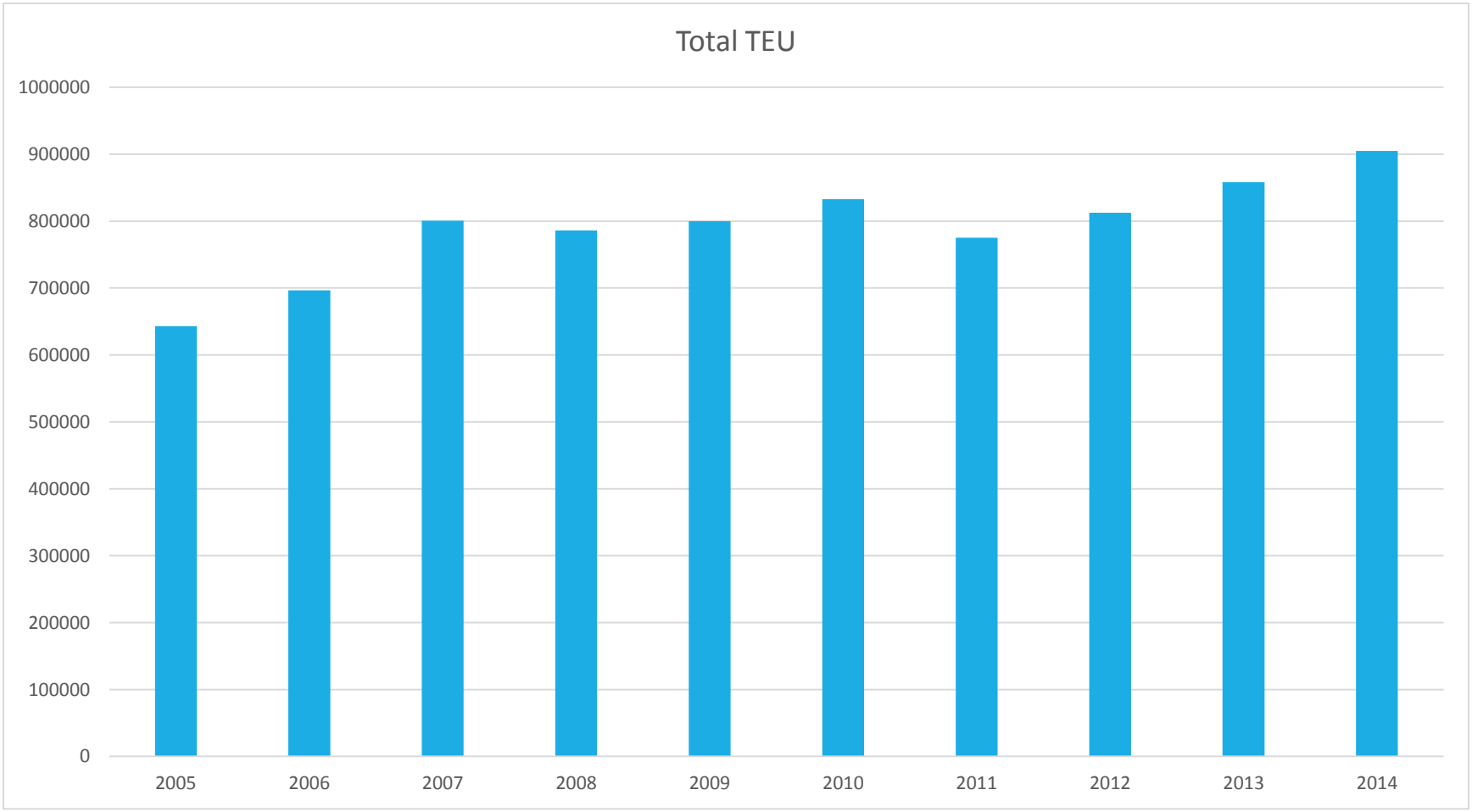
شركة الإسكندرية لتداول الحاويات والبضائع



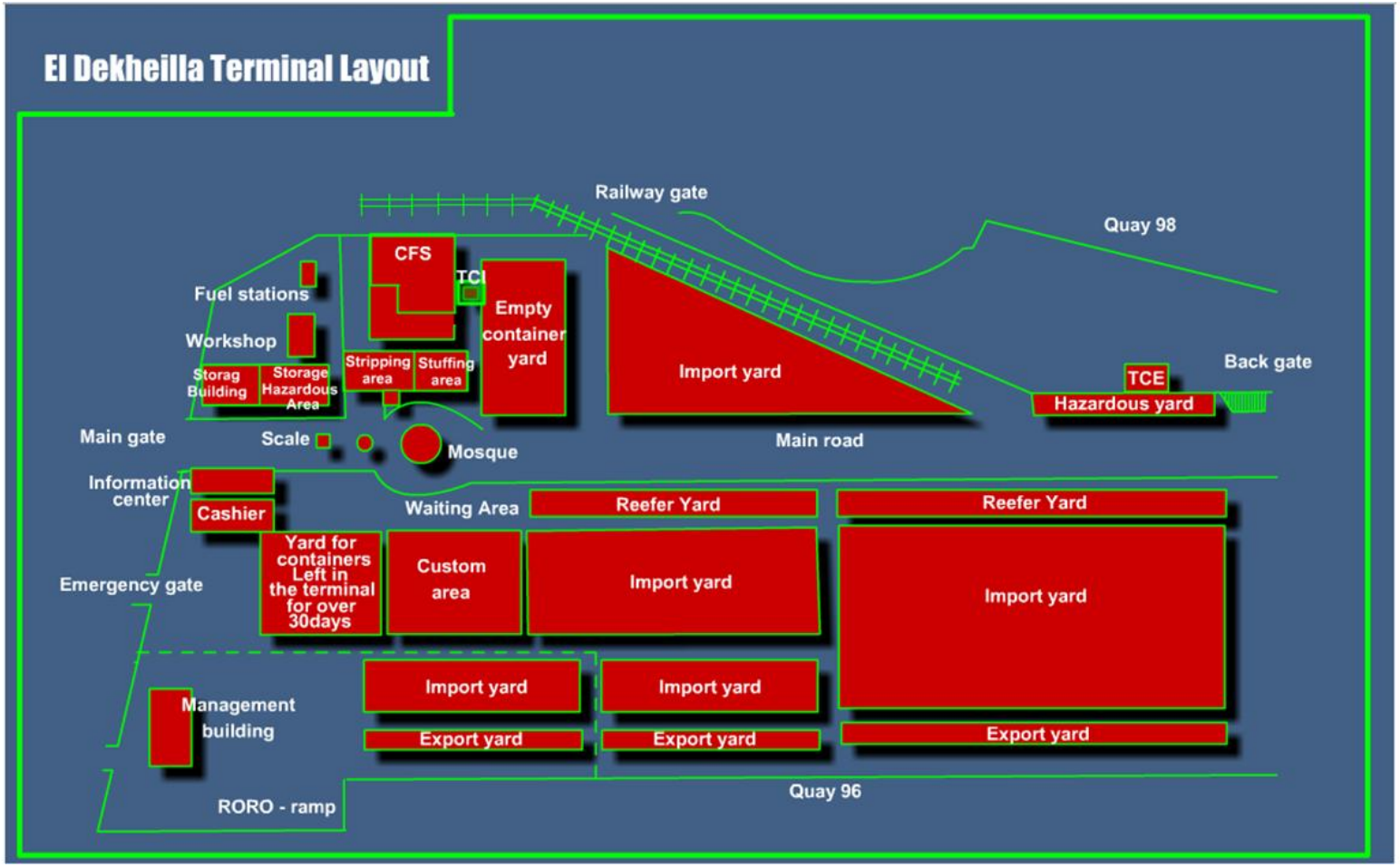
Alexandria Container & Cargo Handling Company (ACCHC) is the first specialized container handling company in Egypt

The company operates two major terminals, the first is the Alexandria container terminal at the port of Alexandria and the second is El-Dekheila terminal at the port of Dekheila

A case study in Alexandria Container & Cargo Handling Company (ACCHC) Cont,

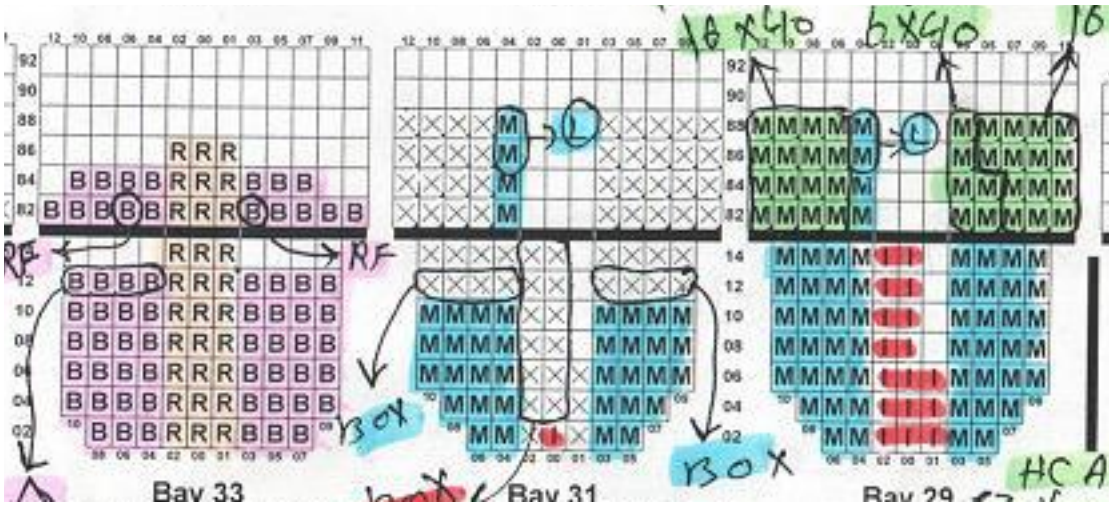


A case study in Alexandria Container & Cargo Handling Company (ACCHC) Cont,



A case study in Alexandria Container & Cargo Handling Company (ACCHC) Cont,

yard position	container no.	weight	shipping line	Container Size	destination	full
PA103003	TRKU2036126	26	TRK	20'	BEY	FCL
PA122001	SOCU1101664	24.2	TAR	20'	IST	FCL
PA122002	GETU3004543	24.2	TAR	20'	IST	FCL
PA122003	NOCU0052489	24.2	TAR	20'	IST	FCL
PA122004	ARKU2396205	26.1	ARK	20'	TRM	FCL
.....	.....	.....	.....	.....	.....	...



A case study in Alexandria Container & Cargo Handling Company (ACCHC) Cont,

A case study was conducted in El-Dekheila container terminal, the available data were for “Mira” vessel with about 1000 containers to be loaded on the vessel.

Three bays were selected to apply the proposed solution methodology.

The timing data were collected during loading the vessel "Ever Unicorn" operating for the Ever Green Line, on Saturday 24th, 2015.

A case study in Alexandria Container & Cargo Handling Company (ACCHC) Cont,

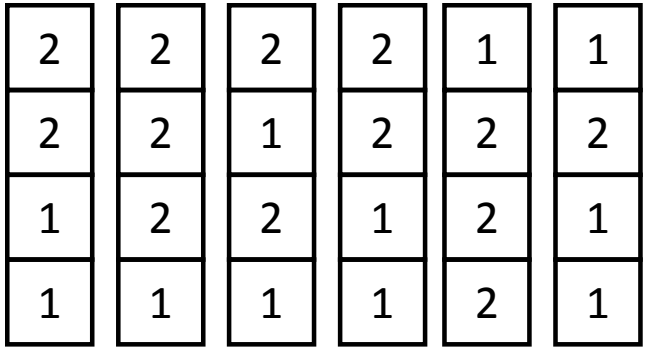
Number of containers:

Bay 1: 24 containers

Bay 2: 15 containers

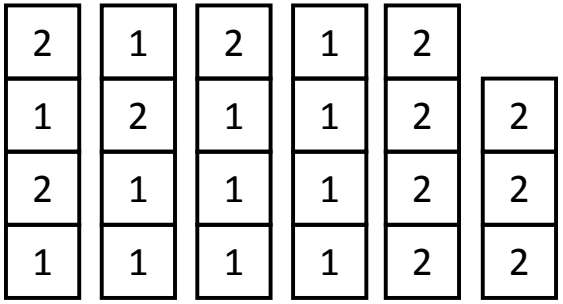
Bay 3: 23 containers

Occupancy rate = 86 %



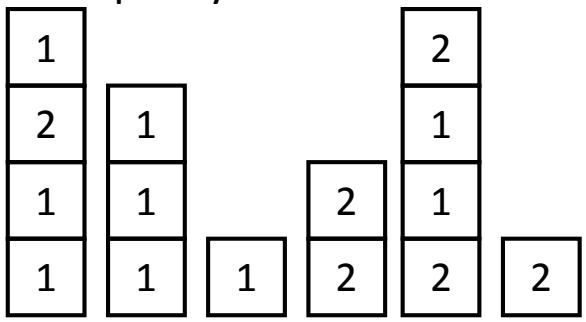
Bay 1

Occupancy rate = 82 %



Bay 3

Occupancy rate = 53%



Bay 2

A case study in Alexandria Container & Cargo Handling Company (ACCHC) Cont,

	Bay	Retrieval before pre-marshalling	Pre-marshalling	Retrieval after pre-marshalling	Potential % Savings
Time (min)	1	36	28	18	50%
Movements		21	17	11	48%
Time (min)	2	17	4.3	13	24%
Movements		10	3	9	10%
Time (min)	3	28	5	20	29%
Movements		16	6	12	25%

Conclusions

The developed software is able to solve the container pre-marshalling problem

The software was used to solve a case study

Solving the container pre-marshaling problem is vital in container terminals and affects the performance measures of the container terminals

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The Container Pre-marshalling Problem