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Tworty Box to Improve the Equipment Logistics of Container Lines

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ABSTRACT: A major share of all empty container positioning (deadheading) is resulting from imbalances with regard to container sizes (20ft/40ft). In order to reduce the shipments of 'containerised air' a new type of container has been developed by the author: The *Tworty Box*es can either be used as a standard 20ft or in coupled condition as a 40ft container. The outside appearance resembles any standard 20ft container. However the *Tworty Box* is unique in that it has an additional door at the front side that opens to the inside. This door can be fixed to the ceiling and by using of bonding elements another *Tworty Box* can be joined up, thereby creating the full 40ft inside space. Operated as a single 20ft box the additional door remains locked, access is only through the existing standard door. *Tworty Boxes* do not require any additional components and fulfil all ISO and CSC requirements.

1 TASK

The commodity most often shipped in containers across the seven seas is pure air: Approximately 20% of all worldwide shipped containers are empty! According to estimates related handling costs alone are more than US$ 15 Billion p.a.! Furthermore carrier's box fleets have to be much bigger than actually needed to satisfy shipper's demand. This results in containers standing empty or idle in average approx. 60% of the time which consequently causes additional costs in ports and at depots. Moreover empty boxes void valuable slots on board the vessels. Hence cost effective container management has become the key issue for the profitability of container lines! It is estimated that each empty positioning is valued at approx. 450 US$/box mostly in terms of handling costs in ports.

Figure 1. A pair of *Tworty Boxes* is loaded in Hamburg in coupled condition on board the "OOCL Montreal"

The high portion of unproductive and costly empty positionings is caused by:

1 structural imbalances of the general cargo flow (general trade imbalance),

2 seasonal impacts of dominating commodities in specific trades,
3 **imbalances of the 20ft:40ft ratio between both trade directions**

A significant share of the empty positioning is resulting from carrier's internal imbalances in container logistics with regard to box sizes (20ft/40ft). Carriers note strong ups and downs in supply and demand of different container sizes in certain areas/ports especially if several services of different trades are calling the same area. Local dispatchers often report: "Too many 20s, not enough 40s", or reverse. Not always the situation can be balanced in time. Not seldom the grotesque situation occures that a carrier has to leave laden (low paying) boxes behind in order to reduce the empty stock of a certain size and position them empty to another port of the world where they are urgently needed for high paying cargo.

Figure 2. Front side with additional door (to be opened to the inside) and bonding elements adjacent to the corner castings.

Figure 3. Inside view of closed additional front side door (cables to open the door are visible).

2 THE TWORTY SOLUTION

In order to significantly reduce the shipments of 'containerised air' the *Tworty Box* has been developed. Its outside appearance resembles any standard 20ft container. However the *Tworty Box* is unique in that it has doors at each end, the second door opens to the inside and can only be locked from the inside. This door can be fixed to the container ceiling and with the use of special bonding and sealing elements another *Tworty Box* can be joined up, thereby creating a watertight 40ft unit of full value (with standard doors at both ends).

Thus *Tworty Boxes* can either be used as a standard ISO 20ft or coupled as a 40ft container:

Twenty + Forty = ***Tworty***

If two *Tworty Boxes* are coupled to form a 40ft box the additional doors will be opened supported by cables and fixed to the container ceiling to receive the full 40ft inside space. Operated as a 20ft box this door is locked, access is only through the existing standard door. Two coupled *Tworty Boxes* make a 40ft container with doors at both ends. The system does not require any additional components and the coupled boxes remain watertight. The *Tworty Box* complies with all ISO requirements for containers and has successfully passed the full CSC testing procedure with DNV-GL.

The coupling is carried out by bonding elements which guarantees that two *Tworty Boxes* can be handled like a single 40ft container. The connection of two *Tworty Boxes* can only be released from the inside. Four coupling elements are located adjacent to the corner castings (Figure 2). Each *Tworty Box* has two male and two female bonding elements. They also keep the distance of 76 mm between the boxes in order to comply with the ISO regulation for the length of a 40ft container.

The *Tworty Box* concept is protected by international patents. Following main design targets have been followed:
- minimum changes compared to a standard 20ft container
- robustness
- easy handling
- (almost) no loose parts

Compared to single standard 20ft/40ft boxes the losses of the *Tworty Box* with regard to payload and capacity (if any) are marginal (Table 1). The only loose parts are the flat surrounding sealing ledges which are screwed after the coupling process from the inside into the gap between both boxes providing the necessary watertightness. As each *Tworty Box* carries a set of seals under the ceiling but only one is needed for the coupling of two *Tworty Boxes* there is enough redundancy if one sealing element was missing or damaged leaving enough time for a replacement. The seal fully complies with international customs regulations.

Table 1. Comparison of payload and capacity.

	20 ft (8'6" high)		40 ft (8'6" high)	
	Payload [t]	Capacity [m³]	Payload [t]	Capacity [m³]
standard container	21.8 … 28.2	32.8 … 33.2	25.8 … 26.7	65.3 … 67.7
Tworty Box	27.8	33.1	25.2	63.5

By operating *Tworty Boxes* empty positionings caused by the need to balance different supply and demand of 20ft and 40ft container sizes can be significantly reduced. Even if empty *Tworty Boxes* have to be empty positioned (e.g. due to inevitable imbalances of the general cargo flow) they can be coupled and immediately 50% of the lift on/lift off charges are saved.

On account of global forwarding company DHL a pair of prototype boxes which had been stuffed with commercial cargo has already made a trial trip in 2013 on board of OOCL and Hapag-Lloyd vessels from Hamburg to Montreal and v.v. to the full satisfaction of the forwarder.

Figure 4. Bolting mechanism with handle for hinged door (from the inside).

Figure 5. Box for bottom male coupling element.

3 ECONOMICS

Approx. 205 Mill TEU (Twenty Foot Equivalent Unit) have been shipped across the seven seas in 2011. Thereof 21% were empty (42 Mill TEU).

In 2011 the world container fleet consisted out of 30 Mill TEU (of which 27 Mill TEU were standard 20ft/40ft dry cargo boxes), i.e. in average each standard TEU has been shipped only 6.8 times throughout the year – thereof 1.4 times empty (empty share of 21%). In average each shipment (full or empty) has caused 2.9 port handlings (the average value of more than '2' is caused by transhipments).

Already in 2001 each empty positioning has been valued at approx. 400 US$/box mostly in terms of port handling costs. It is assumed that this amount has now increased to at least 450 US$/box. Hence in 2011 with a global 20ft/40ft split of 1,53 TEU/box within the standard dry cargo box fleet each TEU had caused at least approx. 410 US$ just for its empty positioning (1.4 x 450 US$/box : 1,53 TEU/box ≈ 410 US$/TEU).

As the average life time of a container is 8 to 9 years it is obvious that each container causes empty positioning costs during its entire life time which are exceeding its current newbuild price (approx. 2,000 US$ for a standard 20ft container) by far. Hence focusing on reducing empty positioning is much more important than achieving the lowest possible purchase price of standard container equipment!

3.1 *Focus on single boxes*

Maximum savings can be achieved when 2 x Tworties are substituting 2 x 20ft and 1 x 40ft standard boxes which are normally due to be empty positioned in opposite trade directions. Table 2 illustrates the economics of operating *Tworty Boxes* compared to standard 20ft/40ft containers.

For the comparison three relevant cost items have been considered whereby the costs of crane moves and the costs for coupling/de-coupling have been varied within a realistic bandwidth. Considering the slightly higher investment for the *Tworty Box*, its daily capital costs have been set more than two times (!) the value of a standard 20ft box, which is by all means much more than the additional door will realistically cause (this leaves some reserve for an eventually slightly higher daily M+R allowance):

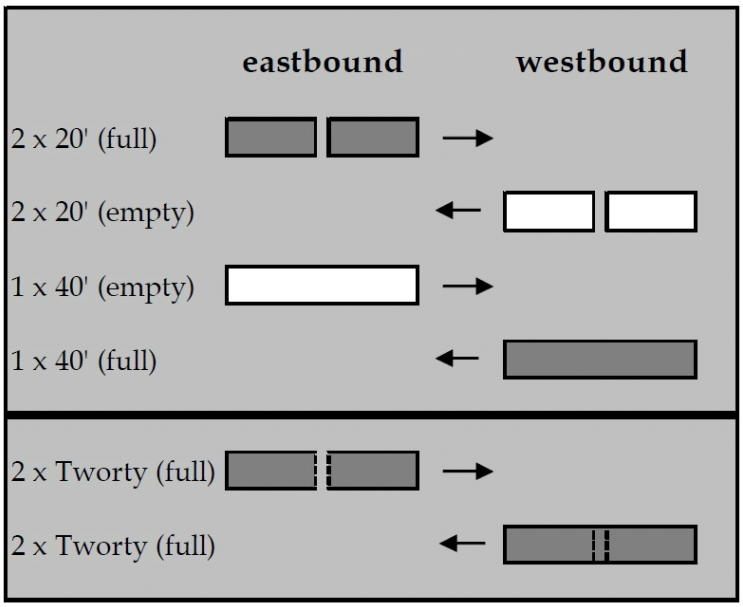
- daily capital costs:
  - standard 20ft container: 0.85 US$/box/day
  - standard 40ft container:[1] 1.36 US$/box/day
  - *Tworty Box*: 2.00 US$/box/day
- (worst case assumption)
  - costs per crane move: 100…200 US$
  - costs per (de-)/coupling:[2] 20…100 US$

[1] According to the industry standard the capital costs of a standard 40ft container are defined to be generally 1.6 times higher compared to a standard 20ft container.

[2] These costs may also cover the efforts to track the *Tworty Box* fleet to ensure that two boxes are always available to be coupled if needed.

Table 2. 2 x *Tworty Boxes* are replacing 2 x 20ft and 1 x 40ft standard container.

Duration	Unitcosts [US$]		Trans-
RV [days]	Move	Coupling	shipment
100	100,-	100,-	0



	Capital Costs [US$]	Moves [US$]	Coupling [US$]	Voyage Total [US$]
2 x 20' (full)	85	400	0	485
2 x 20' (empty)	85	400	0	485
1 x 40' (empty)	68	200	0	268
1 x 40' (full)	68	200	0	268
			Total	**1.506**
2 x Tworty (full)	200	400	100	700
2 x Tworty (full)	200	200	100	500
			Total	**1.200**

Difference	**306**
Percentage of conv. costs	**20%**

3.2 *Results of single box view*

Table 2 illustrates the most unfavourable case for the operation of *Tworty Boxes* within the given range of parameters (arrow in Figure 6 & 7), i.e.:
- minimum lift on/lift off rate
- maximum coupling/de-coupling rate
- longest duration of container voyage
- no transhipment

Nevertheless compared to conventional box operations savings of 306 US$ have been revealed for a round trip of the boxes, i.e. two shipments. This amount represents savings of 20% compared with the operation of standard containers. This magnitude exceeds by far the industry's average profit margin per container shipment (especially at present times). Saved costs for slots on board which do not need to be used for empty positioning have not even been considered.

Savings would logically increase if costs for coupling/de-coupling were decreased. However considering the wide range of this parameter the impact on the *Tworty Box* profitability is not dramatic. It can be revealed from Figure 6 that the impact of the duration of the single container voyage is rather negligible. It is much more the applicable average lift on/lift off rate which is of significant influence on the savings. For general guidance the following rough amounts can be applied (according to the specific trade a respective average out of both ends has to be considered):
- Europe: approx. 100 US$/move
- N.America: approx. 200 US$/move
- Asia: approx. 300 US$/move

As more and more container lines are following the "hub-and-spoke" strategy the influence of transhipment has to be considered as well. In the meantime the share of transhipped boxes in port's global container throughput has risen from 10% in 1980 to more than 30% in 2011! It can be clearly revealed from Figure 7 that the savings the *Tworty Box* can provide become higher the more often the containers are transhipped! Furthermore savings are even much higher if average lift on/lift off charges in excess of 100 US$/move meets with the necessity to tranship empty containers at least once.

It can be concluded that the introduction of *Tworty Boxes* can provide dramatic savings if they are operated and kept in certain imbalanced trades where their advantages can be fully utilised. Thus contrary to standard containers they have to be individually tracked and treated as special equipment like e.g. flats, reefers etc.

A simple low scale example as per Figure 8 demonstrates that even trades with an almost balanced cargo flow and an identical general 20ft:40ft ratio both ways would very much benefit from the *Tworty Box*. It is assumed that in a hypothetical trade 100 TEU have to be shipped eastbound whereas 120 TEU are due to be carried westbound. Contrary to reality and not beneficial for *Tworty Box* operation both volumes shall exactly have an identical 20ft:40ft ratio (= 0.86) on their ocean leg. In reality this ratio is however varying more or less around an average

figure among the various loading and discharging ports involved

Hence deadheading is not only required to compensate the general imbalance in required equipment flow between both regions but also to balance the various requirements for different container sizes among the ports within a region. The required box fleet is determined by the dominant trade direction. In this case for both sizes the westbound leg is stronger. Hence at least 240 TEU of equipment would be required to ship both volumes simultaneously.

Just due to the apparent general trade imbalance additional 20 TEU (6 x 20ft + 7 x 40ft = 13 boxes) seems only to be necessary to be empty positioned eastbound (Figure 9). However considering also the various local imbalances at each port 44 TEU (14 x 20ft + 15 x 40ft = 29 boxes) have actually to be shipped empty (also within the regions) in order to compensate the imbalanced supply and demand of container sizes. This is 120% more (in terms of TEU) than one would expect from the pure general trade imbalance, resulting in 123% more empty box movements! Also the box fleet has to be slightly larger than originally anticipated as boxes which are due for an additional intra-regional deadheading cannot be immediately stuffed after having been stripped.

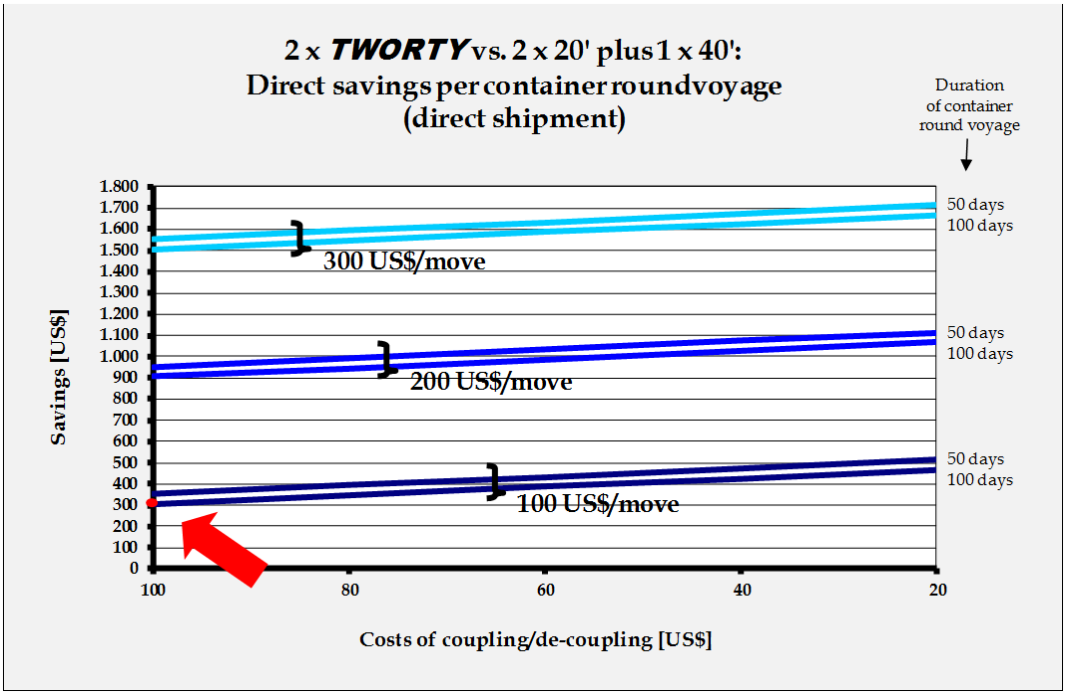


Figure 6.

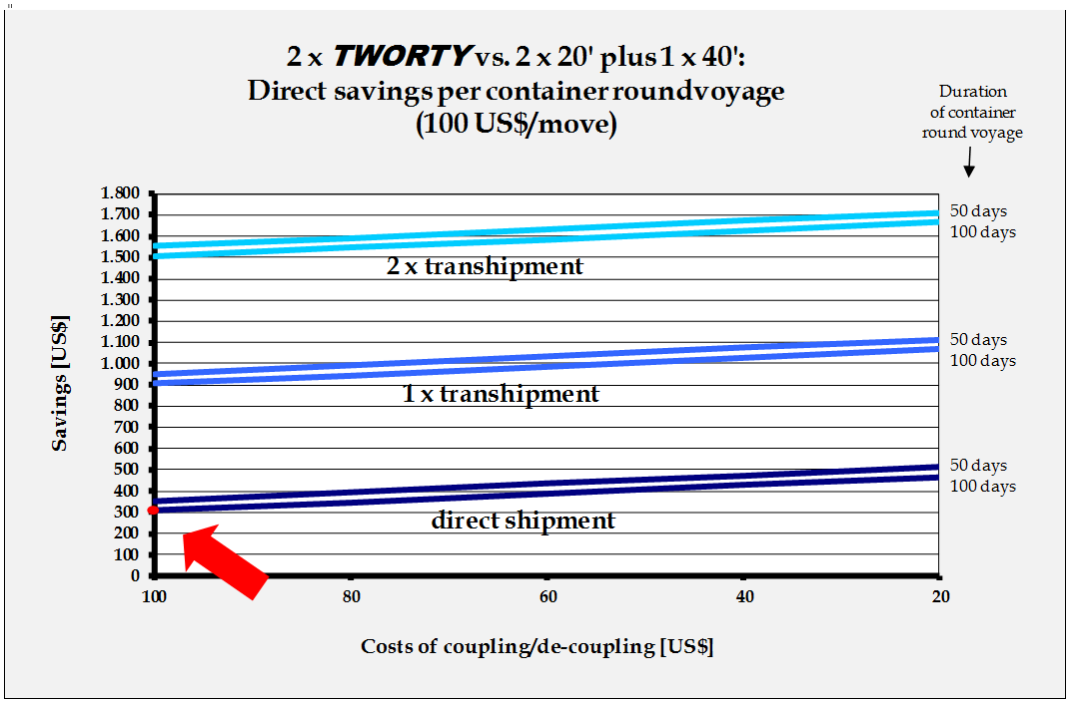


Figure 7

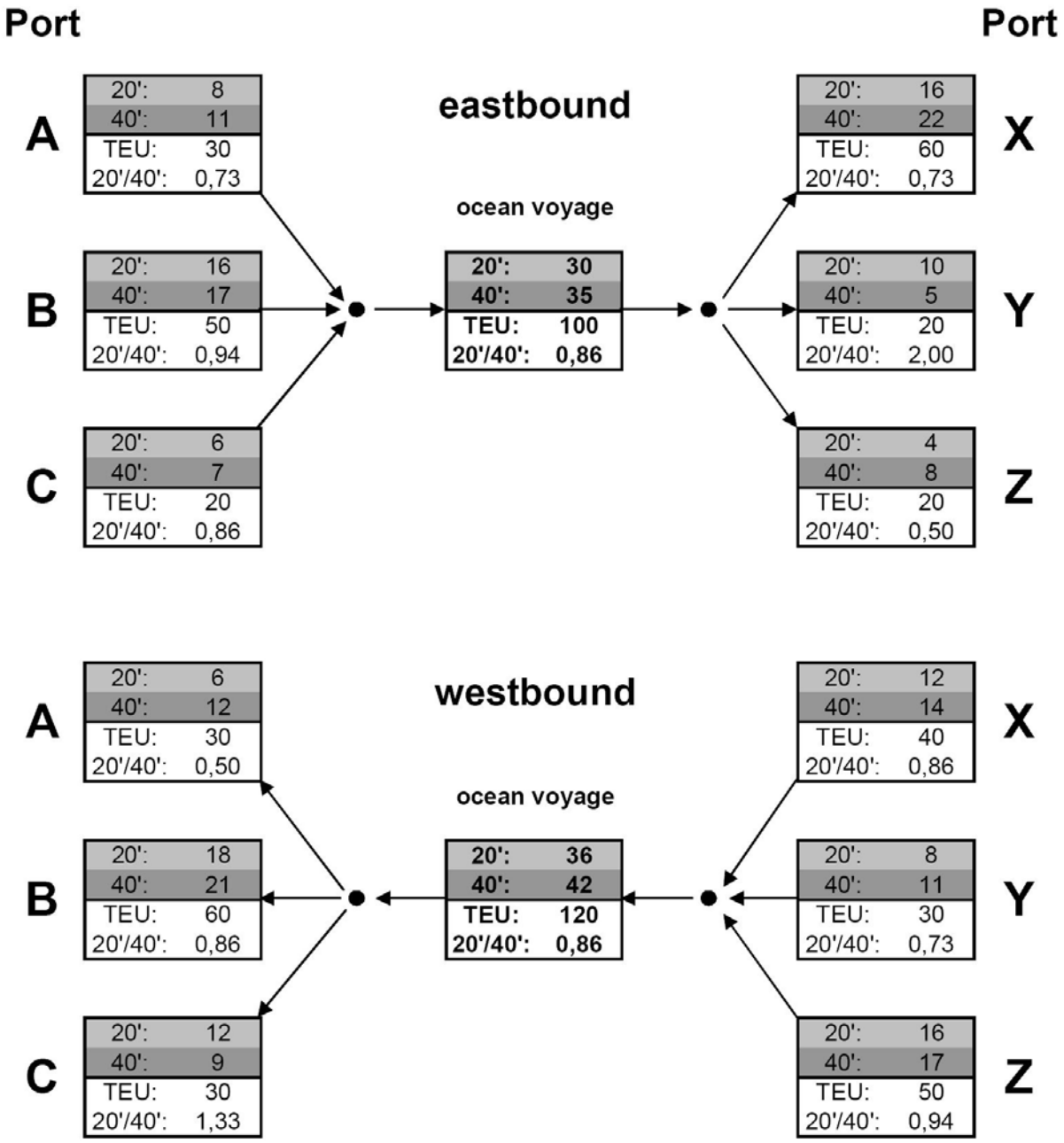


Figure 8. General trade imbalance (low scale example).

3.3 *Result of carrier's entire fleet view*

At all ports which suffer from a sudden or permanent lack of one size and a surplus of the other size (e.g. port "A" and "Y") the operation of *Tworties* would be very advantageous (Figure 10). If in the example only 4 x *Tworties* were introduced (replacing 2 x 40ft standard boxes) and these boxes were kept plying only between port "A" and "Y" just only 40 TEU (including the *Tworties*) would have to be empty positioned (instead of 44 TEU). Hence a *Tworty* share of only 2% (in terms of TEU) within the box fleet could theoretically lead to a reduction of deadheading costs by 10%! Furthermore the entire fleet could be reduced by 4 TEU (-2%)!

Thus a homogeneous container fleet existing completely out of *Tworties* is not necessary. The huge majority of the fleet can still consist out of standard 20ft and 40ft boxes. As it can be derived from the example even a small number of *Tworty Boxes* which are kept plying between ports where a chronic surplus of one size meets with the lack of the other size can significantly contribute to improved economics of a carrier's container fleet.

Although the *Tworty Box* cannot supersede all repositioning necessities, there are many trades where the 40ft:20ft ratio of equipment is varying among the ports and where the *Tworty Box* concept can help substantially.

Because 2 x *Tworty Boxes* are destined to replace approx. 2 x 20ft standard boxes and 1 x 40ft standard box the capital costs of the entire box fleet do not increase as the additional expenses for one *Tworty Box* would not exceed half the costs of a 40ft standard box.

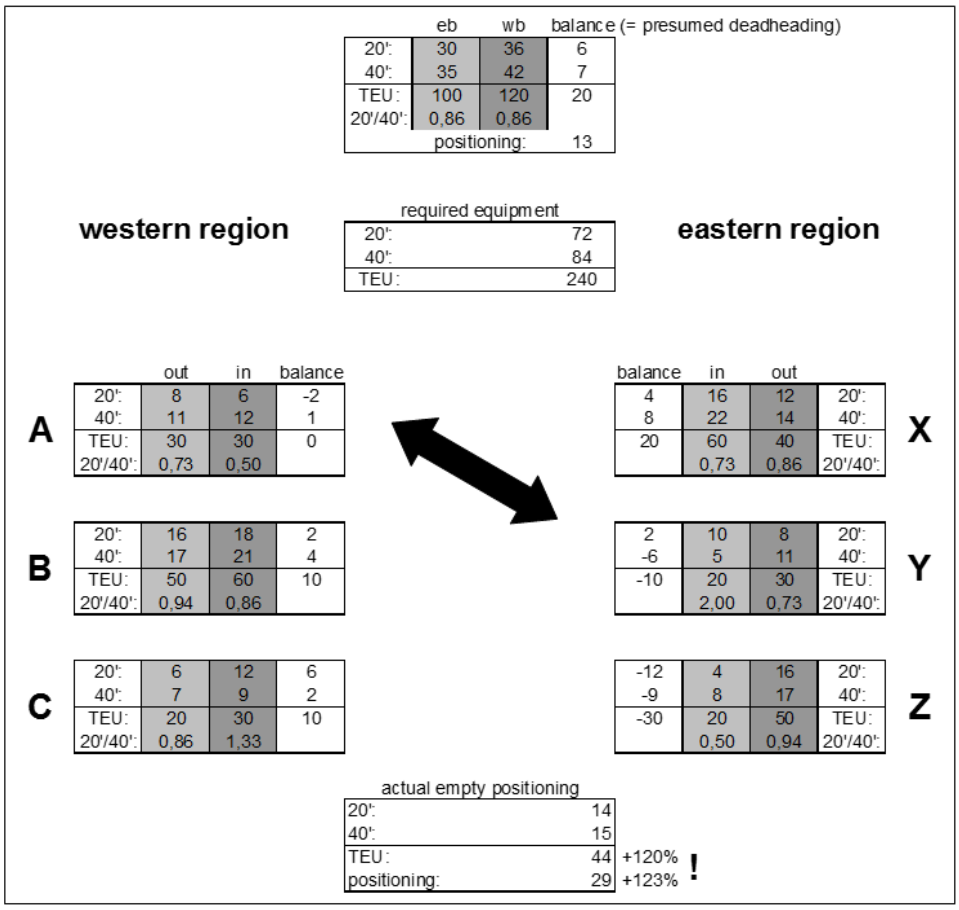


Figure 9. Empty positioning caused by general trade and local imbalance (example).

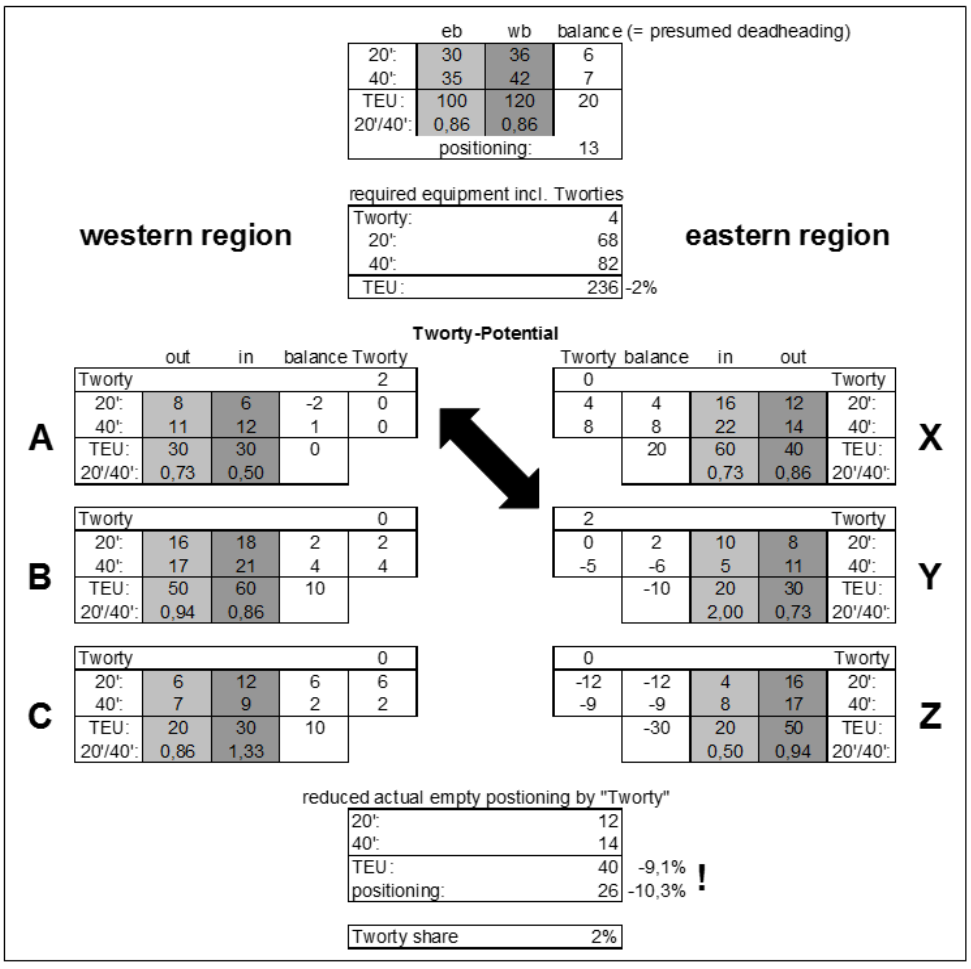


Figure 10. Empty positioning caused by general trade and local imbalance reduced by *Tworty Boxes* (example).

Table 3. Expected effect of *Tworty Box* operation on container fleet parameters

		just by general trade imbalance (theory)	reality (due to locally imbalanced sizes)	including 2 % *Tworty* share	**savings in reality**
necessary	boxes	13	29	26	**-10 %**
deadheadings	TEU	20	44	40	**-9 %**
required fleet	TEU	240	240 plus	236 plus	**-2 %**

4 CONCLUSIONS

The *Tworty Box* is most advantageous for container trades which suffer from a clear imbalance with regard to the container seizes, i.e. where the 20ft/40ft split of both trade directions differs significantly.

However the calculations have revealed that significant savings can even be realised in case of imbalances with regard to the pure trade volume, i.e. when coupled *Tworty Boxes* could replace 2 x 20ft standard boxes which otherwise would have to be empty positioned individually. By using *Tworty Boxes* the empty movements can be realised as one unit, i.e. the respective handling costs can be cut by 50% which exceeds the additional expenses for coupling/de-coupling by far.

Hence the *Tworty Box* can avoid empty positioning caused by having not the right container sizes available and even if empty positioning is unavoidable it can cut the costs for empty movements of 20ft containers almost by half.

Who is benefiting? It is the container lines which would directly take advantage from operating *Tworty Boxes*. Presently 53% of the world container fleet is operated by container lines, thereof 90% are of standard 20ft/40ft dry cargo type. However it is not necessary that a container line replaces its entire container fleet by *Tworty Boxes* to gain maximum savings. Only the portion equivalent to the lines' individual (average) imbalance needs to be replaced.

It is not expected that leasing companies which presently control approx. 44% of the world's container fleet would be immediately interested to operate *Tworty Boxes*. They are only reacting to the demand of the container lines and therefore are expected to be interested only at a later stage. However big forwarders with shipper's owned containers might be interested as well as it has been already proven by global forwarder DHL which have successfully tested two prototype boxes on occasion of a trial trip.

According to Boedeker, Global Head Ocean Freight, DHL Global Forwarding, (2013) the *Tworty Box* is a very attractive solution which ensures flexible container management and cost efficiency by eliminating empty positioning due to structural imbalances in the general cargo flow or seasonal fluctuations in the dominant commodities in specific sectors. It was quoted to be a smart alternative for customers that note strong ups and downs in supply and demand of different container sizes in certain areas, especially if several services of different trades are calling the same country or region.

Taking the fact that 21% of all containers shipped are empty for reasons of imbalance of whatever kind it is assumed that the potential market volume for the *Tworty Box* might be 20% of the existing global standard 20ft/40ft dry cargo container fleet which is presently operated by container lines, i.e. presently 27 Mill TEU x 0.53 x 0.2 = 2.9 Mill TEU. Hence with an average life time of 8.5 years 34.000 TEU of *Tworty Boxes* would be needed to be introduced annually.

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