# Causal Relationship between Indian Ports' Originated Container Traffic and Total Transshipments of Port of Colombo: a Granger Causality Analysis

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# Approval Page

This dissertation, which is an original work undertaken by J.R.M. Sooriya Bandara in partial fulfillment of the requirements for the degree of Master of Shipping Management, is in accordance with the regulations governing the preparation of dissertation at the Graduate School in the Korea Maritime and Ocean University, Republic of Korea.

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## Abstract

India is both the number one port of destination for transshipments moving out of Colombo, and the number one port of origin for transshipments coming in the port. The port of Colombo is complementary to India's growth aspirations. Today out of 4.7 million (TEUs) transshipment volumes of port of Colombo, close to 40% are Indian transshipments coming from East and West multiple ports of India and a major portion of the Indian transshipment container traffic handled by the port of Colombo is down to India. Using the Granger causality approach, this research investigates the causality relationship between Indian ports' originated transshipments and total transshipments of port of Colombo based on monthly time series data (transshipments throughput in TEUs) from 2008 to 2017.It finds a unidirectional causality from total transshipments of Colombo to Indian ports' originated transshipments in port of Colombo. It suggested that the ongoing port expansion projects, opening up for new markets and attracting new shipping lines in port of Colombo have been created a significant impact on Indian ports' container traffic through port of Colombo.

**Key words**: Unit root test, Granger causality, Total transshipments, Indian originated transshipments, Port of Colombo

# Chapter 1 Introduction

## 1.1 Research Background

In Southern Asia, Sri Lanka has bypassed his neighbors. Colombo accommodates large container ships that are deployed on services between Asia and Europe, as well as some services to Africa and South America. Feedering from Colombo to ports in India can be done with ships under any flags, as these services are not affected by the Indian cabotage restrictions (UNCTAD 2017).

Colombo noticeably became the most economical gateway to the Indian subcontinent in both cost and time wise. Today out of its 4.7 million (TEUs) transshipment volumes, close to 40% are Indian transshipments coming from East and West multiple ports of India and a major portion of the traffic handled by the port of Colombo is down to India. India is both the number one port of destination for transshipments moving out of Colombo, and the number one port of origin for transshipments coming in the port. The port of Colombo is complementary to India's growth aspirations. To attract the biggest vessels with increased frequency in to Colombo, it is needed carries to think and rethink shipping networks so that Colombo can expand its current volume in the catchment area. Clearly an increased frequency sailing from West coast Indian ports will provide this much need increase in volume exchange to attract the bigger ships (Inaugurated Colombo maritime conference concludes 2016).

Many alliances and many new services showed their interest to call Colombo emphasizing the immediate need of capacity and capability building. Colombo Port Expansion Project (CPEP) started commencement with the purpose of accommodating mega ships under the long term strategies of making Colombo the hub of South Asia.

### 1.2 Objectives of the study

The objective of this study is twofold: first, the research aims to identify the most effective factor to total transshipments throughput of port of Colombo through SWOT analysis in studying strength, weakness, opportunities and threats in the port of Colombo. The SWOT analysis is the archetypal approach to undertaking then summarizing a strategic evaluation. It embodies an internal analysis, in terms of strengths and weaknesses and an external analysis by reflecting on opportunities and threats. In relation to a sea port it is possible to apply this analysis as an overview of strengths, weaknesses, opportunities and threats to understand the port's perspective considering its inherent factors. The SWOT analysis is frequently applied when considering historical factors that have had a major impact in the past, current factors that are likely to impact on future performance, and actors that render the organization distinct from the competition. The best SWOT analysis is one that is supported by logic, argument and evidence (Gibson, 2012).

Through the SWOT analysis, it was clearly identified about the strength and opportunities of Colombo's strategic location in the Indian Ocean with enormous market potential to be the maritime hub of the Indian Ocean as well as the key transshipment port for the Indian sub continent region. Therefore, studying about the relationship between Indian ports' container traffic through port of Colombo is extremely important currently making sense of strategic planning and the policy implementation process in the port of Colombo.

In this context, the aim of this study is to investigate the causal relationship between Indian ports' originated container traffic and total transshipments of port of Colombo and also to identify the nature of the causality between the two variables, evaluating the Granger causality test results. The findings would be helpful for future forecasting of container traffic in Colombo port and the policy making process in the port as well.

### 1.3 Methodology of the study

Granger (1969) proposed a time-series data based approach in order to determine causality. In the Granger-sense *X* is a cause of *Y* if it is useful in forecasting *Y*. In this framework "useful" means that *X* is able to increase the accuracy of prediction of *Y* with respect to a forecast, considering only past values of *Y*.

Regression on non stationary time series directly may lead to a misleading conclusion, that is, it may show an apparently significant relationship between uncorrelated variables. The quality of the causality test is also sensitive to the stationary of the time series. Thus, it is needed first to determine whether the data series are stationary using the unit root test. For non stationary time series, then it is needed to test whether they are co-integrated. If the time series are neither stationary nor co-integrated, then it is determined the relationship between the two time series. If the two time series are stationary or co-integrated, then it is determined their Granger causality relationship using the Granger test (Granger 1969), and compute the long-run relationship coefficient by using the ADL model or co-integrating equation. The relationship between the two variables can be determined by the Granger causality relationship and long-run relationship coefficient.

### 1.4 Organization of the study

The study is structured as follows: chapter 1 provides a brief introduction, the research background and the methodology applied. Chapter 2 provides a brief introduction about port of Colombo, and Indian originated container traffic in the port of Colombo and a SWOT analysis of port of Colombo. Chapter 3 deals with the literature review, the challenges and the methodological approach. Chapter 4 discusses about the research methodology and empirical results for the unit root test and Granger causality test. Chapter 6 concludes by discussing about the research findings, the significance and the limitation of the study and policy recommendations.

# Chapter 2 Container Traffic through the Port of Colombo

## 2.1 Port of Colombo: an overview

Growing ship sizes open up the opportunity for Colombo port to develop as the maritime hub of south Asia. Colombo has just 4 hours deviation from the main route, where the nearest next port in the Indian subcontinent has a deviation of 12 hours. With this inherent advantage, Colombo has already become a preferred shipping destination.

**Table 2.1 Shipping time from Colombo Port to selected locations**

| PORT | SHIPPING TIME |
|---|---|
| Tuticorine, South India | 8 Hours |
| Chennai, India | 2 days |
| Singapore | 3 days |
| Mumbai, India | 4 days |
| UAE | 5 days |
| Sydney | 11 days |
| Busan, South Korea | 15 days |
| Amsterdam | 18 days |
| New York | 21 days |

Source: Board of Investments in Sri Lanka

Containerization started in south Asia with Queen Elizabeth Container Terminal at Port of Colombo on 1st of August in 1980. But the internal conflict started in middle of 1980s pushed Sri Lanka back from development. When the war is over in 2010, Colombo had 3 container terminals, Jaya Container Terminal (JCT), Unity Container Terminal (UCT) and South Asia Gateway Container Terminal (SAGT).

**Table 2.2 Current facilities of Port of Colombo**

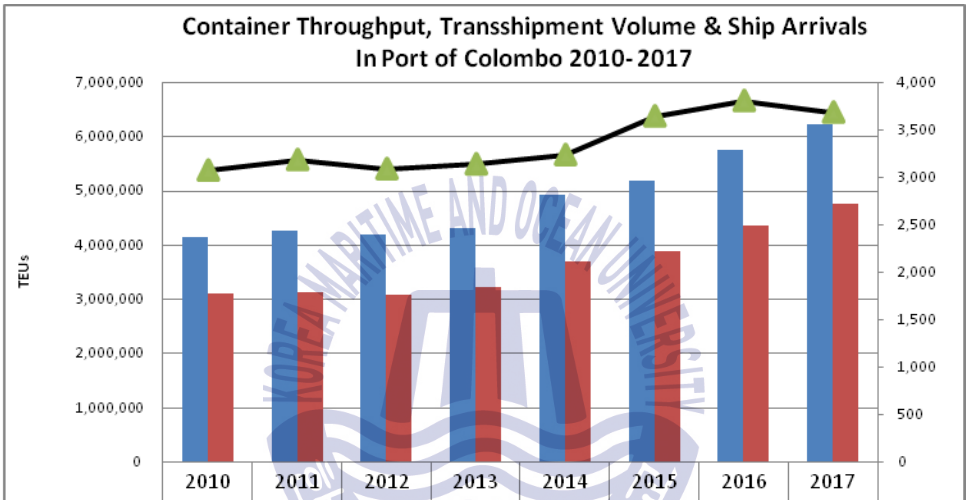
| Terminal | Depth(m) | Length(m) | Annual capacity (TEUs) |
|---|---|---|---|
| **In operation** | | | |
| Jaya Container Terminal (JCT) | 13 to 15 | 1640 | 2.70 million |
| Unity Container Terminal (UCT) | 9 to 11 | 590 | 0.30 million |
| South Asia Gateway terminal (SAGT) | 15 | 940 | 1.95 million |
| Colombo International container terminal (CICT) | 18 | 1200 | 2.40 million |
| Bandaranayake Quay (BQ) | 4.8 to 9.45 | 608 | - |
| Prince Vijaya Quay (PVQ) | 9.45 | 330 | - |
| Guide Pier (GP) | 9.15 | 330 | - |
| **Constructing** | | | |
| East Container Terminal (ECT) | 18 | 440 | 0.80 million |

The new breakwater at Colombo port is about 6 km from length and it has a depth of 18 meters compared to the previous 14-15 meters, a crucial difference in a world in which ever bigger cargo ships require ever deeper berths. The construction of breakwater was completed in 2012. The first container terminal of new Colombo South Port is completed in July 2013 and this made possible for Colombo port to accommodate the latest generation container ships which carry 18,000TEU and more. The completion of Colombo South Port Expansion Project will eventually increase the capacity of Colombo by 12.5 million TEUs per year. In April 2014 South Container Terminal which is named as Colombo International Container terminal (CICT) was fully completed and commenced its operations.


**Figure 2.1 Google map of Port of Colombo**

Colombo continued to record throughput growth following the opening of a third terminal, the only deep- water terminal in Southern Asia capable of handling ships with a capacity of 18,000 TEUs and above (UNCTAD 2017).

Port of Colombo has been ranked among the world’s best 25 ports accordance with the Lloyd’s rankings in 2017. According to the categorization, in 2016 Port of Colombo has been ranked for the 23rd place moving three places up in this list relative to the ranking in the 2015. In 2016, the annual growth was 10.5% from 5.2 million TEUs to 5.7 million TEUs recording as its rank as 25th (Lloyd’s list 20017).




| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|---|
| CT | 4,137,4 | 4,262,8 | 4,187,1 | 4,306,2 | 4,907,9 | 5,185,4 | 5,734,9 | 6,209,0 |
| TS | 3,095,5 | 3,123,8 | 3,064,7 | 3,208,1 | 3,699,7 | 3,888,3 | 4,355,2 | 4,741,5 |
| SA | 3,076 | 3187 | 3,092 | 3,142 | 3,239 | 3,643 | 3,804 | 3,683 |

**Figure 2.1 Container throughput transshipment container throughput and container ship arrivals in Port of Colombo during 2010 - 2017**

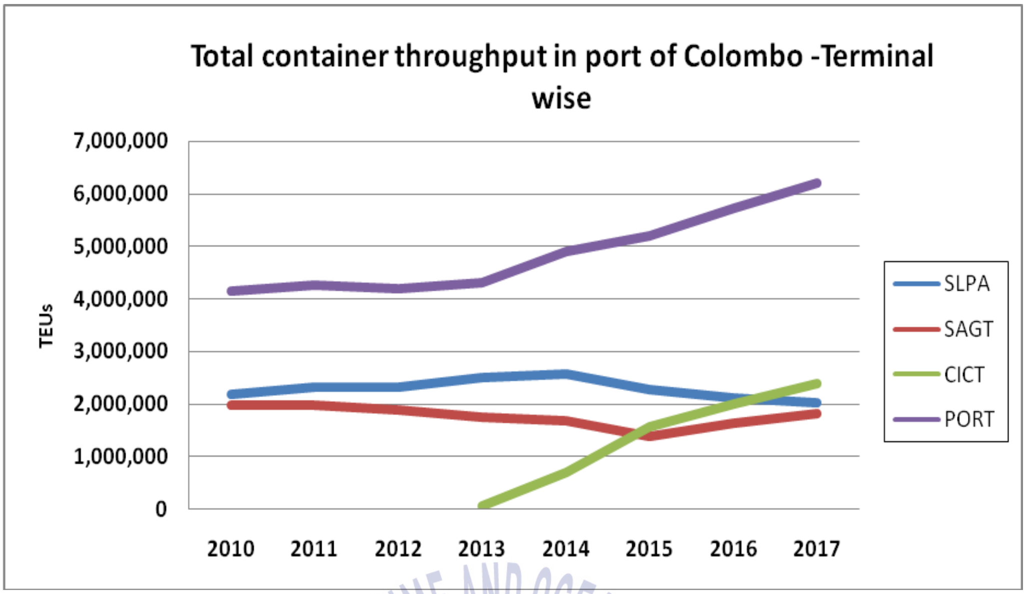



**Figure 2.3 Container terminal wise total container throughputs in Port of Colombo during 2010 – 2017**

**Table 2.3 Container terminal wise total container throughput in Port of Colombo during 2010 - 2017**

| TERMINAL | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|---|
| SLPA | 2,167,173 | 2,299,446 | 2,316,849 | 2,501,863 | 2,559,339 | 2,252,323 | 2,100,117 | 2,010,702 |
| SAGT | 1,970,268 | 1,963,441 | 1,870,271 | 1,746,802 | 1,661,940 | 1,371,245 | 1,632,207 | 1,809,835 |
| CICT | - | - | - | 57,541 | 686,636 | 1,561,899 | 2,002,599 | 2,388,531 |
| PORT | 4,137,441 | 4,262,887 | 4,187,120 | 4,306,206 | 4,907,915 | 5,185,467 | 5,734,923 | 6,209,068 |

Source: Statistics section of SLPA

In December 2017, port of Colombo reached 6.2 million containers for the first time in the port's history. The port recorded a 16.4% year- over-year increase in its total container throughput as it handled 564,155 TEUs in January 2018, compared to 484,866 TEU seen in the corresponding month a year earlier. In addition, container volumes at the Sri Lanka Ports Authority controlled terminals rose by 24.8% to 194,688 TEUs in January 2018.

Transshipment operations at the port of Colombo also showed a 20.4% YOY increase. Together with the Jaya Container Terminal (JCT), South Asia Gateway Terminal (SAGT) and the Colombo International Container Terminal (CICT), the port of Colombo recorded 436,303 transshipment TEUs in January this year, against 362,451 TEUs reported in the same month of 2017.

The number of container ships, conventional cargo vessels, other cargo vessels and ships for repairs and bunkering also increased to 388 vessels in January 2018 from 339 in the same period of 2017. The port's January in 2018, figures show that a total of 332 contained vessels called at the port of Colombo, against 304 ships a year earlier. SLPA has prepared a three-year development plan in an effort to further increase container volumes aiming to make Colombo the maritime center in Asia (World Maritime News, February 23, 2018).

Colombo port is mainly a transshipment hub with 76% of throughput coming from transshipment as past records of container traffic of the port. In 2014 container transshipments were grown up by 15% and the growth in 2015, 2016 and 2017 respectively about 5%, 12% and 9% (see the Figure 2.4).

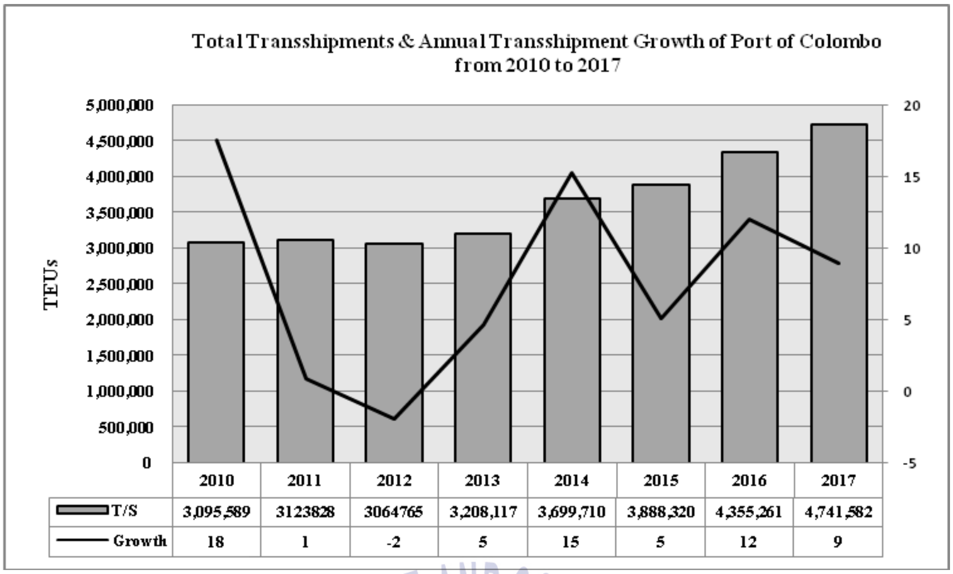



**Figure 2.4 Total transshipments and annual transshipment growth in port of Colombo**

Source: Statistics section of SLPA

Sri Lanka ports authority is currently looking to grow its' container handling volumes by developing East Container Terminal under the South port expansion project. According to the Asian Development Bank, which supported the port upgrade project with a $ 300 million loan, made a bold projection that Colombo port will handle 10 million TEUs by 2020.

Ultra large container carriers and very large container carriers, many of a size that only the Colombo South Terminal (CICT) is capable of handling, had contributed 70% to the volumes it achieved in 2016.CICT is the first and currently the only deepwater terminal in South Asia equipped with facilities to handle the largest vessel afloat.

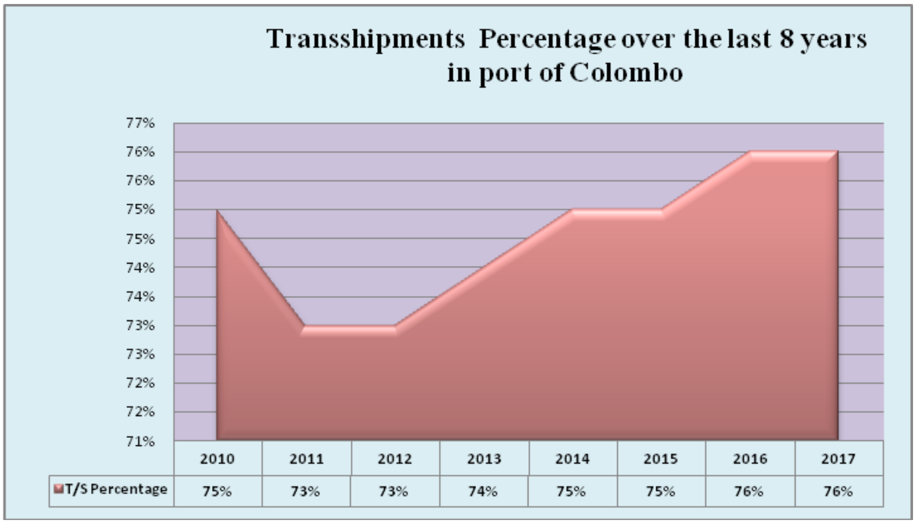



**Figure 2.5 Transshipments percentage over the last eight years in port of Colombo**

Source: Statistics section of SLPA

## 2.2 South Indian ports' originated container traffic in port of Colombo: an overview

The transshipment container volumes over the port of Colombo are almost totally depend on volumes coming in/out of South Indian sub continent, mostly India, Bangladesh, Pakistan and Male Islands (see Figure 2.6 ).

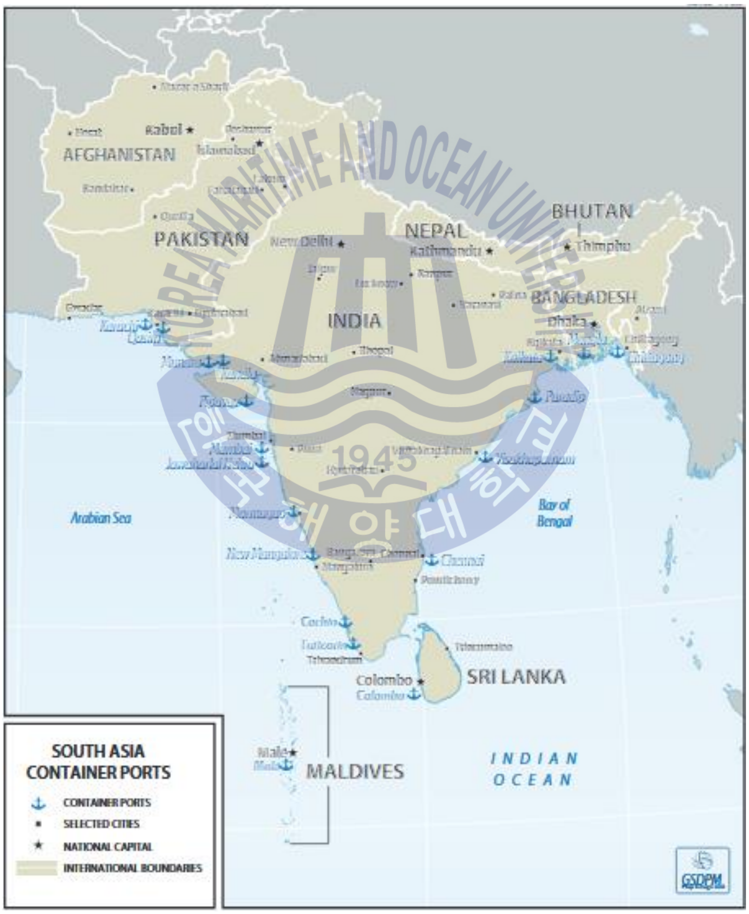
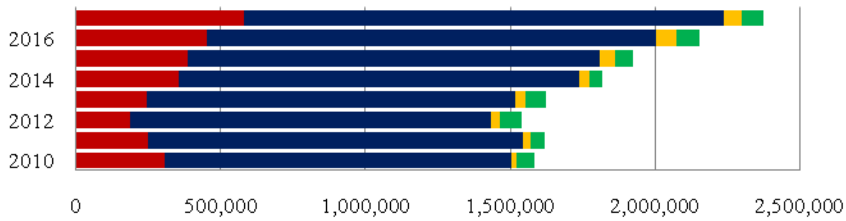



**Figure 2.6 Container ports in South Asia**

Source: Competitiveness of South Asia's container ports, World Bank group, 2016




| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|---|
| Bangladesh | 306,240 | 247,497 | 185,411 | 244,155 | 352,448 | 384,481 | 449,972 | 577,990 |
| India | 1,193,627 | 1,295,747 | 1,245,314 | 1,269,255 | 1,381,989 | 1,423,535 | 1,551,224 | 1,657,831 |
| Maldive Island | 21,320 | 22,948 | 30,071 | 36,830 | 36,005 | 50,858 | 69,505 | 62,168 |
| Pakistan | 58,103 | 49,885 | 77,184 | 71,435 | 45,582 | 62,664 | 79,820 | 72,885 |

**Figure 2.7 Country wise transshipment container traffic via port of Colombo**

Source: Statistics section of SLPA

**Table 2.4 Indian Sub Continent (ISC) ports' transshipments volumes via port of Colombo in year 2017**

| Country | Port | Tranship volumes through Colombo in 2017 ( TEUs) | The share from the total throughput of Colombo (%) | Share in Colombo transshipment (%) |
|---|---|---|---|---|
| India – East Coast of India | Calcutta | 187035 | 3.0 | 3.9 |
| | Chennai | 267519 | 4.3 | 5.6 |
| | Haldia | 66420 | 1.1 | 1.4 |
| | Kakinada | 10464 | 0.2 | 0.2 |
| | Krishnapathnam | 105938 | 1.7 | 2.2 |
| | Tuticorin | 531487 | 8.6 | 11.2 |
| | Visakapatnam | 126984 | 2.0 | 2.7 |
| | Bombay | 04 | - | - |
| | Cochin | 169186 | 2.7 | 3.6 |
| | Goa(Marmagoa) | 26760 | 0.4 | 0.6 |

| | | | | |
|---|---|---|---|---|
| **India – West Coast of India** | **Hazira**<br>**Kandla**<br>**Mangalore**<br>**Mundra**<br>**Nava Sheva (JN port)**<br>**Pipavav** | 7322<br>102<br>58382<br>117605<br>196317<br>39936 | 0.1<br>-<br>0.9<br>1.9<br>3.2<br>0.6 | 0.1<br>-<br>1.2<br>2.5<br>4.1<br>0.8 |
| **Bangladesh** | **Chittagong** | 587335 | 9.5 | 12.4 |
| **Pakistan** | **Karachi** | 72885 | 1.2 | 1.5 |
| **Male** | **Male** | 62168 | 1.0 | 1.3 |
| **Others** | **Others** | 2107733 | 33.9 | 44.4 |
| **Total** | | 4741582 | | 100 |

Source: Statistics section of SLPA

In the global shipping market too, the transshipment of cargo has a major role to play and it will continue to be so in the foreseeable future. Due to the increase in ship size & capacity, the cost of calling many ports in the same region is not a cost effective exercise to a shipping line.

Most of the Indian ports as they stand now are unable to accommodate the Ultra- large container carriers that are now being introduced to the main haul service this is mainly due to the restricted depth and other infrastructure and labor related issue which are perennial in nature. The geographical locations of some Indian ports may not ideally fit into the shipping line's requirement of minimum deviation and Colombo will continue to fit into the shipping lines equation.

India's extant major ports do not have such deep drafts, so quarter of all containers are transshipped through hub ports of other countries like Colombo, Singapore and Port Klang. Colombo (Sri Lanka), Singapore and Klang (Malaysia) handle more than 80% of India's transshipment cargo; of them, Colombo alone handles about 43% (Nidhi Jamwal, 2017).

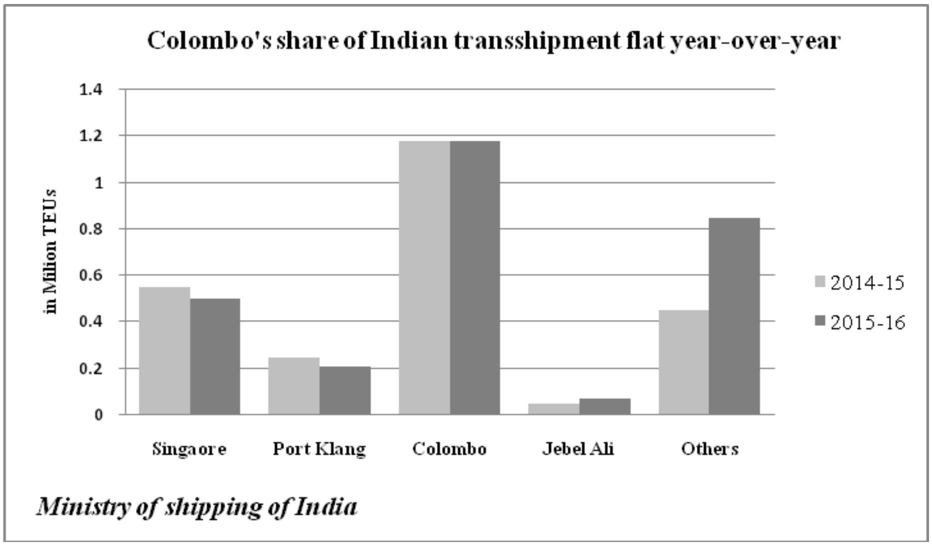



**Figure 2.8 Colombo's share of Indian ports' transshipments**

Source: Ministry of shipping of India

Statistics show in 2015- 2016 volume of transshipped containers moving through Colombo for India's major, or public, ports stayed flat with the prior year at 1.9million TEUs. Colombo had the largest share of the Indian transshipment throughput in last year accounting for 42%, while Singapore with the second largest gateway for Indian transshipments with 17% share followed by Port Kelang Malaysia at 8% (see Figure 2.8) (Indian demand for Colombo transshipment, 2016).

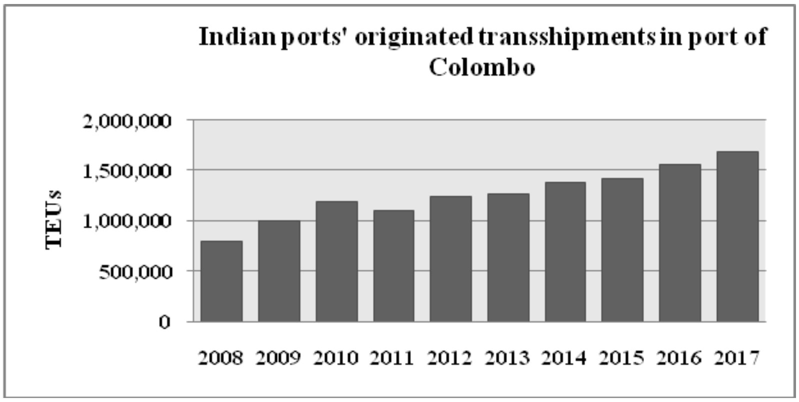



**Figure 2.9 Indian ports' originated transshipments in port of Colombo**

Source: Statistics section of SLPA

*East Coast Indian Ports*

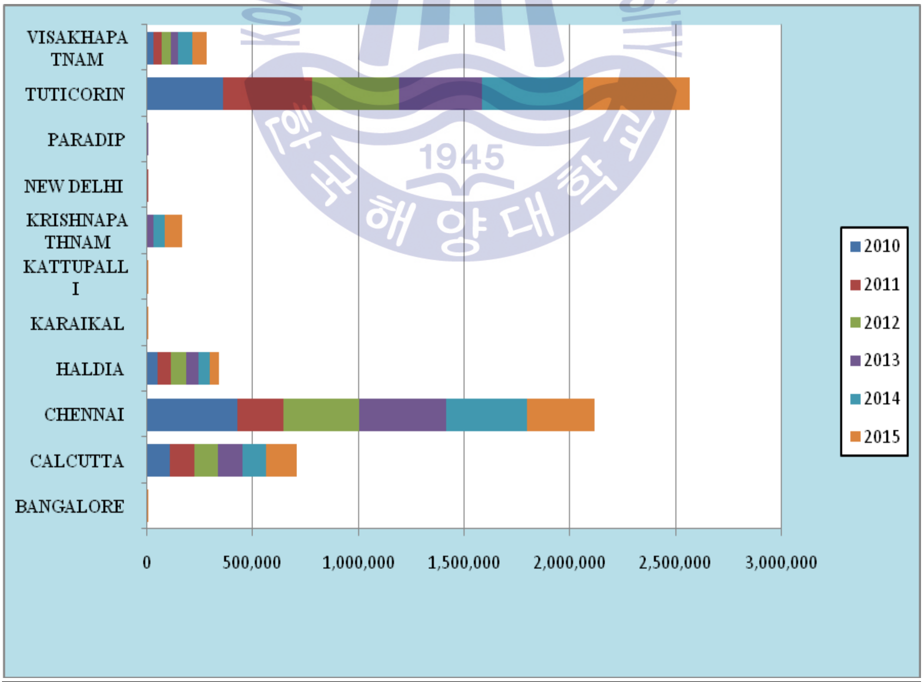



**Figure 2.10 East Coast Indian ports' container traffic via Colombo 2010-2015**

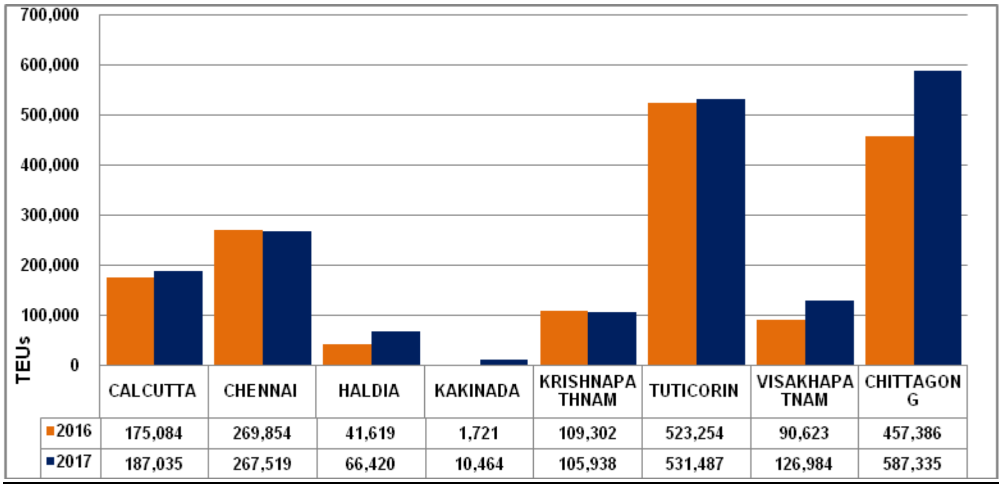



**Figure 2.11 East Coast of India (ECI) & Bangladesh total container traffic via port of Colombo, 2016-2017**

*West Coast Indian Ports*

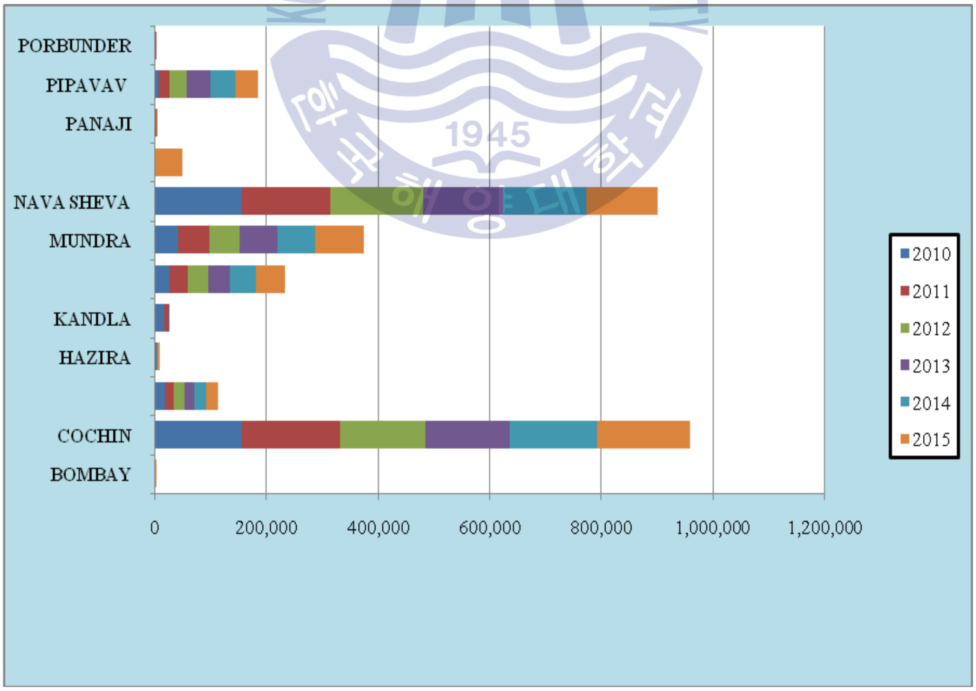
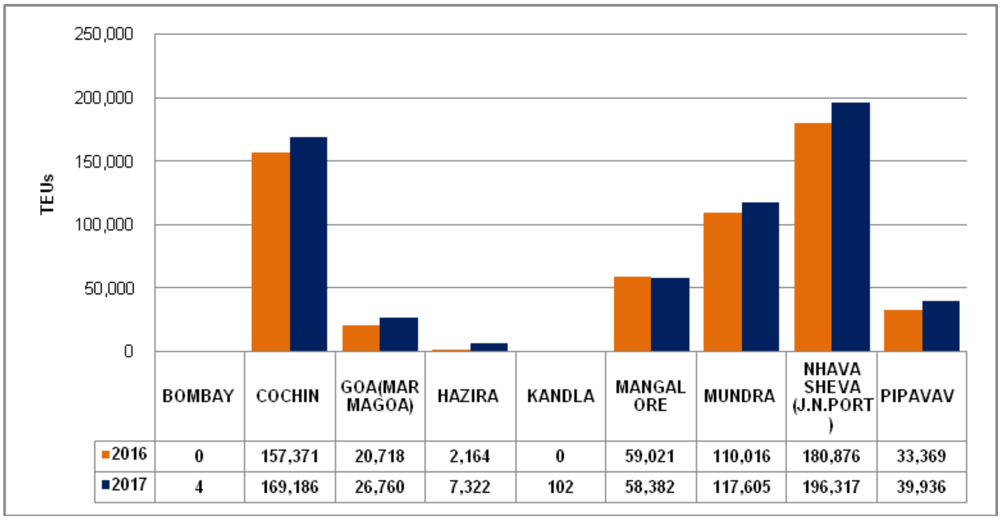



**Figure 2.12 West Coast Indian ports' container traffic through Colombo**




| | BOMBAY | COCHIN | GOA(MAR MAGOA) | HAZIRA | KANDLA | MANGAL ORE | MUNDRA | NHAVA SHEVA (J.N.PORT ) | PIPAVAV |
|---|---|---|---|---|---|---|---|---|---|
| 2016 | 0 | 157,371 | 20,718 | 2,164 | 0 | 59,021 | 110,016 | 180,876 | 33,369 |
| 2017 | 4 | 169,186 | 26,760 | 7,322 | 102 | 58,382 | 117,605 | 196,317 | 39,936 |

**Figure 2.13 West Coast of India ports' total container traffic through port of Colombo, 2016-2017**

## 2.3 SWOT analysis of port of Colombo

The idea came to the writer's mind of investigating the causal relationship between Indian ports' originated container traffic and total transshipment of port of Colombo, when studying the SWOT analysis of port of Colombo done by Japan International Cooperation Agency Padeco Co., Ltd in 2012 (Table 2.5). Even though, this SWOT analysis had been done in 2012, the internal and external factors which studied for this analyzes are both timely and very relevant to the port and these inherent factors to the port of Colombo give clues to even this current study about the port. Based on the JICA SWOT analysis, the current internal and external developments in the port of Colombo have been added in this discussion to make a truthful and updated analysis.

Through this analysis, it was identified the most important factor in port of Colombo to maintain its position as the maritime hub in the region, is not other than the strategic geographical location in the Indian Ocean and it can be highlighted in two aspects either strength or opportunity to the port.

Therefore, the studying about the causal relationship between Indian ports' originated container traffic via Colombo and the total transshipments of port of Colombo is highly useful for process of port policy planning and implementations. In this particular situation of 76% from the total container throughput are transshipments in the port of Colombo and the future hinterland will be the Indian sub continent (ISC) ports and Bay of Bengal. In this aspect, this research is both timely and essentially important to the port of Colombo.

**Table 2.5 SWOT analysis of port of Colombo**

| | |
|---|---|
| **Strengths** | <u>External Factors,</u><br>• The port is located very closed to the main shipping line between Singapore & Suez, one of the fastest growing container markets in the world<br>• Sri Lanka offers lines to serve the whole of Indian subcontinent (ISC) market in both Easterly & Westerly directions<br>• Further economic development in Asia is likely to strengthen ties between ICS & the Far East against the traditional markets. Sri Lanka is better placed to benefit from this change in the long term<br>• Faster growth of container volume is likely from a lower base on the ISC East Coast & Bay of Bengal, Sri Lanka's key future hinterland<br>• Deep draught terminals<br><u>Internal Factors,</u><br>• Management is implementing appropriate policies<br>• Colombo is less expensive than Indian ports, & more efficient than many Colombo does not have a particularly hostile labor environment |
| **Weakness** | <u>External Factors,</u> |

| | |
|---|---|
| | • Sri Lanka lacks an adequate domestic cargo base. Shipping lines' clear preference is to serve markets direct if justified by volume<br>• Shipping lines prefer to serve markets where market conditions result in high fright rates. Higher rates would possibly further encourage direct calls<br>• India may build a rival transshipment port, modify its present hostility to foreign flag cabotage & introduce a tariff policy which simulates direct calls<br>• Transshipment is an interim, not a final solution. Sri Lanka has neither the range of services nor the frequency that Singapore has<br>• No shipping lines are operating container terminals at Colombo port. Shipping lines cannot be relied upon to be loyal to a hub unless they run it<br><u>Internal Factors,</u><br>• Colombo productivity is still not competitive with the major hubs<br>• The institutional situation is complex. SLPA does not always behave as neutral port authority<br>• The port is not competitively priced against its Eastern competitors |
| **Opportunities** | • Sri Lanka offers a law-cost & efficient transshipment alternative to ports on the Bay of Bengal. With service improvements, the cargo using Singapore could be won back<br>• Sri Lanka can compete with Middle East ports for Westerly transits from ports south of Mumbai on price, efficiency & speed of turnaround<br>• For easterly cargoes, Sri Lanka is well placed to win west coast ISC transshipment for those lines without direct services |
| **Threats** | • ISC might not grow to the extent forecasted<br>• Indian government may implement policies against foreign transshipment in future<br>• Building appropriate infrastructure for a major hub port does not guarantee that it will be used, because the port is largely at the mercy of external events |

Based on Data Collection Survey by JAICA

Strength

It is commonly understand that the main strength of Sri Lankan ports is the geographical location of Sri Lanka in the international maritime transport networks: Sri Lanka is located only 55 Nautical Miles away from the main shipping lane between Singapore and the Suez Canal. This sea lane connects Asia and Europe passing through the past growing economies of Asia and the India Sub Continent (ISC). This sea lane is one of the busiest trade routes in the world and is experiencing significant growth. The cargo volume transported along this sea lane is rapidly increasing and demand for Sri Lankan ports is also growing.

Sri Lanka is also located at the Southern tip of ISC, where a remarkable economical growth is generating considerable volume of maritime cargo. The Sri Lankan ports can geographically serve the whole of the growing ISC market in both easterly and westerly directions. To consolidate its strong geographic position in maritime container transport, SLPA has been developing the South Harbor of Colombo port under the Colombo Port Expansion Project.


**Figure 2.14 the strategic geographical location near to main East West shipping lane**

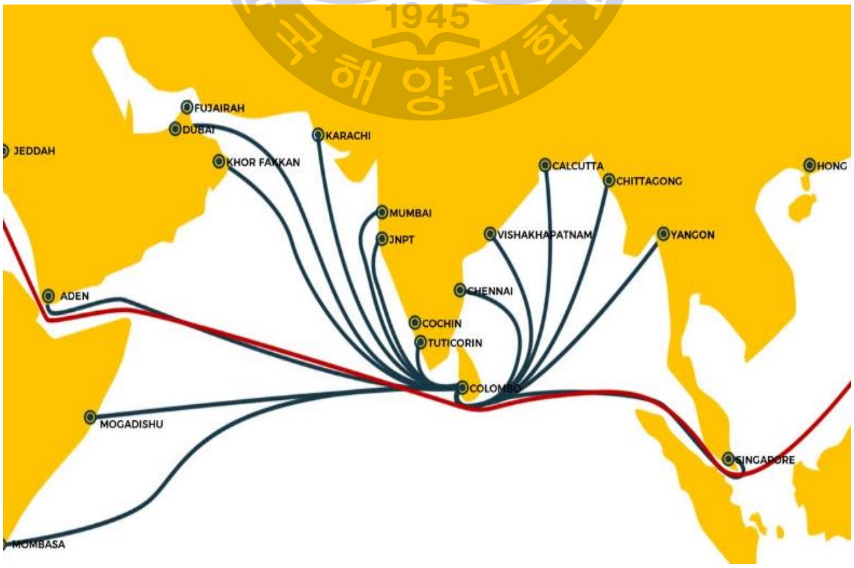



**Figure 2.15 the strategic location in the Southern tip of Indian Sub Continent**

In 2011, China Merchant Holdings won the rights to develop the South Container Terminal with 35-year BOT and started operations as Colombo International Container Terminal (CICT) in 2013.Colombo International Container Terminals Ltd (CICT) is a Joint venture between China Merchant Holdings (International) Co. Ltd (85% ownership) and the Sri Lanka Ports Authority (15% ownership) under a 35 year build, operate and transfer (BOT) agreement.

CICT (Colombo International Container Terminal) has reported a throughput of two million TEUs for the 12 months ending 31 December 2016 with annual growth of 28% in volume. Colombo South terminal is capable of handling ULCCS (Ultra Large Container Carriers) and VLCCS (Very Large Container Carrier). Colombo south terminal is the first and currently the only deep water terminal in South Asia equipped with facilities to handle the largest vessels afloat. CICT started in 2013 under public private partnership on BOT basis and in 2015, its full year of operation; CICT handled 1.561 million TEUs, with the ULCC and VLCC segments making a 67% contribution to the volume.

The concluded year also saw CICT winning the prestigious 'Highly Commended' award in the 'Port Operator' category at Lloyd's List Middle East and Indian Subcontinent Awards, and being cited as one of the factors in its parent company – China Merchants Port Holdings (CMPH) – being adjudged Port Operator of the Year at the Lloyd's List 2016 Global Awards

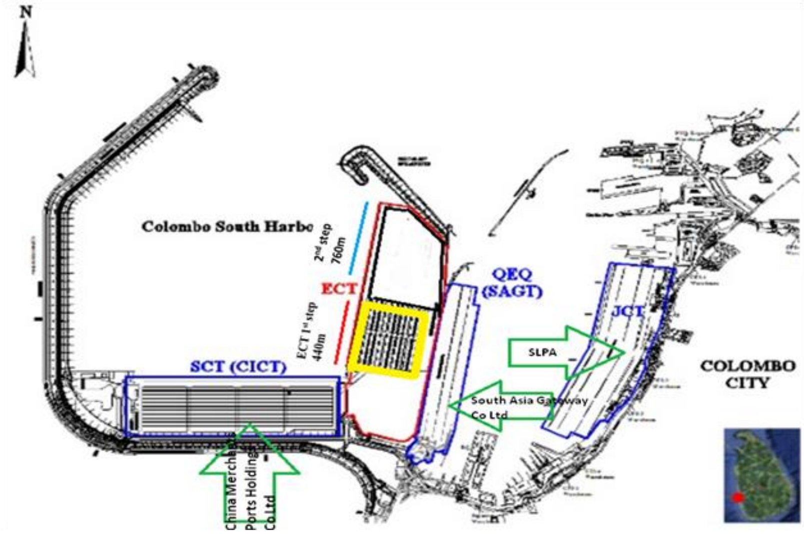



**Figure 2.16 Colombo Port Expansion Project**

**Figure 2.17 Colombo International Container Terminal (CICT)**

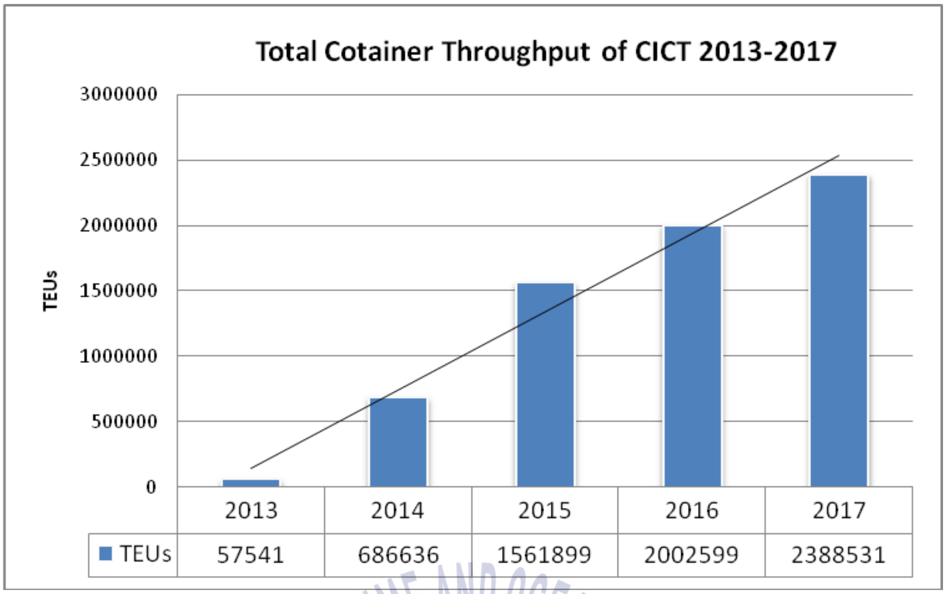



**Figure 2.18 Total container throughput handled by CICT**

**Table 2.6 Some of Mega vessels handled in CICT**

| **Vessel Name** | **Capacity** | **LOA** | **Draft** |
|---|---|---|---|
| MSC MAYA | 19224 TEUs | 396 m | 16 m |
| MSC NEWYORK | 16652 TEUs | 399 m | 11.6 m |
| CMA CGM MARCO POLO | 16020 TEUs | 396 m | 16 m |
| EDITH MAERSK | 13500 TEUs | 399 m | 12.6 m |
| EBBA MAERSK | 15500 TEUs | 397 m | 16 m |
| ELLY MAERSK | 15500 TEUs | 397 m | 16 m |
| EUGEN MAERSK | 15500 TEUs | 397 m | 16 m |

Under the circumstances, the developments of East Container Terminal of Phase 1 and 2 under the Colombo port expansion project will be a great advantage to attract a large share of the container transshipment traffic originated from India as the fastest growing, largest economy of the South Asia. Under the Colombo expansion project, East Container Terminal (ECT) is the second deep water terminal and it is going to build in two stages and according to the master plan of Expansion project, the total length of East Container terminal is 1200m and the construction of a 440m stretch of the terminal already been completed (depth- 18m and capacity 2.4 million TEUs) under the 1st step and The second step of ECT, 760m in length and 18m in depth.

A. The total length of East Container terminal is 1200m and the construction of a 400m stretch of the terminal already been completed ( depth- 18m and capacity 2.4 million TEUs) under the 1st step. The government again would decide whether it handles by SLPA or PPP model and waiting until get the decision by ministers of cabinet.
B. The second step of ECT, 760m/18m will be operated as PPP model and constructions should be completed in 2018 under the WRMMP but it will be delayed under current situation.
C. East terminal bidding process involves the Asian Development Bank as the transactional advisor.


**Figure 2.19 Geographical location of port of Hambantota**

**Figure 2.20 Completion of the first phase of the Hambantota port**

On the other hand, SLPA has completed the phase 1 construction of Hambantota port on the southern coast of the island, which is the commercial port closest (only 15 Nautical miles away) to the main shipping lane between Singapore and Suez Canal (Figure 2.19).

China Merchant Holdings and China Harbor Engineering developed Hambantota port at a cost of about $600 million and for the Hambantota project Sri Lanka government borrowed $310 million from China with interest charged at 6.3%- well above the rate for soft loans from the WB and ADB, which ranged 0.25%-3%. Hambantota port and nearby airport (Mattala) opened in 2010.

In 2015 the new government aimed to cut the national debt of USD 64.9 billion of which about 12% is owed to China and Hambantota Port was handed over to a Chinese state- owned company (China Merchants Ports holding) with a 99 year lease deal worth US$ 1.1 billion.

Hambantota port is located near the main shipping route from Asia to Europe and likely to play a key role in China's "Belt and Road initiative in future and there will be a plan for 99-year lease of 15000 acres (23 sq miles) to develop industrial zone and develop the tourism industry and related industries in the area. The port will be expanded according to the development plan but cargo that can be attracted to the port still to be clearly identified. As a wide hinterland is available for industrial use, the port can be flexibly developed to best utilize its geographic strength, and wide and available land for industries and logistics.

Containerization started in Queen Jetty in port of Colombo in 1970s in the South India region and American President Line (APL) involved for the first container handling at that time and so far, the world ranked main shipping lines were the best customers in the port and this is also a huge advantage. In the year 2018, Port of Colombo has been ranked as the 13th best connectivity port in the world and the best connectivity port in the South Asia according to the Drewry Port Connectivity Index ranking (https://www.drewry.co.uk/...container-index.../world-container-index-). In ranking this connectivity index, the no of main line services calling at each port per week and the regions in the world to which each directly linked with the port are used as the variables.

So far, port of Colombo maintained very successful port policies and it was helped to keep the port as the maritime hub in the South India region. Sri Lanka Ports Authority was awarded as the ports authority of the year 2018 and South Asia Gateway Terminal received the award as the best terminal in the South Asia region by the Singapore based Global Ports Forum (GPF) in the same year. The GPF awards evaluate the organizations and professionals' contribution in different areas of the ports and terminals industry (globalportsforum.com).

**Table 2.7 ISC ports and the deviation hours from the main shipping route**

| Port | Deviation hours |
|---|---|
| Colombo – Sri Lanka | 8 |
| Tuticorin – India | 20 |
| Mumbai - India | 31 |
| Chennai - India | 35 |
| Khor Fakkan - UAE | 65 |
| Karachi - Pakistan | 90 |
| Chittagong – Bangladesh | 100 |

Weakness

It is also commonly understood that the main weakness of Sri Lankan ports is lack of Sri Lankan domestic cargo. As shipping lines prefer when the export and import cargo exceeds a certain amount, they are likely to gradually put direct call service to such ports that have sizable domestic activity. This has already taken place at several Indian ports like JNPT. Transshipment to JNPT at Colombo port has virtually ceased since shipping lines put their mother vessels into direct call service to JNPT. It would be difficult for Sri Lankan ports to compete with JNPT for cargo that is directly transported by container mother vessels to JNPT (Data collection survey).

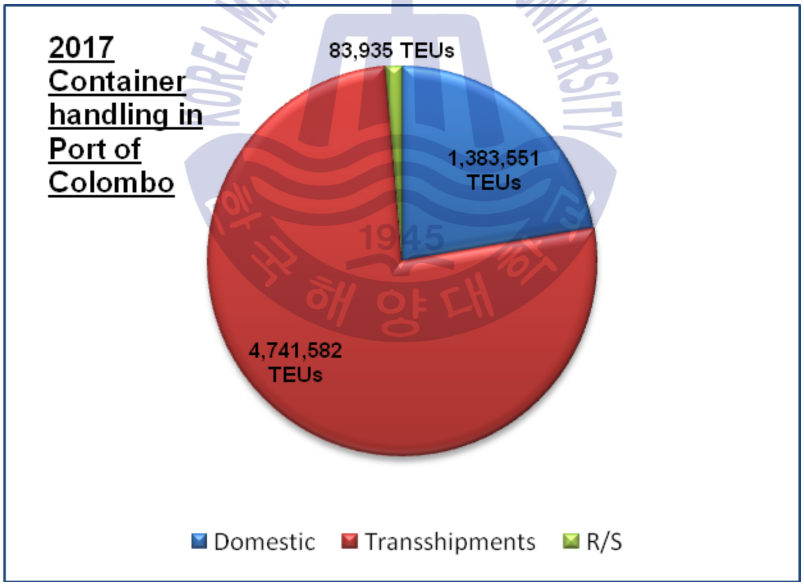



**Figure 2.21 Category wise container throughputs in port of Colombo in 2017**

One of the major weaknesses in Sri Lankan ports is that the lack of sufficient feeder services to attract mother vessels. Normally, shipping lines prefer faster connection of their cargo to feeder vessels at a hub port. The more feeders that call at a port the more mother vessels will call at that port. This is very true of Singapore port; even though the shipping route from Chittagong port to Singapore port is longer than to Colombo port, shipping lines use Singapore as their transshipment port not only for their easterly destined cargo but also westerly destined cargo (Data collection survey).

Opportunities

There are several opportunities for Sri Lankan ports to sustain their current strong position in the international maritime transport network and keep pace with competitor ports with ISC and Bengal Bay that are ambitiously planning to develop their infrastructure to meet demand generated by the growing economy of their hinterlands.

One of the opportunities which can be pursued is feeder service to small scale ports on both the east and west coast of ISC. When mega container vessels call Colombo port, more specially the South Harbor, feeder service will be put in between Colombo port and the small ports in both coasts of ISC. The mega container vessels and Colombo's geographic position will enable containers to be transshipped more economically through Colombo port than Indian ports. Competition for this service from JNPT and Cochin port on the India's west coast and Chennai port and Vishakhapatnam port on the east coast will also be hampered by India's sabotage restrictions on her coastal shipping which it appears will remain in place for the time being.

In addition, when lower transport cost is achieved by the mega container vessels calling South harbor in Colombo port and service raise to level similar to Singapore port, westerly bound cargo from/to Bangladesh can be captured. Similarly westerly bound cargo from/to Yangon port can also be regained from Singapore port (Data collection survey).

**Table 2.8 Terminal handling charges at selected ports**

| Port | Charge ( US$ / TEU) |
|---|---|
| Chennai | 65 |
| Chittagong | 85 |
| JNPT | 95 |
| Karachi | 115 |
| Mundra | 116 |
| Colombo | 151 |
| Singapore | 161 |
| Shalala | 194 |
| Dubai | 215 |
| Rotterdam | 268 |
| Los Angeles | 390 |
| Male | 415 |

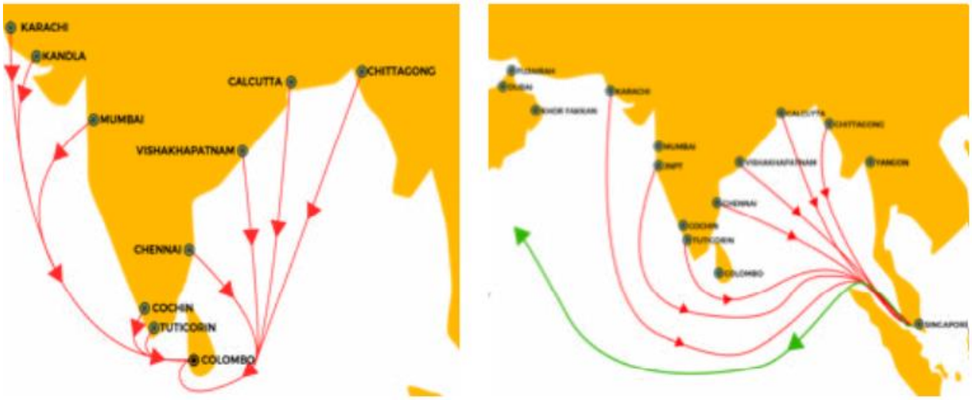



**Figure 2.22 Feeder network from ISC to port of Colombo and port of Singapore**

# Chapter 3 Literature Review

## 3.1 Granger causality studies in public finance sector

The contribution of Granger (1969) regarding statistical causality was one of the main starting points for the empirical analysis to find the direction of causality between two variables. In the field of public finance, the majority of the Granger causality tests have been conducted in two directions. The first one is on the relationship between economic growth and government expenditures. The other one is the relationship between government expenditures and national income (Wan Kyu Park 1998).

Mihai Mutascu (2016) surveyed "Government revenues and expenditures in the East European Economies: A Bootstrp panel Granger Causality Approach" and found that a unidirectional causality from public expenditures to revenues in Bulgaria. For the Czech Republic, Hungary, and Slovenia, government revenues explain expenditures, and a two-way causality exists for the Slovak Republic and no Granger causality is found for Estonia, Lithuania, Poland, and Romania.

Wan Kyu Park (1998) also investigated the Granger causal relationship between government revenues and expenditures in Korea over the period of 1964 to 1992 using time series data and found that there was a unidirectional causal relationship from government revenues to expenditures.

## 3.2 Granger causality studies in transportation sector

A number of causality studies can be found in investigating about the transportation sector as well as in shipping and port related matters during the past years. Elton Fernandes & Ricardo Rodrigues Pacheco (2010) surveyed "The casual relationship between GDP and Domestic air passenger traffic in Brazil" and explored that there is a unidirectional Granger causal relationship from economic growth to domestic air transport demand in Brazil. The methodology followed time series causality analysis procedures and total domestic passenger-kilometers are used as a proxy for air transport demand and gross domestic product (GDP) as a proxy for economic growth.

The study points out the finding the causality relationship between GDP and domestic route passenger-kilometers in Brazil were important implications for planning national air transport infrastructure and should be studied in greater depth. Causality studies show that there may be unidirectional or bidirectional causality between historical time series or there may be no evidence of a causal relation between two or more series.

Air transport is a business requiring a large capital investment and also very high operating cost. In recent years, Brazilian market has shown signs of imbalance between service potential, supply and quality. So this analysis of air transport demand was important for formulating a national air transport policy and for defining capital investment for parties interested in scaling infrastructure and related business appropriately. This research can be considered as a case study for understanding air transport sector behavior.

The Granger causality test conducted in this paper revealed that there is a unidirectional Granger causality from GDP to domestic route passenger kilometers (RPK) in Brazil. This study results indicate that air transport policy in Brazil, as an element of considerable importance to the country's socio-economic development, should take account of the sectors' significant income elasticity and its sensitivity to market structure.

### 3.3 Granger causality studies in shipping sector

In shipping sector, Granger causality analysis was used by Amir H. Alizadeh & Nikos K.Nomikos (2003) in their survey of “The price-volume relationship in the sale and purchase market for dry bulk vessels” and causality tests between the two variables indicated that price changes Granger cause trading volume in the market for handysize and Panamax vessels as well as in the aggregate dry bulk price index. Through this research, the impact of trading volume on price variability has been studied.

Investigating the price-volume relationship in the market for second-hand ships is also extremely interesting due to the unique features that this market possesses. This paper investigates, for the first time, the relationship between prices and trading activity in a market where real assets are traded. Investigation of this issue is of interest since the level of trading activity may contain information about the sentiment and the future direction of the prices in the market.

Several important conclusions emerge from this analysis. It is found that price changes are useful in predicting trading volume, which suggests that higher capital gains encourage more transactions in the market. Additionally, it seems that volume has a negative impact on the volatility of price changes. More specially, in contrast to what is reported for financial markets, it was found evidence that, in the market for ships, increases in trading activity lead to a reduction in market volatility. This can be explained by the unique underlining characteristics of the market for ships, including thin trading, which imply that increase in trading activity result in price transparency and stability. These findings indicate that practitioners in the market may use that information contained in the level of trading activity so as to guide their market decisions in the sale and purchase market.

### 3.4 Granger causality studies in ports sector

In applying Granger causality test for ports sector, causality between port performance and traffic had been studied by Prabir De Buddhadeb Ghosh (2003) and surveyed “Causality between performance and traffic: an investigation with Indian ports”. For this study, port performance index and port/transport statistics over 15 years of the 11 Indian ports were used as the data and applied Unit Root tests, Co integration tests and Granger causality tests in sequential manner to judge the nature and strength of this causality.

The major finding of this study was port traffic does not course port performance but port performance does course port traffic in the ports of India. Policies to increase efficiency have been pursued in the port sector in many countries by changing the structure and institutional framework of this industry. The changes have been introduced across the globe by such measures as privatization and deregulation so that the role of governments has been reduced significantly.

The countries in which the policy changes have been greatest are those in which national policies exerted a strong influence on port performance. The more competitive environment has implications for national port policies and for port management. The paper point out that Indian government has taken some discrete initiatives in the recent period for expanding their port capacity.

Lili Song & Jianing Mi (2016) surveyed “Port infrastructure and regional economic growth in China: a Granger causality analysis”. This article investigated the Granger causality between port investment and economic growth in China both at the full regional level and the sub-regional level. By applying the panel data for the period of 1999-2009, the error correlation model (ECM) is employed to test the Granger causality between port investment and economic growth. The results showed that short-term bidirectional causality exists between port investment and economic growth, and the long-term unidirectional causality exists between port investment and the economic growth.

A port's development is highly related to its regional economy because port activities such as transferring, loading and unloading, warehousing, processing, packaging, logistics services, and value added activities have multiplier effects on the local, regional, and national economy. Chinese ports play a crucial role in the development of the world port system. China has made substantial capital investment in its port facilities in recent years.

Jiang (2010) calculated the contribution of the seaport investments to the gross domestic product of the entire country using time series data of China, and the results showed that the seaport investments have a positive impact on the economic growth both in the long-term and short-term.

Yoo (2006) investigated the causality between seaport infrastructure investment and economic growth in Korea by applying time series data from 1970 to 2002. The results showed that unidirectional causality runs from seaport infrastructure investment to economic growth without any feedback, which means that there is no strong causality running from economic growth to seaport infrastructure investment in Korea.

Wen and Shen (2008) applied the Granger causality test to investigate the relationship between the five modes of transportation infrastructure and economic growth in China; the conclusion indicated that transport infrastructure has a positive impact on the economic growth in China, and the railway, inland navigation, and civil aviation infrastructures have bidirectional causality with economic growth.

An another Granger causality study related ports was conducted by Xin Tian, Liming Liu & Shouyang Wang (2015) to find the competing relationship between Shenzhen port and Hong Kong port in their research named “Evolving competition between Hong Kong and Shenzhen ports”.

This study used Container throughput monthly time series data of the two ports and conducted the Unit root test and the Granger causality test to determine the relationship between the two time series and concluded that Hong Kong port does not affect Shenzhen port, whereas Shenzhen port has competitive power over Hong Kong port. The same methodology presented here was applied to understand of the port transport sector and analyze container traffic behavior in port of Colombo in this research as well.

**Table 3.1 Contributions of Granger causality approaches**

| Field | Authors | Analysis | Conclusion |
|---|---|---|---|
| **Public finance** | Mihai Mutascu (2016) | Government revenues and expenditures in the East European Economies | A unidirectional causality Expenditures → revenues in Bulgaria<br>Revenues → expenditures in Czech Republic, Hungary, and Slovenia<br>A bidirectional causation in Slovak Republic |
| **Public finance** | Wan Kyu Park (1998) | Granger causal relationship between government revenues and expenditures in Korea over the | A unidirectional causal relationship government revenues→ expenditures |

| | | | |
|---|---|---|---|
| | | period of 1964 to 1992 | |
| **Transportation sector** | Elton Fernandes & Ricardo Rodrigues Pacheco (2010) | The casual relationship between GDP and Domestic air passenger traffic in Brazil | A unidirectional Granger causal relationship economic growth → domestic air transport demand in Brazil |
| **Shipping sector** | Amir H. Alizadeh & Nikos K.Nomikos (2003) | The price-volume relationship in the sale and purchase market for dry bulk vessels | A unidirectional Granger causal relationship price changes → trading volume |
| **Ports sector** | Prabir De Buddhadeb Ghosh (2003) | Causality between performance and traffic: an investigation with Indian ports | A unidirectional Granger causal relationship port performance → port traffic in the ports of India |
| **Ports sector** | Lili Song & Jianing Mi (2016) | Port infrastructure and regional economic growth in China: a Granger causality analysis | A short-term bidirectional causality port investment → economic growth A long-term unidirectional causality port investment → the economic growth |
| **Ports sector** | Xin Tian, Liming Liu & Shouyang Wang (2015) | Evolving competition between Hong Kong and Shenzhen ports | A unidirectional Granger causal relationship on competitive power Shenzhen port → Hong Kong port |

| | | | |
|---|---|---|---|
| **Ports sector** | Jiang. N (2010) | Seaport investment and economic development in China | A unidirectional Granger causal relationship on The seaport investments → the economic growth both in the long-term and short-term |
| **Ports sector** | Yoo, S.H. (2006) | Seaport Infrastructure Investment and Economic Growth in Korea | A unidirectional causality Seaport infrastructure investment → economic growth |
| **Ports sector** | Wen.H. and Y. Shen (2008) | Granger causality analysis on the economy and transportation infrastructure construction | A unidirectional causality transport infrastructure → the economic growth in China, and the railway, inland navigation, and civil aviation infrastructures have bidirectional causality with economic growth |

# Chapter 4 Research Methodology and Empirical Results

## 4.1 Research methodology

The Granger causality test is a statistical hypothesis test for determining whether one time series is useful in forecasting another, first proposed in 1969. Ordinarily, regressions reflect "mere" correlations, but Clive Granger argued that causality in economics could be tested for by measuring the ability to predict the future values of a time series using prior values of another time series. If a time series is a stationary process, the test is performed using the level values of two (or more) variables. If the variables are non-stationary, then the test is done using first (or higher) differences.

The number of lags to be included is usually chosen using an information criterion, such as Akaike information criterion or the Schwarz information criterion. Any particular lagged value of one of the variables is retained in the regression if it is significant according to a t-test and it and the other lagged values of the variable jointly add explanatory power to the model according to an F-test. Then the null hypothesis of no Granger causality is not rejected if and only if no lagged values of an explanatory variable have been retained in the regression.

The two variables studying in this research are Indian ports originated container traffic through port of Colombo and total transshipment throughput in port of Colombo and the monthly container throughput in TEUs for the year 2008- year 2017, relevant these two variables were used for the test.

## 4.2 Causal relationship between different time series

The world does not consist of independent stochastic processes. Just the contrary: in accordance with general equilibrium theory, economists usually assume that everything depends on everything else. Therefore, the next question that arises is about (causal) relationships between different time series.

In principle, we can answer this question in two different ways. Following a bottom up strategy, one might first assume that the data generating processes of the different time series are independent of each other. In a second step, one might ask whether some specific time series are related to each other. This statistical approach follows the proposals of Clive W.J.Granger (1969) and is today usually employed when causality tests are performed. The alternative is a top down strategy which assumes that the generating processes are not independent and which, in a second step, asks whether some specific time series are generated independently of the other time series considered.

This approach is pursued when using vector auto-regressive processes by the methodology, which goes back to Christopher A. Sims (1980). Both approaches are employed to investigate the causal relationships which potentially exist between different time series.

## 4.3The Unit root test

When considering the unit root test, we first use the Augmented Dickey-Fuller (ADF) test (Said and Dickey 1984) to determine whether the data should be differentiated to render stationary data. The ADF test here consists of estimating the following regression:

$$\Delta Y_t = \alpha + \beta t + \gamma Y_{t-1} + \sum_{j=1}^{p} \delta_j \Delta Y_{t-j} + \varepsilon_t \qquad (1)$$

where, $\Delta$ is the first deference operator, $t$ is the time trend, $\alpha$ is an intercept consistent called drift, $\beta$ is the coefficient on a time trend, $\gamma$ is the coefficient presenting process root, i.e. the focus of testing (if $\gamma = 0$, Y has a unit root) , $\varepsilon_t$ is an independent identically distributes residual term. In addition, $p$ is the lag order of the first-differences autoregressive process, which is chosen carefully using the Akaike information criterion (Akaike 1973) and Schwarz information criterion (Schwarz 1978).

### 4.4 Granger causality test

Granger (1969) proposed a test for the direction of causality, and this was commonly used as a convenient and general approach by later researches to detect the presence of a causal relationship between two variables, using time series data. The definition of causality between two series, given by Granger (1969), is entirely in terms of predictability. Essentially, *X* is said to cause *Y* if a prediction of *Y* on the basis of its' previous history can be improved by taking in to account past values of *X*. It is also possible for causation to proceed in the reverse direction, given the validity of a symmetric statement. That is, reverse causality or feedback from *Y* to *X* can be said to exist if *X* can be predicted better by taking account of past values of *Y* than by not using them. Therefore, the causal relationship between *X* and *Y* can be bidirectional, if the causation is found to run in both directions simultaneously (Lili Song & Jianing Mi 2016).

There are three different types of situation in which a Granger-causality test can be applied:

- In a simple Granger-causality test there are two variables and their lags.
- In a multivariate Granger-causality test more than two variables are included, because it is supposed that more than one variable can influence the results.
- Finally Granger-causality can also be tested in a VAR framework; in this case the multivariate model is extended in order to test for the simultaneity of all included variables.

The Granger causality test is applied in this study to explore the causality between Indian originated container traffic and total transshipments of Colombo with using monthly time series data from 2009 to 2017. Causality tests assuming that both variables are stationary are performed using the following Vector Autoregressive (VAR) model,

$$IND_t = \alpha_{1,0} + \sum_{i=1}^{p} \alpha_{1,i}\, IND_{t-1} + \sum_{i=1}^{p} \beta_{1,i}\, COL_{t-1} + \varepsilon_{1,t} \quad (2)$$

$$COL_t = \alpha_{2,0} + \sum_{i=1}^{p} \alpha_{2,i}\, IND_{t-1} + \sum_{i=1}^{p} \beta_{2,i}\, COL_{t-1} + \varepsilon_{2,t} \quad (3)$$

In terms of this model, total transshipments of Colombo Granger causes Indian ports' originated transshipments if the coefficients $\beta_{1,i}$ for $i = 1,2,\ldots p$ in the first equation are jointly significant, i.e. the null hypothesis of $\beta_{1,i} = 0$ for $i = 1,2,\ldots p$ is rejected. Similarly, Indian ports' originated transshipments Granger cause Colombo transshipments if the null hypothesis of $\propto_{2,i} = 0$ for $i = 1,2, \ldots p$ is rejected.

With respect to this model we can distinguish the following cases:

1 If $\{\alpha_{11}, \alpha_{12}, \ldots, \alpha_{1k}\} \neq 0$ and $\{\beta_{21}, \beta_{22}, \ldots, \beta_{2k}\} = 0$, there exists a unidirectional causality from $X_t$ to $Y_t$ , denoted as X →Y.

2 If $\{\alpha_{11}, \alpha_{12}, \ldots, \alpha_{1k}\} = 0$ and $\{\beta_{21}, \beta_{22}, \ldots, \beta_{2k}\} \neq 0$, there exists a unidirectional causality from $Y_t$ to $X_t$ , denoted as Y→X.

3 If $\{\alpha_{11}, \alpha_{12}, \ldots, \alpha_{1k}\} \neq 0$ and $\{\beta_{21}, \beta_{22}, \ldots, \beta_{2k}\} \neq 0$, there exists a bilateral causality between $Y_t$ to $X_t$ , denoted as X ⇔Y.

In order to test the hypotheses referring to the significance or not of the sets of the coefficients of the VAR model of equations and the usual Wald F-statistic could be utilized, which is the following:

$$F_c = \frac{(SSR_r - SSR_u)/\,k}{SSR_u/(n-2k-1)} \sim F(k, n-2k-1)$$

where:

$SSR_u$= sum of squared residuals from the complete equation (unrestricted)

$SSR_r$= sum of squared residuals from the equation under the assumption that a set of variables is redundant (restricted)

The hypotheses in this test may be formed as follows;

$H_0$: X does not Granger cause Y, i.e. $\{\alpha_{11}, \ldots, \alpha_{1k}\} = 0$, if $F_c$ < critical value of F

$H_a$: X does Granger cause Y, i.e. $\{\alpha_{11}, \ldots, \alpha_{1k}\} \neq 0$, if $F_c$ < critical value of F

(1)

and

$H_0$: Y does not Granger cause X, i.e. $\{\beta_{21}, \ldots, \beta_{2k}\} = 0$, if $F_c$ < critical value of F

$H_a$: Y does Granger cause X, i.e. $\{\beta_{21}, \ldots, \beta_{2k}\} \neq 0$, if $F_c$ < critical value of F

(2)

It has to be noted here that in the hypothesis (1) and (2) it is not tested if 'X causes Y', but instead it is tested if 'X causes Y according to the Granger type'. This is because the Granger test is just a statistical test based not on specific theory of causation but based on the ability of the equation to predict better the dependent variable. Furthermore, the validity of the test depends on the order of the VAR model and on the stationary or not the variables. The validity of the test is reduced if the variables involved are non-stationary (Seddighi Lawler & Katos, 2000).

### 4.5 Test results

Only stationary series are involved in terms of the definition of Granger causality (Granger 1969).To check whether the variables used in this study are stationary, we run the augment Dickey-Fuller (ADF) test on the Indian ports' originated transshipments and total transshipments in port of Colombo as a first step. As the empirical findings show, when the ADF test is applied on the original value of both variables, the results indicate that the null hypothesis of a unit root cannot be rejected at the 5% level; however, the null hypothesis of non-stationary can be rejected for the first difference of each of the two variables at a 5% level of significance (see Table 4.2).

**Table 4.1 Indian originated container traffic through port of Colombo monthly figures (TEUs) from 2008- 2017**

| Year | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Jan** | 47,095 | 75291 | 95667 | 87876 | 99843 | 100873 | 109832 | 117342 | 128098 | 135289 |
| **Feb** | 50,053 | 78560 | 88625 | 87543 | 98043 | 105458 | 112020 | 120215 | 126098 | 137898 |
| **March** | 58,902 | 79340 | 93065 | 89021 | 100563 | 99843 | 138700 | 119001 | 129431 | 139043 |
| **Apr** | 66,224 | 83132 | 96812 | 90342 | 99053 | 105440 | 101530 | 117089 | 128042 | 140093 |
| **May** | 68,098 | 83498 | 99101 | 93215 | 105678 | 107920 | 116789 | 121430 | 128227 | 141087 |
| **June** | 69,875 | 79499 | 98981 | 98219 | 108931 | 99982 | 112345 | 119043 | 130032 | 137094 |
| **July** | 70,062 | 83678 | 97832 | 89031 | 99043 | 106753 | 109953 | 118076 | 130043 | 146021 |
| **Aug** | 70,210 | 89542 | 109012 | 98021 | 108043 | 108732 | 117808 | 118977 | 131021 | 139043 |
| **Sept** | 73,392 | 91411 | 106567 | 95043 | 118932 | 109975 | 118630 | 113943 | 131092 | 141097 |
| **Oct** | 73,092 | 92875 | 110123 | 88021 | 109041 | 106776 | 117632 | 117798 | 129021 | 148092 |
| **Nov** | 75,021 | 85243 | 99970 | 90120 | 98065 | 109730 | 110050 | 120841 | 131021 | 141054 |
| **Dec** | 78,032 | 83701 | 97872 | 90211 | 100079 | 107773 | 116700 | 119780 | 129098 | 141043 |
| **Total** | **800,056** | **1005770** | **1193627** | **1096663** | **1245314** | **1269255** | **1381989** | **1423535** | **1551224** | **16557831** |

Source: Statistics section of SLPA, South Asia Gateway Terminal and Colombo International Container Terminal data base

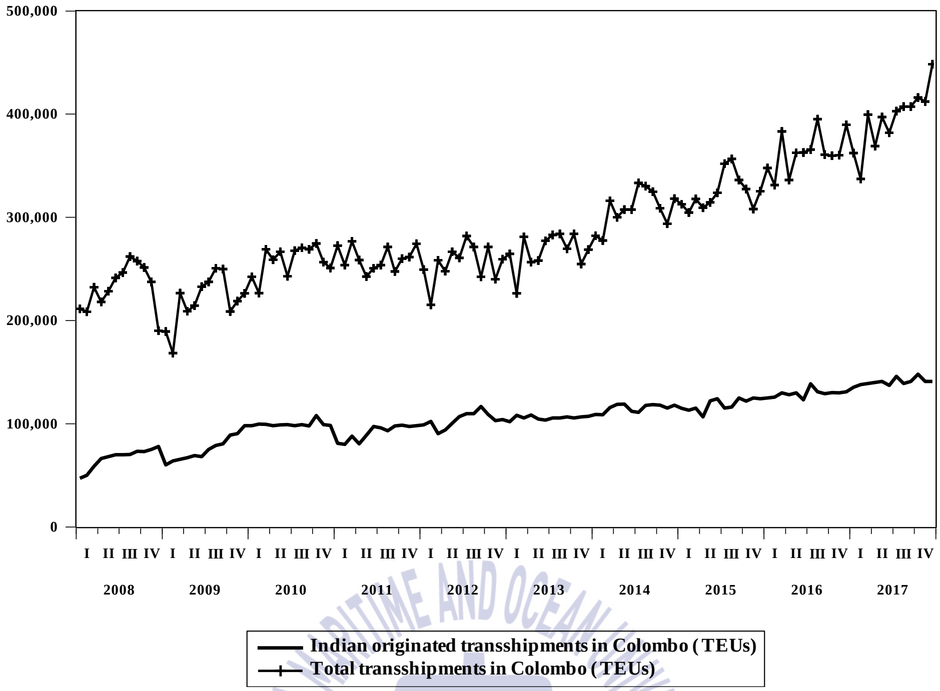



**Figure 4.1 Indian ports' originated transshipments and total transshipments in port of Colombo monthly data from 2008 to 2017**

**Table 4.2 Unit root (ADF) test results**

| **Variables** | **Level ADF** | | **1st difference ADF** | |
|---|---|---|---|---|
| | Critical values | *p*-value | Critical values | *p*-value* |
| **Total TS** | -3.448 | 0.2247 | -3.452 | 0.0000** |
| **Indian TS** | -3.448 | 0.0009** | -3.449 | 0.0000** |

*Note*: *MacKinnon (1996) one sided *p*- values.

**Denotes the rejection of null hypothesis at the 5% level

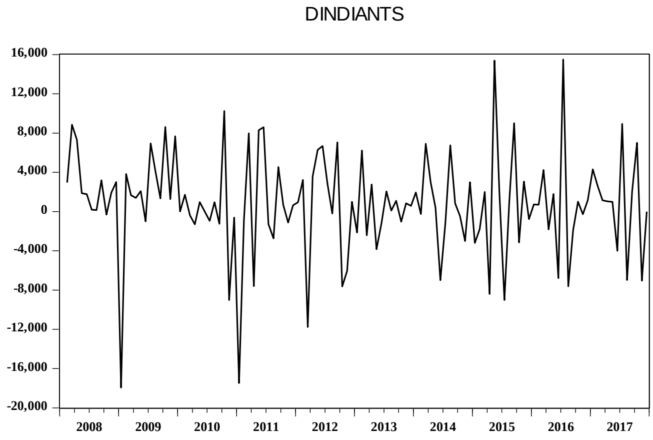



**Figure 4.2: Indian originated transshipments in Port of Colombo graph of 1st difference level**

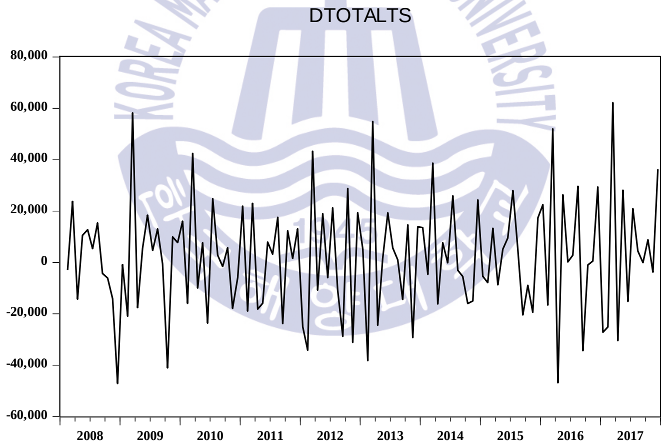



**Figure 4.3: Total Transshipment throughput in Port of Colombo graph of 1st difference level**

The optimal lag length is important to identify the true dynamics of the model. VAR system is used to determine the optimal lag length. We employed the popular criteria to choose the optimal lag order and the results shown in the Table 4.3.

**Table 4.3 Optimal Lag Order in the VAR System**

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| **0** | -2568.241 | NA | 2.94e+17 | 45.89716 | 45.94571 | 45.91686 |
| **1** | -2380.673 | 365.0887 | 1.11e+16 | 42.61915 | 42.76479 | 42.67824 |
| **2** | -2370.333 | 19.75498 | 9.89e+15 | 42.50596 | 42.74868* | 42.60444 |
| **3** | -2363.268 | 13.24821* | 9.37e+15* | 42.45121* | 42.79102 | 42.58908* |
| **4** | -2363.144 | 0.227375 | 1.00e+16 | 42.52043 | 42.95733 | 42.69770 |
| **5** | -2361.188 | 3.528326 | 1.04e+16 | 42.55693 | 43.09092 | 42.77358 |
| **6** | -2360.664 | 0.926667 | 1.11e+16 | 42.61899 | 43.25007 | 42.87504 |
| **7** | -2356.125 | 7.861592 | 1.10e+16 | 42.60938 | 43.33755 | 42.90482 |
| **8** | -2353.926 | 3.730311 | 1.14e+16 | 42.64154 | 43.46680 | 42.97637 |

*Note*: *indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

From the Table 4.3 it is clear that lag order 3 is the optimal lag according to sequential modified LR test statistic, FPE, AIC and HQ information criterion. Hence, we accept the judgment of the four criteria which indicates optimal lag order of 3.

Table 4.4 reports the results for the Granger causality tests on the Indian Ports' TS between Total TS in the port of Colombo. The empirical findings show that there is a unidirectional Granger causality from Total TS to Indian TS in the port of Colombo but there seems not to be any causality from Indian TS to Total TS.

**Table 4.4 Results of Granger causality test for Total TS and Indian TS**

| Null hypothesis | Granger causality test results (*p*-value) |
|---|---|
| Total TS does not Granger-cause Indian TS | 0.0048* |
| Indian TS does not Granger-cause Total TS | 0.2594 |

*Note*: *means that the null hypothesis should be rejected at a significance level of 5%.

# Chapter 5 Conclusions

## 5.1 Research findings

Granger (1969) pointed out that if co-integration exists in a pair of series, there must be causation in at least one direction. The study investigates the relationship between Indian ports' originated transshipments and total transshipments in the port of Colombo and to identify any possible direction of causality between them. The result of the study shows that total transshipments in the port of Colombo has much to contribute to Indian ports' originated transshipment traffic via the port of Colombo. This Granger causality test result can be interpreted in different ways,

- Colombo total transshipments throughput has a positive impact on Indian originate container traffic via port of Colombo
- Colombo total transshipment throughput guides the Indian originate container traffic via port of Colombo

Furthermore, this sends an important message to policymakers to take immediate actions to improve total transshipments volumes and container handling capacity in the port and through that level it would be easy to attract more transshipments volumes from Indian sub continent ports.

Therefore to expand container handling capacity and transshipment throughput in the port the following long-term and short term strategies and related activities should be implemented rapidly in the port of Colombo.

## 5.2 Policy recommendations

Given the research findings described in the previous paragraph, policy makers in port of Colombo may utilize partially the result of the study in order to analyze thoroughly the new port system reform; first of all, it may be useful to understand the importance of the transshipments throughput of port of Colombo and how can be developed it. The biggest advantage of port of Colombo as discussed earlier not other than the strategic geographical location. To keep the position of the maritime hub in the South Indian region it is important to keep the highest volumes in transshipments and the policy makers have to give their attention for this without delay.

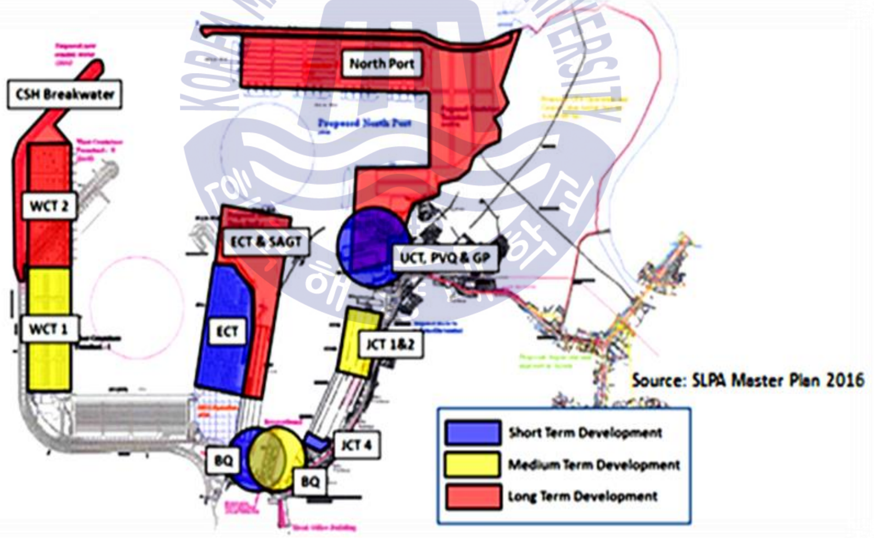
Secondly, this causality relationship shows the total transshipment throughput of port of Colombo has a positive impact on Indian container traffic and this can be used to make the policy improvement process. Particular attention should be given to other transshipment sources like Bangladesh, Pakistan, Myanmar and Male ports and have proven to be essential for the local, regional and national economy, but are currently not as efficient as others.

To strengthen the total transshipments in port of Colombo here recommends the implement the following policy decisions in port of Colombo,

- Implementing the proposed Colombo port development plan without delay
- Attracting new transshipment volumes, introducing new services and new shipping lines
- Explore new transshipment market volumes like Bangladesh, Myanmar and attract new business opportunities
- Success management policy implementation

Implementing the proposed Colombo port development plan without delay

This sends an important message to policymakers to carry out the Colombo port expansion project and other proposed development plans (Figure 5.1) under the master plan of port of Colombo in order to attract much more strong transshipment volumes from the Indian subcontinent region specially, India, Bangladesh, Pakistan and Male. With increased use of larger vessels in the South Asia transshipments markets, development of additional deep water berths are urgently needed as the only port in the South Asia region with a deep water terminal that can accommodate the latest generation of mega ships.




| Short Term Development | Medium Term Development | Long Term Development |
|---|---|---|
| Completion of ECT ( phase2) | WCT 1 | Extension of CSH break water |
| JCT4 expansion | Deepening of JCT 1&2 | WCT phase 2 |

| | | |
|---|---|---|
| Improvement of UCT, PVQ & GP | Passenger Terminal at BQ | North port |
| Recreational facilities deepening at BQ | | Extension of ECT & SAGT |

**Figure 5.1: Colombo Port development plan under the WRMMP ( Western Region Megapolis Master Plan)**

**Table 5.1 Planned development schedule under the master plan in port of Colombo**

| No | Development Plan | Commencement | Completion |
|---|---|---|---|
| **01** | Completion of ECT | 2013 | 2018 |
| **02** | Commencement of WCT 1 | 2018 | 2020 |
| **03** | Construction of Port Shipping & Business Centre | 2016 | 2018 |
| **04** | Development of BQ as a passenger Terminal | 2016 | 2018 |
| **05** | Shifting of conventional cargo to JCT 1&2 | 2016 | 2017 |
| **06** | Establishment of CFS for LCL in the in JCT 1&2 | 2016 | 2018 |
| **07** | Allocation of SAGT and JCT 3&4 for feeder handling | 2018 | 2020 |
| **08** | Cargo inspection facilities close to the port of Colombo | 2015 | 2017 |
| **09** | Development of 250ha of land adjacent to port of Colombo for CFS operation & | 2015 | 2025 |

| | | | |
|---|---|---|---|
| | cargo value added services | | |
| **10** | Extension of CSH breakwater | 2021 | 2025 |
| **11** | Construction WCT 2 | 2022 | 2025 |
| **12** | Improvement to UCT, PVQ & Guide Pier for conventional cargo operation | 2023 | 2025 |
| **13** | Commercial developments in JCT 1&2 | 2024 | 2026 |
| **14** | Development of yacht terminal | 2025 | 2026 |
| **15** | Development of North port | 2025 | 2040 |

Source: WRMMP Western Region Megapolis Master Plan – 2013

<u>Success management policy implementation</u>

- Port privatization policy – Public private Partnership (PPP)/ Build Operating and Transfer (BOT) model.

In 1999 the SLPA established a joint venture operation a consortium South Asia Gateway Terminal (SAGT) led by P&O ports. This is on a 30-year concession on a BOT basis in Sept 1999, the concession was awarded to a consortium led by P&O ports and the new facility was fully operational in 2003 and the SLPA, which secured a 15 per cent equity in SAGT paid rental and royalty for the containers handled in this terminal.

In 2011 China Merchant Holdings won the rights to develop the South Container Terminal with 35-year BOT and started operations in 2013.Colombo International Container Terminals Ltd (CICT) is a Joint venture between China Merchant Holdings (International) Co. Ltd (85% ownership) and the Sri Lanka Ports Authority (15% ownership) under a 35 year build, operate and transfer (BOT) agreement. These two terminals are doing their terminal operations very successfully and the future terminal operation will be implemented under this success policy frame work in port of Colombo especially in South Harbor Expansion project.

- Rebates

East coast of India & Bangladesh rebates: Transshipment rebates of 10% will be granted on containers to and from East coast of India & Bangladesh to improve transshipment volumes from Indian Sub Continent ports.

Volume rebates are granted to the main line operators for the pure volumes generated by the individual lines in port of Colombo.

- Keeping the competitive tariff rates to attract more business

**Table 5.2 Terminal handling charges in selected ports**

| Port | Charge ( US$ / TEU) |
|---|---|
| Chennai | 65 |
| Chittagong | 85 |
| JNPT | 95 |
| Karachi | 115 |
| Mundra | 116 |
| Colombo | 151 |
| Singapore | 161 |
| Shalala | 194 |
| Dubai | 215 |
| Rotterdam | 268 |
| Los Angeles | 390 |
| Male | 415 |

- Improve the image of port of Colombo to attract more shipping lines

Recently signed a MOU between container terminals in the port of Colombo, in order to promote Colombo collectively to share the resources to market & protect the greater interest of the port. Compete with each other but cooperate with each other in order to better service to clients and moving from competition to co-competition. The coordination in between all the three terminals to develop the image of Colombo port is very important and to introduce this kind of important policy and implementing them is the responsibility of ministry of port and shipping of Sri Lanka.

**5.3 Limitations of the study**

Granger causality is a statistical method for investigating the flow of information between time series. The relationship of the test is depends on the time series data we use for the test and when the range of data is high the reliability of the test results are high. To get success results of the causality test the number of lags level should be kept high and in this test, we used monthly container throughput data in port of Colombo from the year 2009 to 2017. But normally, in most Granger causality tests use 10- 20 years monthly data, but it is really hard to collect monthly data such a long time in relating this type of study. In Colombo, since there are four container terminals involved in container operations and most of the terminals doesn't keep monthly data such a long time in their terminal management systems. So, this study depends on the available limited data and it is one of the major problems to hinder the success of the research.

In considering the methodology in this research, the Granger causality has common limitations and arguments in itself. Some argues that as its name implies, Granger causality is not necessarily true causality. The definition of Granger causality did not mention anything about possible instantaneous correlations between $x_t$ and $y_t$. If the innovation to $y_t$ and innovation to $x_t$ are correlated we say there is instantaneous causality. It will be usually found instantaneous correlation between two time series, but since the causality (in that "real" sense) can go either way, one usually does not test instantaneous correlation.

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