Factors affecting Productivity of Container Terminals of Ports in Tanzania: Case of Dar es Salaam Port

Lucas P. Mwisila[1] Deus Ngaruko[2]

[1] Science and Management Department, Dar es Salaam Maritime Institute
P.O.Box 6727 Dar Es Salaam: lmwisila@yahoo.com

[2] Department of Economics, The Open University of Tanzania
P.O.Box 23409 Dar Es Salaam
ngaruko.papers@gmail.com

Abstract

This paper presents the productivity model for the container terminal in Tanzania. The study analysed the factors effecting productivity of DSM port. It was found that the productivity model has explanatory (predictors) variables that are jointly significant. Likewise, the predictors have neither long-run nor short-run relationships to the respondent variable because they are weak to stimulate it. The weaknesses include the controversy that TN and CS are decreasing while the container terminal throughput (CTP) is increasing. The inverse relationship could be quite okay for CS if large container ships replaced the smaller ships; but this was not due to draft limitations. On the other hand, the port is faced with congestion and delay despite the fact that, the increase in container moves per hour (CMPH) increases CTP. The scenario implies that the increase in CMPH doesn't match with the increase in CTP; hence CMPH is not desirable to reduce ship turnaround time. Also the increase in dwell time (DT) makes containers stay longer at the port before being cleared. The study recommends that, productivity factors and benchmarks from the quay, yard, gate and cost effective areas be precisely reviewed and set.

Key words: Container terminal Productivity, Dar es Salaam Port, Tanzania.

1.0 Introduction

Productivity at DSM port is being hampered by congestion and delays. The inadequacy in productivity is caused by delays in the operation process at anchorage, berthing, loading, unloading, custom clearance and exiting the port. The inadequacy lead to prices increase of goods; when price of intermediary goods are higher for local producer it implies higher price to finished products. If prices of local and imported finished goods are higher, the purchasing power of consumers is reduced resulting in decrease in consumption levels and welfare. The decrease in consumption reduces demand of goods and supply of tonnage (ships) hence revenue and profits from port operators, local producers and the Nation (GDP) are reduced. Tanzania is losing a lump sum of about USD 157 per year which is equivalent to 3 percent of annual public revenue. Similarly, consumption by Tanzanian house hold could have saved 8.5% of total expenditure or USD 147 per year if the port could be productive. The value of merchandise passing at the port of DSM was USD 15 billion which was equivalent to 60% of Tanzania's GDP in 2012 (World Bank, 2013).

Throughput has been by average increasing from 240,792TEU in 2011 to 368,967 in 2015. However, there was a fall in 2013 and sharp increase in 2014, the reason could be from imbalance in trade, market replenishment and loss of market due to congestion and delays. Likewise, the container moves per hour at DSM GCCT for the period from 2010 to 2014 has been increasing. The container moves per hour increased from 8.5 CMPH in 2010 to 16.6 CMPH in 2014 (TPA, 2015a, b). Lu and Park (2013) found the terminal cranes and yard tractor to be the critical productivity factors of container terminal; therefore the increase in CMPH indicates either an increase in container automation resulted from employing more modern equipment and else work extra time and or growth in container traffic per annum. This is a potential growth and researcher wanted to have an understanding of DSM General Cargo Container Terminal (DSM GCCT) productivity and more indicative productivity factors with their relevant effects on productivity of container terminal. The researcher focused on the quay and yard areas because of constraints such as time, finance and unavailability of data for the gate and cost effectiveness.

Smith (2012), SUMATRA (2009) and Rankine (2003) provided some indicative factors for assessing productivity of the container terminal. The factors include; ship turnaround time, Crane moves per hour, TEUs per hour, berth utilization/occupancy, TEUs per gate hour, dwell time and yard density. UNCTAD (1976) provides a summary of financial and operational indicators to be used in general cargo terminal. The financial indicators include Tonnage worked, Berth occupancy revenue per ton of cargo, Cargo handling revenue per ton of cargo, Labour expenditure per ton of cargo and Capital equipment expenditure per ton of cargo. The operation indicators include: Arrival rate, waiting time, Service time, Turn-around time, Tonnage per ship, Fraction of time berthed ships worked, Number of gangs employed per ship per shift, Tons per ship-hour in port, Tons per ship hour at berth, Tons per gang–hour and Fraction of time gangs idle. The indicators are conventional and can be used to measure container terminal productivity. The indicators are very essential in assessing productivities of the container terminal in general and of the individual activities related to operations of the container terminal. They provide picture of the output (actual) which can be compared against what were planned. The output information is important for decision making therefore the indicators should be precise and not ambiguous. Likewise, Esmer (2008) provided seven different core productivity factors to be used in monitoring productivity. However there can be more than the identified core productivity depending on the nature and depth of the desired outcome. The seven core productivities are ship productivity, equipment productivity, quay productivity terminal area productivity, labour productivity, crane productivity and cost effective.

DSM GCCT container terminal is faced with delay at anchorage, berthing, unloading, loading, and customs clearances. Similarly, the port is having inadequacy in terms handling facilities, space and channel limitations in terms of draft. This study exhausted as much as possible the various productivity factors benchmarked from the literature review and developed DSM GCCT productivity model that conforms to Tanzanian conditions. The productivity model is developed for the purpose of bridging the gap that was found by the researcher as very little was known in regard of the factors affecting productivity of the container terminal in Tanzania. The findings will also, help to improve container terminal productivity and broaden the understanding to port mangers, community and other stakeholders.

2.0 Review of Literature

The UNCTAD (1976) report stipulated the importance of having a control system from which the actual output can be measured and compared with the desired output of an operation or a process. Two control systems have been discussed in regard of gang productivity as an indicator. Firstly, the 'Open Loop Control System (OLCS)', this system has no feedback loop and secondly, the Closed Loop Control System (CLCS), this system has feedback loop. In OLCS the management becomes aware when productivity is very poor and there are a lot of complaints from customers. In CLCS the management timely identifies the area holding down productivity and takes steps to improve. CLCS provides performance indicator feedback from which the planned performance can compare to actual performance.

Likewise, Henesey (2004) on the Container System Model (CSM) described that, the container terminal system has four sub systems whose functions affect the performances of each other. The sub-systems included the ship-to-shore movement, transfers, storage and delivery-receipts. The sub systems involve allocating berth to ships, pilotage, unloading and loading (import and export) of containers, moving containers to yard, transhipment and the incoming and outgoing containers through the gate. On the other hand, Beškovnik (2008) said that, the container terminal management has to have its own productivity model which captures productivity at management level, strategic level and operational level. The management level comprises long-term decisions on matters such as terminal layout, infrastructure and contracts with ocean carriers. The strategic level is concerned with mid-term decisions in regard of use of space, working hours, shifts and number of gates. And the operational level in concerned with the day to day operational activities such as container moves per hour, truck turnaround time in terms and seaside transport turnaround time within the terminal.

Several studies on productivity of the container terminal have been done globally and locally. TPA (2011) indicated that container traffic has been increasing and the port is experiencing inadequacy capacity to accommodate the container traffic. The increase in container traffic in turn raises ship turnaround time, dwell time and delay for both the inbound and outbound container flow. These impediments caused some shipments from nearby countries like Zambia to go to Durban. For example in 2006 shipment of cargo from Zambia through Durban was 624,000 tons exceeded 559,000 tons from Zambia to Dar es Salaam (Haralambides et al, 2011). The World Bank (2013) report pointed out that, if DSM port could be productive; Tanzania and its neighbouring countries could have gained 2.6 billion (TZS) while Tanzania alone could gain1.8 billion (TZS). Containerization has changed the transportation pattern. Container business was found growing both globally and at locally. Bigger ships have been built requiring more depth, use of electronic automation software to easy the scheduling, payments, scanning, security, safety, navigations and space management. This study was guided by modified Schematic container terminal productivity model focusing on quay and yard areas. The benchmarked productivity factors were Container Ships (CS), Tonnage (TN), Ship Turnaround Time (STT), and Container Moves per Hour (CMPH), Crane Utilisation (CU), TEU across Quay Edge (TQE), Berth Occupancy (BoC), Berth Utilisation (BU), TEU Ground Slots (TGS), Storage Utilisation (SU) and Dwell Time (DT. It was revealed from literature review that Tanzania could have gained more if its ports would be productive. DSM container terminal is faced with delay at anchorage, berthing, loading, unloading and customs clearances. Similarly, the port has inadequate handling facilities and draft limitation on size of container ship. The researcher did not find adequate information from which DSM GCCT productivity and causality could be based. One of the reasons could be the absence of a productivity model from which the explanatory and respondent variables are expressed. For that matter very little is known about the productivity of DSM GCCT, causal relationships, factors affecting DSM GCCT productivity and trend of container traffic. The study therefore, exhausted as much as possible the various productivity factors benchmarked from the literature review and developed DSM GCCT productivity model that conforms to Tanzanian container terminal conditions. The productivity model is likely to increase container terminal productivity and broaden the understanding to port mangers, community and other stakeholders.

The Conceptual framework for DSM GCCT productivity was developed by amalgamating the theories from Henesey (2004) on the Container System Model and from UNCTAD (1976) on Closed Loop Control System (CLCS) found from theoretical review. The modified Schematic Container Terminal Productivity Model (STPM) in Figure 2.1 includes quay productivity, yard productivity and gate productivity and the fourth is cost effective. The benchmarked productivity factors from the four areas are Container Terminal Throughput (CTP), Number of Ships (NS), Ship Turnaround Time (STT), Container Moves per Hour (CMPH), Crane Utilisation (CU), TEU across Quay Edge (TQE), Berth Occupancy (BoC), Berth Utilisation (BU), TEU Ground Slots (TGS), Storage Utilisation (SU), Dwell Time (DT), Horizontal Transport Time (HTT), Truck Turnaround Time (TTT), Gate Utilisation (GU), Labour Cost per Tonnage in TEU (LCTT), Operational Cost per Tonnage in TEU (OCTT), Capital Cots per Tonnage in TEU (CCTT) and Revenue per Tonnage in TEU (RTT). The identified productivity factors have been locally and globally reported depending on purpose and interest of stakeholders (UNCTAD, 2015; PMAESA, 2011; SUMATRA, 2009).

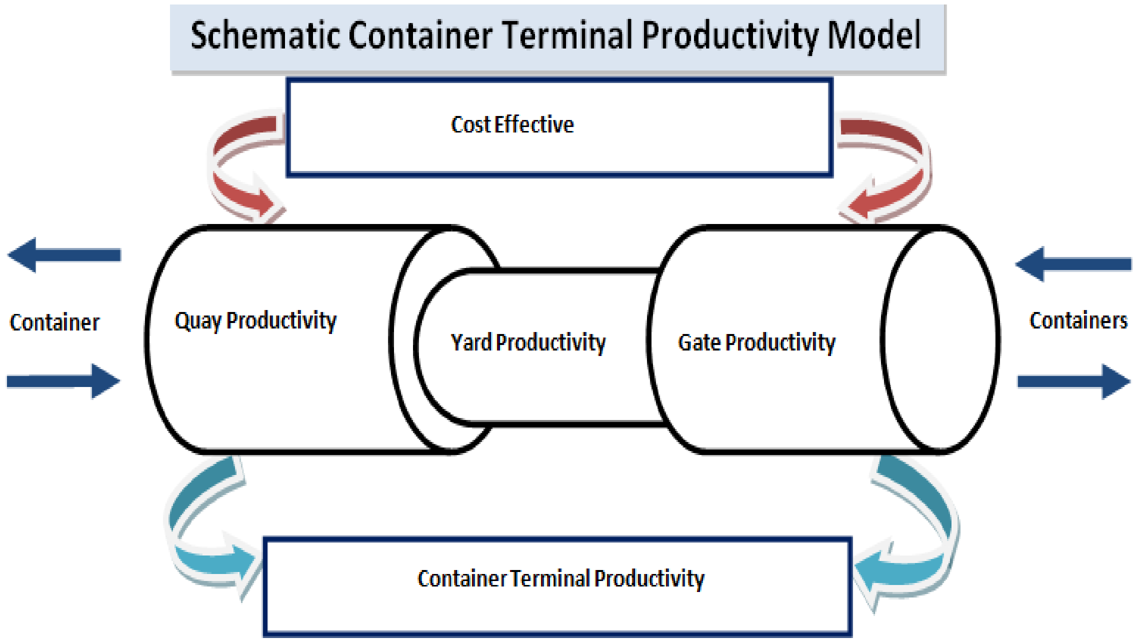

Figure 2. 1: Schematic container terminal productivity model
Source: Modified by Author

The empirical study on productivity of DSM GCCT considered productivity factors from yard and gate because of the availability of data. Therefore, the dependent (respondent) variable was the Container terminal throughput (CTP) and the explanatory variables were Container Ships (CS), Tonnage (TN), Ship Turnaround Time (STT), and Container Moves per Hour (CMPH), Crane Utilisation (CU), TEU across Quay Edge (TQE), Berth Occupancy (BoC), Berth Utilisation (BU), TEU Ground Slots (TGS), Storage Utilisation (SU) and Dwell Time (DT). The hypothesis in determining DSM GCCT productivity model was H_{01}: There is no significant relationship between the respondent variable CTP and the jointly explanatory variables TN, CS, STT, CMPH, CU, TQE, BoC, BU, TGS, SU and DT.

3.0 Methodology

3.1 Research design

This study is a ‘case study’ which analysed productivity of DSM GCCT. The research design provided a direction from which the relevant numerical data were collected, analysed, interpreted, presented and reported with minimum expenditure efforts, time and money. This was an exploratory research study intended to discover ideas and insights. The research design in case of this exploratory research study had opportunity to survey relevant literatures which were used in developing the hypotheses, data collections and analysis (Creswell, 2014). The data were obtained from secondary sources from the quay and yard areas at DSM GCCT. The respondent variable is the GCCT productivity represented by monthly container terminal throughput (CTP) measured in TEU. On the other hand the explanatory variable is the container terminal processes represented by the benchmarked productivity factors including Tonnage (TN) measured in Ton, Container Ships (CS) measured in unit number, Ship Turnaround Time (STT) measured in days, Container Moves per Hour (CMPH) measured in TEU moves per hour, Crane Utilisation (CU) measured in TEU per year per crane, TEU across Quay Edge (TQE) measured in TEU per metre per year , Berth Occupancy (BoC) measured in percentage, Berth Utilisation (BU) measured in unit, TEU Ground Slots (TGS) measured in annual TEU per hectare, Storage Utilisation (SU) measured in unit and Dwell Time (DT) measured in days. The quantitative data collected at GCCT container terminal were 60 months from the recent five years taken from 2011 to 2015. The researcher used the econometric software-Stata to produce output and having guided by reviewed theories, analysed and discussed the finding of the study.

3.2 Methods of data collection

The methods of collecting data were selected depending on the hypotheses addressed, type of sample and desire of the researcher to have information in depth. Anderson et al (2005) stipulates the importance of understanding the depth and breadth of the problem being addressed before embarking in the process of gathering data. The researcher surveyed and sorted secondary data in relevance of research study context. The data collection methods, limitations, delimitation, time, reliability and validity of information collected from the study were systematically geared to this research study. The secondary data came from documentaries such as books, articles, pamphlets, journal, magazines, newsletter and internet. The quantitative data collected at DSM GCCT container terminal were from the two strata namely as quay and yard. The past years data for DSM GCCT were difficult to obtain, therefore, the 60 months data from the recent five years taken from 2011 to 2015 were collected. Each month had 12 inputs which in total amounted to 720 date entries.

3.3 Data processing and analysis

The assumption from hypothesis is H_{01}: There is no significant relationship between the respondent variable CTP and the jointly explanatory variables TN, CS, STT, CMPH, CU, TQE, BoC, BU, TGS, SU and DT being variables of DSM GCCT. The formulated multiple regression equation for DSM GCCT productivity model was:-

$$CTP = \beta_0 + \beta_1 TN + \beta_2 CS + \beta_3 STT + \beta_4 CMPH + \beta_5 CU + \beta_6 TQE + \beta_7 BoC + \beta_8 BU + \beta_9 TGS + \beta_{10} SU + \beta_{11} DT + \varepsilon \quad (1)$$

Where:-

$\beta_0 .. \beta_{11}$: Constant terms
TN : Tonnage
CS : Container ships
STT : Ship turnaround time
CMPH : Container moves per hour
CU : Crane utilisation
TQE : TEU across quay edge
BoC : Berth Occupancy
BU : Berth utilisation
TGS : TEU per ground slots
SU : Storage utilisation

DT : Dwell time

ε : Error term (assumed to be normally distributed, independent, random and identical

The respective coefficients ($\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7, \beta_8, \beta_9, \beta_{10}$ *and* β_{11}) are multipliers showing the individual effects on respondent variable. Similarly, β_0 is the constant from which the dependent variable CTP is predicted when the independent variables are equal to zero. Furthermore, the positive and negative signs on coefficients indicate the directions of the effect. The positive and negative signs explain the extent the dependent variable CTP increases or decreases respectively when the independent variable increases by one unit while holding other independent variables constant (PUL Web, 2007).

The model was analysed using p-value value of the F-statistic for the model representing all variables jointly and r^2 value. According to Schopohl (2014) and Brooks (2008) the null hypothesis H_0 is rejected when the p-value is less than 0.05 and the argument would be made in favour of the alternative hypothesis. The significance of the model and other statistical tests for multicollinearity and model fitness and goodness were carried out. Moreover, analysis on causality on causal relationship and factors affecting DSM GCCT productivity was done. The causal relationships analysed the long-run and or short-run relationship between the respondent variable (CTP) and respective explanatory (predictor) variables. On the other hand, the factors affecting DSM GCCT productivity was done by analysing the coefficients of the model predictors against the respondent variables.

4.0 Results and discussion

4.1 DSM GCCT productivity model

The productivity factors TN, CMPH, TQE, SU and DT are correlated to CTP. According Udovičić et al (2007) asserts that correlation is mainly for examining the relationship between two variables and not the cause; however, it forms the base for causal analysis. Therefore, the productivity factors TN, CMPH, TQE, SU and DT and CTP were used in developing the DSM GCCT productivity model.

The model $\text{CTP} = \beta_0 + \beta_1\text{TN} + \beta_2\text{CS} + \beta_3\text{CMPH} + \beta_4\text{TQE} + \beta_5\text{SU} + \beta_6\text{DT} + \varepsilon$ was regressed and found to be jointly significant. On the other hand, the coefficient of determination r^2 = 99.97 percent is very high implying that the model has some explanatory power. However, most of t-values with their respective p-value higher than 0.05 are not significant despite of having very high r^2; and only the t-values for CMPH and TQE are statistically significant. Else, some of the coefficients of the explanatory variables such as TN, CS, TQE, SU and DT seem to be inflated. These inconsistencies suggest that some of the explanatory variables depend on each other and multicollinearity exists. This desirable $\text{VIF} \leq 2.5$ was considered in this study (Allison, 2012) and the model was $\text{CTP} = \beta_0 + \beta_1\text{TN} + \beta_2\text{CS} + \beta_3\text{CMPH} + \beta_4\text{DT} + \varepsilon$.

4.1.1 Test for fitness and goodness of the model

The model $\text{CTP} = \beta_0 + \beta_1\text{TN} + \beta_2\text{CS} + \beta_3\text{CMPH} + \beta_4\text{DT} + \varepsilon$ at $\text{VIF} \leq 2.5$ was tested for fitness and goodness using the two approaches known as diagnostic checking and white noise test. The p-values for Skewness/Kurtosis (0.0006) and Shapiro-Wilk-W (0.00802) tests for normality were less than 0.05 which implies that; there is some evidence to reject the null hypothesis which says 'residuals are normally. Then the variables were transformed using Box-Cox transformation with λ = 1.207322 (Osborn, 2010 and Viélez et al, 2015).

i. Test for fitness and goodness of the model after Transformation

The transformed model is

$CTP = \beta_0 + \beta_1 TN + \beta_2 CS + \beta_3 CMPH + \beta_4 DT + \varepsilon$, which satisfied the conditions for diagnostic checking and white noise test. The diagnostic checking were satisfied because the p-values for Skewness/Kurtosis (0.4971) and Shapiro-Wilk-W (0.10226) tests for normality were greater than 0.05 which implies that; there is no evidence to reject the null hypothesis that 'residuals are normally distributed'; the p-values for Breusch (0.2010) test for heteroscedasticity is greater than 0.05 which implies that; there is no enough evidence to reject the null hypothesis which says 'residuals are homoscedasticity'; the p-values for Durbin's alternative (0.3355) and Breusch-Godfrey (0.3141) tests for autocorrelation are greater than 0.05 which implies that; and there are no enough evidence to reject the null hypothesis which says 'residuals have no serial correlation'. Similarly, the white noise test were satisfied because the p-values for Portmanteau test for white noise (0.0628) is greater than 0.05 which implies that; there is no evidence to reject the null hypothesis which says 'residuals are white noise' meaning that residuals are not correlated, not heteroscedasticity, residuals are randomly distributed and they are stationary; and residuals are white noise because P-value (0.7937) for Bartlett's (B) statistics is greater than 0.05 therefore cannot reject the null hypothesis that 'residuals are random and independent'.

4.1.2 Causality analysis of DSM GCCT productivity model predictors

4.1.2.1 Causality analysis relationships

It has been observed that the variables are cointegrated, and there are two cointegration. Therefore VECM was used to analyse whether the relationship among variables are significant and have long-run and or short-run relationships. Results in Table 4.1 shows P>(t) = 0.963 for CEI-L1; which is higher than 0.05, so cannot reject the null hypothesis that coefficient (0.77895) for CEI-L1 is zero meaning that zero is inclusive in the 95% confidence intervals (-3.257952 and 3.413742). Therefore, there is no long-run relationship between the explanatory variables (TN, CS, CMPH and DT) and the respondent variable (CTP).

The short-run causality for the coefficient of lagged difference in Table 4.2 indicate that the P-values for TN (0.9397), CS (0.3334), STT (0.7121) and DT (0.9266) were higher than 0.05, so, cannot reject the null hypothesis that variables are zeros. Therefore, there is no short-run relationship between the explanatory variables (TN, CS, CMPH and DT) and the respondent variable (CTP).

Table 4.1: Causality of GCCT productivity model

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
D_CTP						
_ce1						
L1.	.077895	1.701994	0.05	0.963	-3.257952	3.413742
CTP						
LD.	-1.173731	2.192496	-0.54	0.592	-5.470944	3.123482
TN						
LD.	.0132453	.1750396	0.08	0.940	-.3298259	.3563166
CS						
LD.	-3463.712	3580.656	-0.97	0.333	-10481.67	3554.245
CMPH						
LD.	5935.503	16085.74	0.37	0.712	-25591.96	37462.96
DT						
LD.	-510.0303	5536.308	-0.09	0.927	-11360.99	10340.93
_cons	1252.179	7480.146	0.17	0.867	-13408.64	15913

Sources: Stata Output

Table 4.2: Test for Short-run Causality

```
. test ([D_CTP]: LD.TN)

 ( 1)  [D_CTP]LD.TN = 0

           chi2(  1) =    0.01
         Prob > chi2 =    0.9397

. test ([D_CTP]: LD.CS)

 ( 1)  [D_CTP]LD.CS = 0

           chi2(  1) =    0.94
         Prob > chi2 =    0.3334

. test ([D_CTP]: LD.CMPH)

 ( 1)  [D_CTP]LD.CMPH = 0

           chi2(  1) =    0.14
         Prob > chi2 =    0.7121

. test ([D_CTP]: LD.DT)

 ( 1)  [D_CTP]LD.DT = 0

           chi2(  1) =    0.01
         Prob > chi2 =    0.9266
```

Sources: Stata Output

4.1.2.2 Causality analysis of factors affecting DSM GCCT productivity

Results from Table 4.3 are from DSM GCCT productivity model presented as $CTP = -31708.29 - 0.0153369TN - 5.268949CS + 7387.606CMPH + 123.3396DT$ (2) The DSM GCCT productivity model has Prob> F = 0.0000 which is less than 0.05, so there is some evidence to reject the null hypothesis which says 'r^2 is zero'. The argument is made in favour of alternative hypothesis that r^2 is not zero; therefore the model has some explanatory power and significant. On the other hand, the coefficient of determination r^2 = .9981 implying that 99.81 percent is explained by TN, CS, CMPH and DT and only 0.19 percent is not explained (error).

Table 4. 3: Regression model output of transformed variables

```
regress CTP TN CS CMPH DT

      Source |       SS       df       MS              Number of obs =      60
-------------+------------------------------           F(  4,    55) = 7053.99
       Model |  2.4356e+11     4  6.0890e+10           Prob > F      =  0.0000
    Residual |   474760586    55  8632010.65           R-squared     =  0.9981
-------------+------------------------------           Adj R-squared =  0.9979
       Total |  2.4404e+11    59  4.1362e+09           Root MSE      =    2938

------------------------------------------------------------------------------
         CTP |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          TN |  -.0153369   .0095864    -1.60   0.115    -.0345485    .0038746
          CS |  -5.268949   161.2858    -0.03   0.974     -328.493    317.9551
        CMPH |   7387.606   76.99924    95.94   0.000     7233.296    7541.916
          DT |   123.3396   257.3571     0.48   0.634    -392.4156    639.0947
       _cons |  -31708.29   2645.389   -11.99   0.000    -37009.77   -26406.81
------------------------------------------------------------------------------
```

Sources: Stata output

The effects of productivity factors (predictors) for DSM GCCT productivity model are expressed by the coefficients of the respective predictors discussed below as follows:-

i. Tonnage (TN)

The P>(t) = 0.115 for TN is higher than 0.05, so cannot reject the null hypothesis that coefficient is zero meaning that zero is inclusive in the 95% confidence intervals (-0.345485 and 0.0038746); when the coefficient is zero implies that the coefficient has no effect on CTP. However, it shows from the model that when TN goes up by one tone, CTP decrease by 0.0153369TEU. This is contrary because by increasing tonnage the expectation is that throughput CTP would increase slightly due to exchangeability between Twenty-foot Equivalent Unit (TEU) and Forty-foot Equivalent Unit (FEU). The inverse proportionality between CTP and TN is contrary to the perspective of the container business in UNCTAD (2015), TPA (2015a, b) and PMAESA (2011). Furthermore, further study should be carried out to investigate the phenomenon.

ii. Container ship (CS)

The P>(t) = 0.974 for CS is higher than 0.05, so cannot reject the null hypothesis that coefficient is zero meaning that zero is inclusive in the 95% confidence intervals (-328.493 and 317.9551). When the coefficient is zero implies that the coefficient has no effect on CTP. However, it shows from the model that when CS increases by one ship, CTP decrease by 5.268949TEU. This is contrary because by increasing number of ships, the expectation is that throughput CTP would increase regardless of the exchangeability between Twenty-foot Equivalent Unit (TEU) and Forty-foot Equivalent Unit (FEU). It was found in literature review that ships have been growing large and large and bigger container ships have been deployed as shown in Figure 1.1 (World Maritime News (2017). On the other hand the phasing out from smaller ships to larger ones (UNCTAD, 2015) replaces the smaller vessels with bigger ones hence in totality reduces the number of ship while increasing the container throughput. This phenomenon at DSM port requires a thorough investigation.

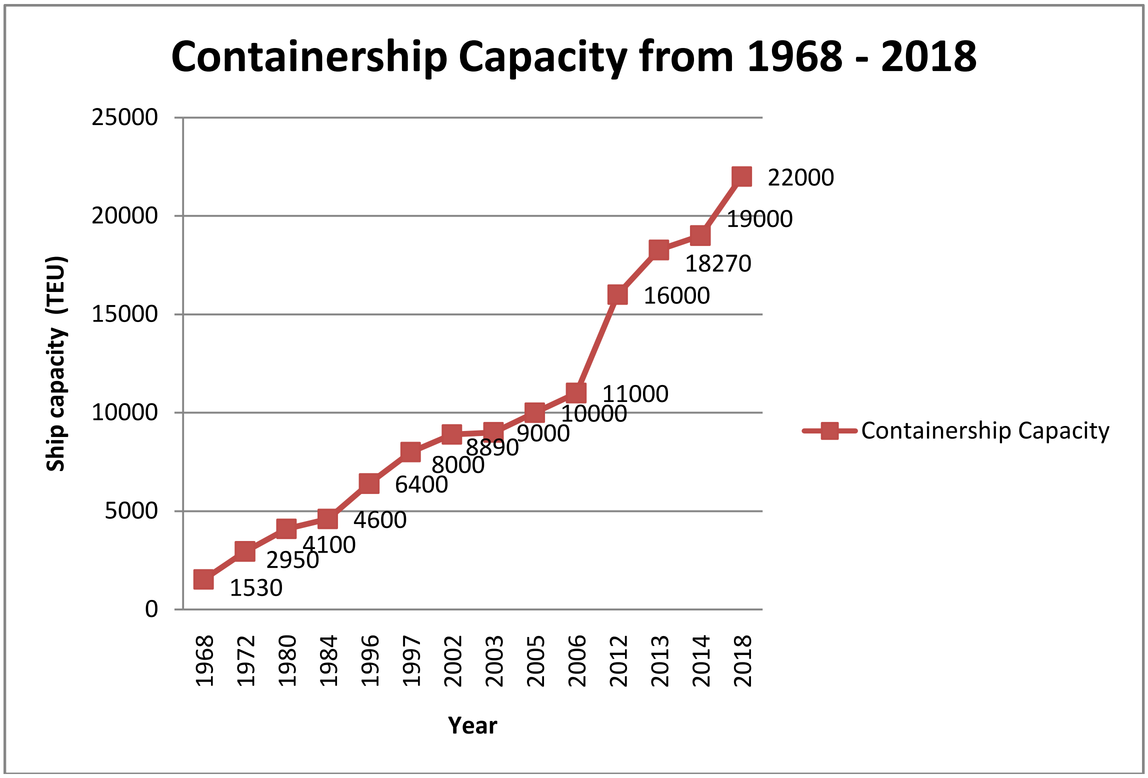

Figure 3. 1: Containership Capacity from 1968 to 2018
Source: World Maritime News- Figure made by Author

iii. Container moves per hour (CMPH)

The P>(t) = 0.000 for CMPH is less than 0.05, so there is some evidence to reject null hypothesis that coefficient is zero meaning that coefficient is different from zero and is not inclusive in the 95% confidence intervals (7233.296 and 7541.916). When the coefficient is different from zero implies that coefficient has effect on CTP. Furthermore, it was revealed from the model that, when CMPH goes up by one container move per hour, CTP increases by 7387.606 TEU. The effect of CMPH1 to dependent variable CTP is enormous. It is obvious that more moves can be performed prior to increase of CTP. According to Djellal and Gallouj (2008) it is important to know how CMPH is measured, types of resources required, how resources are measured and what CMPH level is optimal. Findings by UNCTAD (2015) signify that, ships have grown bigger; the bigger ships carry massive of container at the same time require shorter STT. For GCCT to accommodate these gigantic container ships must have infrastructures and superstructures in order to move container faster as desirable by port Managers across the quay, yard and gate. According to Smith (2012) high automation of CMPH can be managed by accommodating several approaches such as transhipments at the waterside and landside, increase yard storage density and sufficient number of gates. If CMPH is not well managed may result into ships taking long hours at the port and the impact would firstly, shipping line dissatisfactions due to wastage of time (delays) and surcharges. Secondly, dissatisfactions of agents in using port services because of surcharges. Thirdly, loss of market share because of the surcharges spill-over effect to goods from which consumers' wellbeing could be enjoyed when the port could be productive. And fourthly, the Government earn low revenue and hence little or no profit because of unproductively.

iv. Dwell time (DT)

The P>(t) = 0.634 for DT is higher than 0.05, so cannot reject the null hypothesis that coefficient is zero meaning that zero is inclusive in the 95% confidence intervals (-392.4156 and 639.0947). When the coefficient is zero implies that the coefficient has no effect on CTP. However, it shows from the model that when DT goes up by one day, CTP increases by 123.3396TEU. This is contrary because by increasing dwell time of container for one day does not increase throughput CTP. But the opposite is true that when CTP increase likely DT will slightly increase because dwell time is supposed to be kept down as it hampers operation of the port for both import and export reducing port space. So dwell time (DT) does not result in increasing of DSM GCCT throughput CTP rather reduces port flexibility in its operations hence proper management and care as per benchmarks in regard of container dwell time by SUMATRA (2009) and Rankine, (2003).

v. The constant (β_0)

The P>(t) = 0.000 is less than 0.05, so there is some evidence to reject null hypothesis that coefficient is zero meaning that coefficient is different from zero and is not inclusive in the 95% confidence intervals (-37009.77 and -26406.81). When the coefficient is different from zero implies that coefficient has effect on CTP. The effect are obvious when there no cargo (TN = 0), no container ship (CS = 0), no container handled per hour (CMPH = 0) and no or less than one day for container stay at the port (DT = 0); therefore, CTP measured in TEU will severely decrease by 31708.29TEU being average TEU per month. These will reduce government revenue.

In the general as per F>statistics, jointly factors TN, CS, CMPH and DT are crucial for DSM GCCT productivity Model, despite the fact that the model predictors have no long-run and short-run causality to respondent variable. According to Elmakki et al (2017) pointed that, absence of causal relationship is due to weak or inability of the explanatory variable to stimulate the respondent variable. Therefore, the coefficients of the key productivity factors in the DSM GCCT productivity model provide highlights on strategic issues requiring improvement. The issues are in terms of number ships and capacity, tonnage handled at port, the moves performed per hour and the number of days the container stay at the port. The factors if not well managed will lead increasing ship turnaround time, to limited space, inflexibility and loss of potential customer and revenue (PRSA, 2016 and World Bank. 2013).

5.0 Conclusion and Recommendations

This was a descriptive empirical analysis on productivity of container terminal in Tanzania; a case study of Dar es Salaam General Cargo Container Terminal (DSM GCCT). The productivity model for DSM GCCT is $CTP = \beta_0 + \beta_1 TN + \beta_2 CS + \beta_3 CMPH + \beta_4 DT + \varepsilon$ obtained after transforming the variables to meet the statistical conditions for fitness and goodness of the model.

5.1 Conclusion

Using the Vector Error Correlation Method (VECM), it was found that there were neither long-run relationships nor short-run relationships between the explanatory variables (TN, CS, CMPH and DT) and the respondent variable CTP. The absence of causality relationship is due to weak or inability of the explanatory variable to stimulate the respondent variable. The inabilities were interpreted by analysing the coefficient of the DSM GCCT model predictors. The productivity model for DSM GCCT has Prob > F = 0.0000 and coefficient of determination $r^2 = .9981$ which implies that the model is jointly significant and has explanatory power that 99.81 percent is explained by TN, CS, CMPH and DT and only 0.19 percent is not explained (error). The equation for DSM GCCT productivity model is given by:-

$$CTP = -31708.29 - 0.0153369TN - 5.268949CS + 7387.606CMPH + 123.3396DT$$

The predictor TN has no effect on CTP because the coefficient is zero at 95% confidence intervals (-0.345485 and 0.0038746). So when TN goes up by one tone, CTP decreases by 0.0153369TEU. This is contrary because by increasing tonnage, the expectation is that throughput CTP would increase slightly due to exchangeability between Twenty-foot Equivalent Unit (TEU) and Forty-foot Equivalent Unit (FEU). The inverse proportionality between CTP and TN is contrary to the perspective of the container business.

The predictor CS has no effect on CTP because the coefficient is zero at 95% confidence intervals (-328.493 and 317.9551). So when CS increases by one ship, CTP decreases by 5.268949TEU. This is contrary because by increasing number of ships, the expectation is that throughput CTP would increase regardless of the exchangeability between Twenty-foot Equivalent Unit (TEU) and Forty-foot Equivalent Unit (FEU). It was found in literature review that ships have been growing larger and larger so one of the reasons could be the phasing out from smaller ships to larger ones. The replacement of smaller vessel with bigger reduces the number of ships and not throughput.

The predictor CMPH has effect on CTP because the coefficient is not zero at 95% confidence intervals (7233.296 and 7541.916). So when CMPH goes up by one container move per hour, CTP1 increases by 7387.606 TEU. The effect of CMPH to dependent variable CTP is substantial; bigger ships carry massive number of container at the same time require shorter STT which can be minimised by increasing the number of container moves per hour (CMPH). For DSM GCCT to accommodate these gigantic container ships must have infrastructures and superstructures in order to move container faster as desirable by port Managers across the quay, yard and gate. High automation of CMPH can be managed by accommodating several approaches such as transhipments at the waterside and landside, increase yard storage density and sufficient number of gates. If CMPH is not well managed may result into ships taking long hours at the port and the impact would firstly, shipping line dissatisfactions due to wastage of time (delays) and surcharges. Secondly, dissatisfactions of agents in using port services because of surcharges. Thirdly, loss of market shares because of the surcharges spill-over effect to goods from which consumers' wellbeing could be enjoyed when the port could be productive. And fourthly, the Government earns low revenues and hence little or no profit because the port is unproductive. Therefore it is important to do timely analysis of CMPH, the required resources and the optimal CMPH level as benchmarked by the industry or stakeholders in container business.

The predictor DT hypothetically has no effect on CTP because the coefficient is zero at 95% confidence intervals (-392.4156 and 639.0947). So when DT goes up by one day, CTP increases by 123.3396TEU. This is contrary because by increasing dwell time of container for one day does not increase throughput CTP. But the opposite is true that when CTP increase, DT will slightly increase, however, dwell time is supposed to be kept down as it hampers operation of the port for both import and export reducing port space. So dwell time (DT) does not increase container terminal throughput (CTP) rather reduces port flexibility in its operations and can results into port being unproductive. Hence proper management and care as per benchmarks in regard of container dwell time is necessary.

Moreover, the constant $\beta_0 = -31708.29$ has effect on CTP because the coefficient is not zero at 95% confidence intervals (-37009.77 and -26406.81). So when there is no cargo (TN = 0), no container ship (CS = 0), no container handled per hour (CMPH = 0) and no container stay at the port (DT = 0), CTP measured in TEU will severely decrease by 31708.29TEU being average TEU per month. These will reduce government revenue.

Generally as per F>statistics, the jointly productivity factors TN, CS, CMPH and DT are crucial for DSM GCCT productivity Model, despite the fact that the model predictors have no long-run and short-run relationships to respondent variable CTP. The absence of long-run and short-run relationships is due to weak or inability of the predictor variable to stimulate the respondent variable. The weakness and inability of the predictor variable are reflected firstly; from the controversy that TN and CS predictors are decreasing while respondent variable CTP is increasing. The increase in TN and CS are expected to directly increase CTP but for this case is not. However, because ships have grown bigger, the call of bigger ships at DSM port could cause a slight decrease in CS while increasing CTP, but this is not the case to DSM port due to draft limitations. Secondly, it is the fact that the CMPH and DT predictors are increasing directly proportion to increase in CTP while the port is congested and succumbed with delays. The increase in CMPH is substantial but not desirable to reduce ship turnaround time and the increase in DT makes container stay longer at the port before cleared for export or imports. Nevertheless, all the coefficients of the key productivity factors provide highlights on strategic issues requiring improvement. The issues are in terms of number ships calling at DSM port and their respective capacity capacities, tonnage handled at port, the moves performed per hour and the number of days the container stay at the port. The factors if not well managed will lead to increasing ship turnaround time, to limited space, inflexibility and loss of potential customer and revenue.

5.2 Recommendations

The study recommends that, review and or put in place policies on strategic issues related to terminal operations, productivity and investments. Similarly, carry out further studies to incorporate all productivity factors in the container terminal model, Productivity factors from the quay, yard, gate and cost effective areas such as truck turnaround time, horizontal transport turnaround time, revenue per TEU, TEU per man hour, labour cost per TEU and capital equipment cost per TEU.

References

Spector, P.E. (2005). Research Methods in Industrial and Organisational Psychology: Data Collection and Data Analysis with Special Consideration to Internal Issues. In Anderson et al(Eds.), *Handbook of Industrial Work and Organisational Psychology (1:10-89).* London: Sage Publications.

Beškovnik, B.(2008). Measuring and increasing the productivity model on Maritime. Pomortvo, god.22, br.2 (2008), str.171-183.

Creswell, J.W. (2014). *Research Design, 'Qualitative, Quantitative, and Mixed Approaches'*.(4th ed.). Loss Angeles.London.New Dell.Singapore.Wahington DC. Sage Publications, (Chapter 7).

Esmer, S. (2008), *Performance Measurement of Container Terminal Operations.* Maritime Business and Administration School. Dokuz Eylul University pp. 1 - 141.

Brooks, C. (2008). *Introductory, Econometrics for Finance.* (3rd .ed). The ICMA Centre, Cambridge University Press. 669pp.

Djellal, F. and Gallouj, Faïz. (2008). *Measuring and improving productivity in Services Issues. Strategies and Challenges*. Edward Elgar, Cheltenham, UK · Northampton, MA, USA. pp261.

Elmakki, A., Bakari, S. and Mabrouki, M. (2017). The Nexus between Industrial Exports and Economic Growth in Tunisia: Empirical Analysis. [Online] Available: https://mpra.ubub.uni-muenchen.de/79360 (June 15, 2017).

Haralambides, H., Veldmanb S. Van Drunenb E. And Liu M. (2011). Determinants of a Region Port-Centric Logistics Hub; the case of East Africa. *Maritime Economics & Logistics*.13(1):78-97.

Henesey, L.E (2004). *Enhancing Container Terminal Performance: A multi Agent System Approach*. Blekinge Institute of Technology S-37179 Karlskorona Sweden. 135pp.

Lu, B. and Park, N.Y. (2013). Sensitivity Analysis for Identifying the Critical Productivity factor of the Container Terminal. *Journal of Mechanical Engineering*. 59(9):536-546.

Osborne, J.W. (2010). Improving your data Transformation: Applying the Box-Cox Transformation. *A Practical Assessment, Research and Evaluation*. 15(12):1-9.

Port Management Association of Eastern South Africa (2011). *Study on Development of Port Statistics and Performance Indicators in PMESA Ports*. Final Report. Trade Mark Southern Africa. pp. 1 - 141.

Ports Regulatory of South Africa (2016). *Benchmarking report: SA Port Terminal (2015/2016).* Burban South Africa. [Online] Available: https://www.portsregulator.org/images/documents/SA-port-benchmarking-report-2015-16.pdf (August 22, 2017).

Rankine, G. (2003). Benchmarking Containership Terminal Performance. Container

Port Conference Rotterdam, February, 2003.18pp. [Online] Available: http://beckettrankine.com/wp-content/uploads/2003/Benchmarking%20container%20terminal%20performance.PDF (March 9, 2017).
Princeton University Library (2007). Data and Statistical Services. [Online] Available: http://dss.princeton.ed/online_help/analysis/interpreting_regression.htm (June 20, 2017).
Schopohl, L. (2014). *Stata Guide to Accompany Introductory Econometrics for Finance.* Cambridge University Press © Chris Brooks (2014).175pp.
Smith, D. (2012). Container Port Capacity and Utilization Metric – Diagnosing the Marine Transportation System. The Tioga Group. [Online] Available: Inc. www.tiogagroup.com/215-557-2142] (August 9, 2017).
Surface and Marine Transport Regulatory Authority (2009). Report on Port Performance Indicators and Benchmarks. 53pp. [Online] Available: https://www.sumatra.go.tz/index.php/publications-statistics/performance-indicators-and-benchmarks (June 9, 2017).
Tanzania Ports Authority (2011). Corporate Strategic Plan 2011/12 – 2015/16.
Tanzania Ports Authority (2015a). Quick Facts about Dar es Salaam Port; The Hub of East African Trade.
Tanzania Ports Authority (2015b). Dar es Salaam Port Hand Book.
Udovičić, M., Bažadarić, K., Bilić-Zulle, L. and Petrovečki, M. (2007). What we need to know when calculating the coefficient of correlation?. *Biochemia Medica*. 17(1):10-15.
United Nations Conference on Trade and Development (1976*). Port Performance Indicators UNCTAD*. TD/B/C.4/131/Supp.1/Rev.1. 27pp.
United Nations Conference on Trade and Development (2015). *Review of Maritime Transport*. Report by the Secretariat United Nations, New York and Geneva.
Viélez, J.I., Correa, J.C. and Marmolejo-Ramos, F. (2015). A new Approach to the Box-Cox Transformation. *Frontiers in Applied Mathematics and Statistics*. 1(12):1-10
World Bank (2013). Tanzania Economic Update. Opening the Gate; how the port of Dar es Salaam can transform Tanzania. *The World Bank Africa Region Poverty Reduction and Economic Management*. Issue 3.76pp. [Online] Available: http://www.worldbank.org/tanzania/economicupdate (August 14, 2014).
World Maritime News (2017). Inforgraphic: 50 Years of Containership Growth. [Online] Available: http://worldmaritimenews.com/archives/155866/infographic-50-years-of-containership (June 30, 2017).