

**FORECASTING CONSUMPTION AND SUBSTITUTION OF SAWNWOOD
PRODUCTS IN THE BUILDING INDUSTRY IN DAR ES SALAAM CITY,
TANZANIA**

JOSEPH EXAUD MGANA

**A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE
REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN
FORESTRY OF SOKOINE UNIVERSITY OF AGRICULTURE,
MOROGORO, TANZANIA.**

2013

ABSTRACT

The future consumption and substitution of wood products in the building industry is not well analyzed and examined hence demand for wood in the industry remain uncertain. The study on forecasting consumption and substitution of sawnwood in building industry was carried out in Dar es Salaam city. Consumption forecasts of sawnwood for years 2016, 2021 and 2026 were determined through income elasticity of demand forecasting model. The sampling unit was obtained from a list of wards, building contractors and architects in Dar es Salaam city. Random sampling with replacement was employed with an intensity of 20% - 100% depending on the population, availability of respondents and willingness to respond. Questionnaires were used to obtain data from interviewees. Statistical data of sawnwood and substitute building materials were recorded in data sheets. Data collected were analyzed using SPSS and MS Excel programmes. The consumption of sawnwood and substitute building materials were assessed in doors and windows. Buildings were categorized into Lower, Medium, and High categories. The lower category involved all none storey buildings and consumed an average of 2.69 m³ per building unit while medium category (1-3 storey) consumed 3.1 m³ of sawnwood per building unit. The last category involved buildings with 4 storeys and above which according to the results consumed an average of 5.3 m³ of sawnwood per building unit. The study show that in year 2011, Dar es Salaam consumed a total of 8,706.9 m³ of sawnwood for doors and window frames in about 2878 building units that were built in that same year. Kinondoni district consumed 42.2% of the total sawnwood while Ilala district consumed 34.8% of total sawnwood and Temeke district consumed 23%

of the total sawnwood consumed in windows and doors in Dar es Salaam city in the year 2011. The per capita building consumption of sawnwood for Dar es Salaam in 2011 was estimated to be 2.7 m³ while for aluminium was 46.2 m². Sawnwood substitution was highly observed in windows compared to doors with aluminium being the main substitute material. The per capita building consumption of sawnwood in 2026 is estimated to be 3.4 m³ which is an increase of 23.4% compared to 2.7 m³ observed in year 2011. For aluminium, per capita consumption for 2026 will be about 86.8 m² which is an increase of 88% compared to 46.2 m² which was observed in year 2011. Sawnwood consumption in none storey buildings will still grow fairly fast because majority of the buildings in urban centers particularly Dar es Salaam are being built by low and middle income people for residential purposes. Therefore, the commercially unknown and underutilized sawnwood species need to be publicized on their strength properties, resistance to weather and durability for future consumption in the building industry.

DECLARATION

I, Joseph Exaud. Mgana, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor being concurrently been submitted for a degree award to any other institution.

Joseph Exaud Mgana

(MSc Candidate)

Date

The above declaration is confirmed

Professor Yonika. M. Ngaga

(Supervisor)

Date

COPYRIGHT

No part of this dissertation may be reproduced, stored in any retrieval system, or transmitted in any form or by any means without prior written permission of the Author or Sokoine University of Agriculture in that behalf.

ACKNOWLEDGEMENTS

First and foremost I would like to thank the Lord Almighty God for my wellbeing and strength during the whole period of my study at Sokoine University of Agriculture.

I would like to convey my deepest gratitude to the Belgium Technical Corporation (BTC) for the financial support without which my two years study at SUA could have not been possible.

I am deeply grateful to my supervisor Prof. Y.M. Ngaga from the Department of Forest Economics for his guidance, positive criticisms and comments throughout the preparation and write-up of this dissertation. His diligent efforts in giving challenging advice have made the completion of this study possible. Regardless of having tight schedule, he always had time for my work. May God grant him with all the favour.

Special thanks are also extended to Municipal Engineers of Dar es Salaam Region for releasing their information and direction on how to collect information from Building contractors and construction sites. I also thank Mr. David Solomon and all the wards executives for their assistance in data collection even in difficult raining conditions.

I am also indebted by the Construction Registration Board (CRB), Engineers Registration Board (ERB), Architects and Quantity Surveyors Registration Board (AQSRB) for providing me with registered experts and their contacts which enabled

me to reach them without any resistance. Lastly, I would like to thank Mr. Grayson Nyamoga for devoting his time and resources to the fulfillment of this dissertation.

TABLE OF CONTENTS

ABSTRACT	ii
DECLARATION.....	iv
COPYRIGHT	v
ACKNOWLEDGEMENTS.....	vi
TABLE OF CONTENTS.....	viii
LIST OF TABLES	xiii
LIST OF FIGURES	xv
LIST OF PLATES	xvi
LIST OF APPENDICES	xvii
LIST OF ABBREVIATIONS AND SYMBOLS	xviii
CHAPTER ONE	1
1.0 INTRODUCTION.....	1
1.1 Background Information	1
1.2 Problem Statement and Justification.....	2
1.3 Objectives.....	4
1.3.1 General Objective	4
1.3.2 Specific Objectives.....	4
1.4 Research Questions	5
CHAPTER TWO	6
2.0 LITERATURE REVIEW.....	6

2.1 Forest industry capacity and employment	6
2.2 Building and construction industry	8
2.3 Factors contributing to the increase in wood consumption.....	9
2.3.1 Economic growth	10
2.3.2 External trade	11
2.3.3 Growth in construction industry.....	11
2.3.4. Population growth	12
2.4 Consumption forecasting	12
2.4.1 Forecasting techniques	12
2.4.1.1 Time series methods.....	13
2.4.1.1.1 Single moving average.....	13
2.4.1.1.2 Single exponential smoothing	13
2.4.1.1.3 Linear moving average.....	14
2.4.1.1.4 Brown's one parameter linear exponential smoothing	14
2.4.1.1.5 Holt's two-parameter linear exponential smoothing.....	15
2.4.1.1.6 Winter's linear and seasonal exponential smoothing.....	16
2.4.1.2 Auto regressive model (AR)	17
2.4.1.3 Moving average model (MA).....	17
2.4.1.4 Mixed autoregressive moving average model (ARMA).....	18
2.4.1.5 Causal forecasting methods	18
2.4.1.5.1 Simple regression methods	18
2.4.1.5.2 Multiple regressions	19
2.4.1.6 Econometric models.....	20
CHAPTER THREE	21

3.0 METHODOLOGY	21
3.1 Description of the study area	21
3.1.1 Location	21
3.1.2 Area, climate and landforms	21
3.1.2.1 Area.....	21
3.1.2.2 Climate	21
3.1.2.3 Population	22
3.1.3 Socio- economic activities	22
3.2 Data collection	23
3.2.1 Sampling procedure	23
3.2.1.1 Primary data collection	24
3.2.1.2 Questionnaires.....	25
3.2.1.3 Direct observation	25
3.2.1.4 Checklists and Key Informants	26
3.2.2 Secondary data collection	26
3.3 Data analysis	26
3.3.1 Wood products consumption forecast.....	27
3.3.1.1 Smoothing (average) technique	27
3.3.1.2 Income elasticity of demand model	28
 CHAPTER FOUR	 29
 4.0 RESULTS AND DISCUSIONS	 29
4.1 Consumption of building materials for doors and windows in 2011	29
4.2 Responses on sawnwood substitution in the building industry.....	41

4.3	Sawnwood products use in building Industry	48
4.4	Sawnwood availability	50
4.5	Sawnwood preference and demand in building industry in Dar es Salaam city..	52
4.5.1	Sawn wood prices in Dar es Salaam city	54
4.5.2	Doors and windows prices	58
4.5.2.1	Sawnwood doors and windows.....	59
4.5.2.2	Aluminium doors and windows	60
4.5.2.3	PVC windows and doors.....	62
4.6	Factors underlying sawnwood substitution in the building industry	63
4.7	Future sawnwood consumption in Dar es Salaam City	65
4.7.1	Population	65
4.7.2	Economic attributes.....	66
4.7.3	Urbanization rate.....	67
4.8	Forecast models chosen	68
4.8.1	Time series Models	68
4.8.2	Income elasticity of demand model	69
4.9	Forecasted sawnwood consumption.....	72
4.9.1	Forecasting substitution	75
4.9.2	Total sawnwood consumption in the future.....	76
	CHAPTER FIVE.....	79
	5.0 CONCLUSION AND RECOMMENDATIONS.....	79
5.1	Conclusion	79
5.2	Recommendations	80

REFERENCES	82
APPENDICES	90

LIST OF TABLES

Table 1: Natural forest area and harvesting potential in selected regions	7
Table 2: Employment statistics in construction and other sectors in Tanzania for year 2005.....	8
Table 3: Consumption of sawnwood and substitute building materials in different building categories.....	32
Table 4: Per capita consumption of sawnwood in building units from 2009- 2011	34
Table 5: Consumption of Sawnwood and Aluminium per district from year 2009-2011	36
Table 6: The trend of consumption of sawnwood and aluminium in doors and windows in different building categories.....	39
Table 7: Estimates by respondents on percentage range on aluminium application and preferences	44
Table 8: Estimates by respondents on sawnwood substitution range in the building industry.....	46
Table 9: Response on percentage estimates for sawnwood substitution in different building categories.....	48
Table 10: Response on sawnwood use preferences	49
Table 11: Sawnwood availability in Dar es Salaam	51
Table 12: Responses on sawn wood demand in building and construction industry in Dar es Salaam city.....	54
Table 13: Retail prices for hardwood sawnwood in Dar es Salaam city	55

Table 14: Stability of sawnwood prices in Dar es Salaam city	57
Table 15: Market price estimates for Pterocarpus angolensis and Afzelia quanzensis sawnwood doors and window frames	59
Table 16: Sawnwood consumption forecast using time series methods.....	70
Table 17: Sawnwood consumption forecast in building and construction industry for Dar es Salaam from 2012-2026.	71
Table 18: A summary of sawnwood consumption forecasts using different models.....	74
Table 19: Forecast of Aluminum Consumption based on IED.....	77
Table 20: Total sawnwood consumption using different forecasting models	78

LIST OF FIGURES

Figure 1: Response awareness on presence of sawnwood substitution in the building industry	41
Figure 2: Building materials substituting sawnwood in doors and window frames	42
Figure 3: Responses on preferences for aluminium substitution	43
Figure 4: Responses on aluminium availability in Dar es Salaam city	45
Figure 5: Responses on sawnwood availability in Dar es Salaam city.....	52
Figure 6: Sawnwood preferences in building industry in Dar es Salaam city	53
Figure 7: Differences between real and current market prices of sawn hardwood species in Dar es Salaam Market	57
Figure 8: Sawnwood doors and windows price changes from 2008-2011	60

LIST OF PLATES

Plate 1: Mar-kim Uni Plast Co. Ltd and workshop located in Dar es Salaam city ... 64

Plate 2: Different designs of plastic window frames at Mar-kim Uni Plast
Co. Ltd 64

LIST OF APPENDICES

Appendix I: Questionnaire 90
Appendix II: List of respondents..... 96

LIST OF ABBREVIATIONS AND SYMBOLS

AIDS	Acquired Immune Deficiency Syndrome
AR	Auto Regressive
ARMA	Auto Regressive Moving Average
AQRB	Architects and Quantity Surveyors Registration Board.
BOT	Bank of Tanzania
CRB	Construction Registration Board
DPG	Development Partners Group
DRC	Democratic Republic of Congo
DSM	Dar es Salaam
EPZ	Export Processing Zone
ERB	Engineers registration Board
FAO	Food and Agriculture Organization
FBD	Forestry and Beekeeping Division
FTE	Full Technical Equivalent
GDP	Gross Domestic Products
HIV	Human Immunodeficiency Virus
IED	Income Elasticity of Demand
IMC	Ilala Municipal Council
IMR	Infant Mortality Rate
IPPC	International Plant Protection Convention
KMC	Kinondoni Municipal Council

m ²	Square Metre
m ³	Cubic Metre
MA	Moving Average
MDF	Medium Density Fiberboard
MNRT	Ministry of Natural Resources and Tourism
MR	Mortality Rate
MSE	Mean Square Error
NBS	National Bureau of Statistics
NHC	National Housing Corporation
NSSF	National Social Security Fund
OSB	Oriented Strand Board
PSPF	Public Service Pension Fund
PVC	Poly Vinyl Chloride
SPSS	Statistical Package for Social Science
TAS	Tanzania Shilling
TBA	Tanzania Building Agency
TIC	Tanzania Investment Centre
TMC	Temeke Municipal Council
UNECE	United Nations Economic Commission for Europe
UNHABITAT	United nations Human Settlements Programme
URT	United Republic of Tanzania
USD	United States Dollar
VAT	Value Added Tax

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Wood is one of the world's main building materials which is widely used in housing and construction activities. It can be sawn longitudinally, with or without its natural rounded surface with or without bark to produce sawnwood (IPPC, 2010). The use of wood-based panels and other wood products in construction and building works have shown an increasing trend hence the link between forest industries and building sector becomes evident (Unasyuva, 1971).

In Tanzania, the construction industry contributes more than 10% of GDP while its contribution to employment is reported to be more than 9% of the population (Ujenzisolutions, 2005). Mwampamba (2007) reported that the contribution of the construction industry in Tanzania for three consecutive years 2006, 2007 and 2008 were estimated to be 1 399 609, 1 641 741 and 1 904 420 TAS respectively. Other studies show that the construction sector is one of the fastest growing sector in the economy with an annual turnover of between 1.8 billion - 1.9 billion USD (Dailynews, 2011). Statistics show that construction projects with a total value of 2.8 trillion TAS were registered in 2010, with building works accounting for half of the total value of the projects. The value of the registered building works amounted to 1.4 trillion TAS, while civil works was 884 billion, specialists in electrical 231 billion TAS and electrical works 187 billion TAS (CRB, 2011). It is also estimated that more than 60% of the government budget is spent in the construction sector (ibid).

The growth rate of the construction sector increased between 12 - 15% in 2009/10

compared to that of about 9% in 2008/09 (Tanzaniainvest, 2009). These changes in growth rate were attributed by an increase in the construction of residential and non-residential buildings, roads, bridges and land improvement activities (ibid).

The construction cost per square metre for houses varies dramatically based on site conditions, local regulations, economies of scale and the availability of skilled trade personnel. The rapid expansion of towns as a result of high rate of urbanization and commercial activities indicate an imbalance between the amount of wood products that can be supplied to the consumers and the actual requirements. Similarly, the emerging competition between wood products in the building and construction works with substitute materials like concrete, steel, plastic and aluminium may result into dwindling of wood markets (FAO, 2007).

High quality reconstituted wood based panels such as particle board, medium density fiberboard (MDF) and oriented strand board (OSB) are predicted to reduce the consumption of locally made wood materials from traditional forest industries due to differences in tastes, preferences and quality (FAO, 2007). Forecasting the consumption of wood products under different driving forces is inevitable because many decisions for future development of the forestry sector will depend on the forces that influence the demand and supply of these wood products.

1.2 Problem Statement and Justification

The quality, tastes, and prices of different building materials have resulted into a strong competition in the building sector. Preferences are changing among building

owners and they are switching from one species to the other. Some owners and building companies shift into none wood building materials. The substitution of wood with none wood materials or with different species causes a shifting demand of these building materials. The future consumption and substitution of wood products in building industry is not well analyzed and examined hence demand for wood in the industry remain uncertain.

According to FBD (2011), there are replacements of wood framed ground floor system by concrete slab foundation, applications of roof trusses replacing sawnwood, plywood substituting sawnwood in roof sheathing and sub flooring, premature poles used in the formwork being replaced by metal poles and the use of aluminium to replace timber in door and window frames. Also, consumers have shifted into diverse species comprising of soft wood and lesser known hardwood species which were previously underutilized and ignored (Machumu, 2008; Zziwa *et al.*, 2006b; Ishengoma *et al.*, 2004). The consequences of these substitutions in the building sector are the decrease in the use of wood products in the sector and also reduced efforts of planting trees and weakening the local wood industries.

The increase in demand for sawnwood in building industry will depend on the efficiency of the wood working industry and its ability to face competition from substitute materials and in this respect research and promotion will have to play an important role (Unasyuva, 1971). Forecasting consumption and substitution in the building sector can be an efficient way of discovering the future consumption behaviour of wood products, the level of substitution and its consequences in the sector and to the forest industry at large.

Despite of the importance of the building sector in Tanzania, little information is available on future demand for wood products and its associated consequences as a result of substitution by other materials. The study on the forecasting consumption and substitution of wood products in this sector provides an insight on wood products market situations and the general trends in the market. This information is useful to stakeholders such as tree growers, wood traders and other stakeholders closely related to the forest sector. Findings from this study will serve as a basis for promoting use of wood products by designers and builders. Moreover, findings on substitute building materials may stimulate trades and promote local industries as well as contributing to environmental and forest conservation. The study also provides some insights on the future consumption of sawnwood products and the rate of substitution in the building industry in Dar es Salaam.

1.3 Objectives

1.3.1 General Objective

The general objective of this study was to investigate substitution of wood products and forecast its consumption in the building industry in Dar es Salaam city, Tanzania.

1.3.2 Specific Objectives

The specific objectives were to:

- i. Estimate the present consumption of sawnwood products by the building industry.
- ii. Identify and assess the types of sawnwood products and areas being

substituted, and the level of substitution in the building industry.

- iii. Identify factors underlying substitution of sawnwood products by other materials in the building industry.
- iv. Forecast future consumption of wood products by the building industry.

1.4 Research Questions

To answer the above specific objectives, the study was guided by the following research questions:

- i. What is the present consumption of sawnwood products in the building industry in Dar es Salaam?
- ii. What sawnwood products are substituted in the building industry and why?
- iii. What is the level of substitution and factors underlying these substitutions?
- iv. What is the future consumption of wood products by the building industry?
- v. What are the potential threats or benefits resulting from these substitutions?

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Forest industry capacity and employment

Tanzania has a total production forest area of about 23.8 million ha (FBD, 2011). The annual harvestable volume per annum in the existing production forests is estimated to be about 87.7 million m³ while the annual volume harvested from natural forests in each district is between 1200-2400 m³ giving an estimate of 84 000 – 168 000 m³ of hardwood logs produced annually (ibid). The forest inventory report from 13 regions of Tanzania (Table 1) show that there is enough harvestable volume in the forest though it is largely from lesser known and commercially unknown species (FBD, 2005).

The forest based industry in Tanzania is largely dominated by sawmills, furniture manufactures and other value added wood product manufactures (FBD, 2011). According to MNRT (2005), the country had about 367 sawmills in year 2005 with the installation capacity of 2 203 703m³ for softwood logs and 458 482 m³ of hardwood logs per annum. However, its utilization capacity has not even reached half of the installation capacity. Most of these sawmills are reported to be small scale with input not exceeding 5000 m³ of logs and providing employment for only 5-8 skilled and unskilled employees per sawmill (ibid).

Table 1: Natural forest area and harvesting potential in selected regions

Region	Total Area, ha	Harvestable area, ha	Harvestable net volume, m³
Morogoro	426 188	343 451	61 101 525
Mbeya	43 258	40 754	22 520 525
Rukwa	2 799 050	2 519 144	11 816 532
Tanga	72 589	58 071	9 180 515
Lindi	206 751	186 075	2 165 024
Kagera	223 676	178 941	1 935 640
Ruvuma	143 234	126 480	1 884 743
Tabora	368 356	294 684	982 014
Dodoma	8 225	6 580	742 421
Coast	19 142	17 147	588 584
Kigoma	130 981	104 785	573 061
Iringa	1 206	965	101 535
Shinyanga	16 000	12 800	45 056
Total	4 458 656	3 872 733	113 637 178

Source: FBD (2005)

Forest sector contribute significantly in the provision of employment in developing countries including Tanzania. FAO (2011) reported that in 2006 Tanzania's forest sector provided an employment of about 15,000 skilled personnel (full technical equivalent). Round wood production employed about 3000 people while wood processing and pulp and paper each employed about 6000 people. On the other hand, DPG (2007) reported that about 1 million rural people are being employed by the forest sector. They further revealed that with proper data collection the statistics may exceed the reported ones. According to FBD (2000), the sector accounted for about 800 000 people including men and women. Milledge *et al.* (2007) found that in

southern Tanzania, 16% of households living adjacent to natural forests benefited from timber trade and logging in 2005.

2.2 Building and construction industry

The building and construction sector in Tanzania is one of the most important sectors that boost the country's economy by transforming various resources into constructed physical, economic and social infrastructure. The construction and other sectors contribute to the creation of economic opportunities such as the ease of market access, increased competition, trade development, tourism and foreign investment, contribution to government revenues and employment opportunities (Tanzaniainvest, 2009). In year 2005, Dar es Salaam region accounted for 43.7% of all the employments provided in construction sector for urban areas while in rural areas the sector provides about 112 326 employments of which 111 320 are males and 1006 females as indicated in Table 2.

Table 2: Employment statistics in construction and other sectors in Tanzania for year 2005

Sector	Dar es Salaam			Other Urban areas			Rural areas		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Construction industry	22 327	0	22 327	28 569	216	28 785	111 320	1006	112 326
Other industries	168 644	124 987	293 631	325 787	279 403	605 190	854 277	432 674	1 306 951
Total	190 971	124 987	315 958	354 356	279 619	633 975	965 597	433 680	1 419 277

Source: Ujenzisolutions (2005)

Wood products substitution in the building and construction industry

Solid wood products (sawnwood and wood based panels) are the potential building materials in most of the countries worldwide (FAO, 2011). The selection of construction materials is determined by among other factors energy, costs, durability and ease of use but these tend to decrease at high levels of income.

Study by FAO (2011) show that substitution of sawnwood has also been driven by the decline in the quality and scarcity of good logs which can produce good quality sawnwood products. Milledge *et al.* (2007) found that in Dar es Salaam, the high urban demand for timber resulted into a depletion of most hard wood and more than 80% of the trees harvested within 20 km of the city were found to be used for house construction or charcoal production.

2.3 Factors contributing to the increase in wood consumption

Most people would like to increase the quantity or quality of the goods they consume. They consume less than they desire because their spending is limited by their income. In the theory of consumer choice, Mankiw (2001) explained that the rate at which a consumer is willing to buy one good for the other depends on the satisfaction that a consumer receives from the goods which he or she is already consuming. On the other hand, Mankiw (2001) and Levin *et al.* (2004) describes that when the price of goods falls, consumer's choices can be impacted by income effect which is the change in consumption that arises because a lower price makes a consumer better off. Also, consumer's choices can be impacted by substitution effect described as the change in consumption which arises because a price change

encourages greater consumption of the goods that has become relatively cheaper. These expiations have been given with assumption that all consumers seek to maximize satisfaction from the combination of goods they wish to consume.

2.3.1 Economic growth

There is a close relationship between growth rate of real Gross Domestic Product (GDP) and the growth rate of consumption of wood based products in the world. According to FAO (2007), countries with high real GDP consume more wood based products compared to those with low growth rate. Asia with a GDP growth rate of 15.8% in 1988-1995 consumed 16.4 % of wood based panels compared to Asia Pacific with real GDP of 8% which consumed 10.2% of global consumption. On the other hand, Africa with a GDP growth rate of 2.2% consumed 1.0% of global consumption. Despite the close relationship between real GDP growth rate and wood based panel consumption, in most cases GDP does not take into account some of the economic activities hence underestimating the growth of economy of a particular country or region.

The construction industry has continued to be one of the fast growing sector contributing significantly in the economic growth despite of the economic hardships experienced in many counties. The Tanzania building industry is currently experiencing a period of growth primarily driven by the recent developments in roads works, housing and mining industries. According to construction registration board (CRB), the construction sector has made an excellent performance in 2011 growing at around 12% of the GDP (Dailynews, 2011).

2.3.2 External trade

Most countries with timber deficiency tend to import wood products to satisfy their local market demand. Countries which are rich in timber resources will expand its market by increasing exports. Study by FBD (2011) show that export of sawnwood in Tanzania increased from 511m³ in 2001 to 310 600 m³ in 2007 while export of poles increased from 905 in 2004 to 31 200 in 2008. However, sawnwood exports from Tanzania are facing challenges in the international market due to poor quality hence mostly are locally or domestically consumed.

2.3.3 Growth in construction industry

Construction of residential and none residential houses remains to be the main activity which requires significant amount of wood based panels, either for concrete frame works, or for flooring, paneling and sheathing (FAO, 2007). FBD (2011) estimated that in Tanzania there are 23 000-24 000 units built annually for both large scale industrial and commercial building activities.

Dar es Salaam continued to register the largest number (76%) of valued construction projects in 2009 compared to other regions. This is an increase of 4.5% when compared to 71% of 2008 (CRB, 2011). Studies show that building and construction industry will continue to grow in urban centres which will cause an increase in demand for construction materials because of the increased number of investments in factories, manufacturing, processing industries and population (Shayo, 2006; FBD, 2011; UN, 2011). It will also increase due to increased newly built office premises, packaging materials and storage facilities.

2.3.4 Population growth

The urban population growth rate in Tanzania is estimated to be around 4.2% which is two times compared to population growth rate in rural areas (FBD, 2011). The rural –urban migrations results into an increased wood consumption for energy, building and construction materials. It is reported that Dar es Salaam has the second highest population growth rate of about 4.3% after Kigoma which has a growth rate of about 4.8%. This is also higher than country's average population growth rate. On the other hand 93.9% of the total region's population in Dar es Salaam lives in urban area (Unhabitat, 2009). The rapid increase in the population leads into growth of building activities and hence demand for building materials.

2.4 Consumption forecasting

Forecasting is defined as quantitative estimates of some specified future conditions or events made as a result of rational study and analysis of available pertinent data (Gregory *et al.*, 1971). There are some elements of uncertainties when economic decisions are made with respect to future events or conditions. Therefore the aim of forecasting is to try to reduce these uncertainties concerning the future conditions or events.

2.4.1 Forecasting techniques

Several techniques which can be used for forecasting future conditions and events exist. In this study different techniques such as time series methods, causal forecasting methods and econometric models have been reviewed.

2.4.1.1 Time series methods

The past history of a subject matter is an important part in application of these methods where by knowing it provides a room for extrapolation of its future behavior. Only variables which need to be forecasted are being explored for its past behavior to suit the models. Smoothing models base their forecasts on the principle of averaging (smoothing) past errors by adding a percent of the error to the percent of the former forecast. These methods differ depending on the way they are being used and the behaviour of data to be forecasted.

2.4.1.1.1 Single moving average

Single moving average forecast for period t is given by:

$$F_{t+1} = X_t/N - X_{t-N+1}/N + F_t \dots\dots\dots (1)$$

Where:

F_{t+1} = The forecast for time t+1.

X_t = The most recent observation.

N = The number of values included in the average.

F_t = Previous moving average.

2.4.1.1.2 Single exponential smoothing

Single exponential smoothing forecast for period t is given by:

$$F_{t+1} = F_t + a (X_t - F_t) \dots\dots\dots (2)$$

Where:

a = the smoothing coefficient (lies between 0 and 1)

F_{t+1} = the forecast for time t+1.

X_t = the most recent observation.

F_t = Previous moving average.

2.4.1.1.3 Linear moving average

The basis of this method is to calculate a second (double) moving average.

Generally, linear moving average can be calculated using the following formulas:

$$S_t' = X_t + X_{t-1} + \dots + X_{t-N+1} / N \dots\dots\dots (3)$$

$$S_t'' = S_t' + S_{t-1}' + S_{t-2}' \dots\dots + S_{t-N+1}', \dots\dots\dots (4)$$

$$A_t = S_t' + (S_t' - S_t'') = 2S_t' - S_t'', \dots\dots\dots (5)$$

$$b_t = 2 / N-1 (S_t' - S_t'') \dots\dots\dots (6)$$

$$\text{The forecast is given by } F_{t+M} = A_t + b_t M \dots\dots\dots (7)$$

Where:

S_t' = Single moving average.

S_t'' = Double moving average

A_t = Base adjustment to a starting point for a forecast.

b_t = Trend in the data at time t.

M = Number of periods ahead to the forecast

2.4.1.1.4 Brown's one parameter linear exponential smoothing

This is one of the linear exponential smoothing methods. The underlying rationale of Brown's linear exponential is similar to that of linear moving averages – using single and double smoothed values. Forecast can be made using the following formulas:

$$S_t' = \alpha X_t + (1-\alpha) S_{t-1}' \dots\dots\dots (8)$$

$$S_t'' = \alpha S_t' + (1-\alpha) S_{t-1}'' \dots\dots\dots (9)$$

$$A_t = 2S_t' - S_t'' \dots\dots\dots (10)$$

$$b_t = \alpha/1 - \alpha(S_t' - S_t'') \dots\dots\dots (11)$$

$$\text{The forecast is given by } F_t + N = A_t + b_t M \dots\dots\dots (12)$$

Where:

S_t' = Single exponential smoothed value.

S_t'' = Double exponential smoothed value.

α = Smoothing coefficient for current smoothed level series

N = The number of values included in the average.

2.4.1.1.5 Holt’s two-parameter linear exponential smoothing

This is another method under linear exponential smoothing. The forecast for Holt’s linear exponential smoothing is found using two smoothing constants (with values between 0 and 1) and the following equations:

$$S_t = \alpha X_t + (1-\alpha) (S_t - 1 + b_{t-1}) \dots\dots\dots (14)$$

$$b_t = \mu(S_t - S_{t-1}) + (1- \mu)b_{t-1} \dots\dots\dots (15)$$

$$\text{The forecast is given by } F_{t+N} = S_t + b_t M \dots\dots\dots (17)$$

Where:

S_t = Exponential smoothing value at time t.

S_{t-1} = Last exponential smoothing value.

μ = Smoothing coefficient analogous to μ ,

b_t = Smoothing trend in the data.

$b_t - 1$ = Smoothed trend of the previous period.

2.4.1.1.6 Winter's linear and seasonal exponential smoothing

Winter's linear and Seasonal exponential smoothing is one of the forecasting methods in time series. The method is capable of dealing with data series that contain a *trend* as well as *seasonal pattern*. This method involves the use of single smoothing parameter, trend smoothing parameter and seasonality smoothing parameter.

The Basic equations for Winter's Linear and Seasonal Exponential Smoothing are:

$$S_t = \alpha X_t / I_{t-L} + (1-\alpha) (S_{t-1} + T_{t-1}) \dots\dots\dots (18)$$

$$T_t = \beta (S_t - S_{t-1}) + (1-\beta) T_{t-1} \dots\dots\dots (19)$$

$$I_t = \gamma X_t / S_t + (1-\gamma) I_{t-L} \dots\dots\dots (20)$$

Where

S_t = Smoothed value of the deseasonalized series at time t

T_t = Smoothed value of the trend at time t

I_t = Smoothed value of the seasonal factor at time t

L = The length of seasonality

β = Smoothing coefficient for trend

α = Smoothing coefficient for current smoothed level series

γ = Smoothing coefficient for seasonality

All smoothing coefficients lies between 0 and 1, and are obtained by trial and error to find the set of values which gives the minimum mean square error (MSE).

X_t / I_{t-L} – Eliminates seasonal fluctuations from X_t . To calculate the value of I_t it first requires to know the value of S_t . The incremental trend $S_t - S_{t-1}$ is weighted with β and the previous trend value T_{t-1} is weighted with $((1-\beta))$ as they appear in equation 2 above.

The forecast relied on winters' method is computed by the following formula;

$$F_{t+m} = (S_t + mT_t) I_{t-L+m} \dots \dots \dots (21)$$

Where m is the number of periods in which the forecast takes place.

2.4.1.2 Auto regressive model (AR)

In this model the current observation depends on a weighted sum of its past values going back to certain number of periods, together with a random disturbance in the current period. The number of past periods included in the model is denoted by p; therefore the process is denoted as AR (p). Auto regressive equation can be presented as follows:

$$y_t = Q_1 y_{t-1} + Q_2 y_{t-2} + \dots \dots \dots Q_p y_{t-p} + \alpha + e_t \dots \dots \dots (22)$$

Where:

y_t = The current observation

Q_1, \dots, Q_p = Autoregressive coefficients

p = number of previous periods included in the model

α = constant term

e_t = an error term at time t

t = the present time

y_t is a p^{th} order autoregressive or AR (p) process

2.4.1.3 Moving average model (MA)

The process y_t in this model is described by a weighted sum of current and lagged random disturbances. The time period referred back for random disturbances is denoted by q giving a process which is MA (q).

The equation of the model can be written as follows;

$$y_t = \mu + e_t + \beta_0 u_t + \beta_1 u_{t-1} + \beta_2 u_{t-2} + \dots + \beta_q u_{t-q} \dots \dots \dots (23)$$

Where;

μ = Constant value

e = random disturbance term

$\beta_0 \dots \beta_q$ = Parameters which may be positive or negative

In short, a moving average process is simply a combination of error terms.

2.4.1.4 Mixed autoregressive moving average model (ARMA)

This model combines Autoregressive and Moving average processes altogether. In this case y_t is a function of both lagged random disturbances and its past values as well as a current disturbance term. The processes AR and MA included in the model are referred as p and q respectively forming (p, q) process.

The equation for the Mixed Autoregressive Moving average Model is presented as follows;

$$y_t = \alpha + e_t + Q_1 y_{t-1} + \beta_0 u_t + \beta_1 u_{t-1} \dots \dots \dots (24)$$

2.4.1.5 Causal forecasting methods

This forecasting method is categorized into simple regression, multiple regression and econometric models.

2.4.1.5.1 Simple regression methods

The technique tries to explain the relationship that exists between dependent and independent variables. These variables can be expressed $Y = f(x)$, which states that

the value of Y (dependent variables) is a function of the value of X (independent variable), and is assumed to be a linear relationship. Simple regression model is represented by the function:

$$Y = a + bX + \mu \dots\dots\dots (25)$$

Where:

Y = dependent variable

X = independent variable

a, b = regression coefficients or parameters to be estimated

μ = disturbance term

2.4.1.5.2 Multiple regressions

This is a causal forecasting method which explains the relationship between a dependent variable and two or more independent variables. Multiple Regression method is expressed in the form of equation as follows:

$$Y = a + b_1 X_1 + b_2 X_2 + \dots\dots\dots b_p X_p + \mu \dots\dots\dots (26)$$

Where:

a, b_1 ... b_p = regression coefficients (parameters to be estimated)

X_1 ... X_p = independent variables

p = number of variables in the equation

μ = disturbance term

In this study Autoregressive and smoothing models will be used for forecasting consumption of wood products in the building and construction industry. This is because the past behavior of the variable is explored to fit in the model. In this case consumption estimates of the previous years in the industry will be explored to fit in the forecasting model.

2.4.1.6 Econometric models

Economic forecasting techniques are based on the concept that changes in economic activity can be explained by a set of mathematical relationships between economic variables. A developed theory on these relationships leads to specification of a mathematical model that expresses the nature of the relationship between the variable to be explained (dependent variable) and a set of explanatory (independent) variables. The parameters of the model will then be estimated on the basis of time series or cross sectional data. The model thus takes the form of an equation (s) that seems to be the best for describing the observed set of relationships and is in conformity with economic theory and statistical analysis. The future values of the dependent variable will then be estimated on the basis of estimated relationships (Gregory *et al.*, 1971).

CHAPTER THREE

3.0 METHODOLOGY

3.1 Description of the study area

3.1.1 Location

Dar es Salaam Region is located between latitudes 6°36' and 7° South and longitudes 33°33' and 39° East. It is bordered by the Indian Ocean on the East and by the Coast Region on the other sides. Administratively, Dar es Salaam is divided into 3 municipalities namely Ilala, Kinondoni and Temeke with 73 wards altogether.

3.1.2 Area, climate and landforms

3.1.2.1 Area

Dar es Salaam has the total surface area of 1800 square kilometers of which 1393 square kilometers is land mass with eight offshore islands, which is about 0.19% of the entire area in Mainland Tanzania. Temeke (786.5 km²) Municipality has the largest land surface area followed by Kinondoni (531 km²) while Ilala (273 km²) has the smallest area (Dar City Council, 2004).

3.1.2.2 Climate

The City experiences a modified type of equatorial climate. It is generally hot and humid throughout the year with an average temperature of 29°C. It experiences the hottest season from October to March where temperature raises up to 35°C.

The city is moderately cool between May and August, with a temperature of about 25°C. The city experiences two main rain seasons; a short rain season from October

to December and a long rain season between March and May. The average rainfall is 1000 mm with the lowest being 800 mm and the highest 1300 mm. Humidity is approximately 96% in the mornings and 67% in the afternoon. The climate is also influenced by the south-west monsoon winds from April to October and north-west monsoon winds between November and March. The City is divided into three ecological zones, which are the upland zone comprising of the hilly areas in the west and north, the middle plateau, and the low lands including Msimbazi valley, Jangwani, Mtoni, Africana and Ununio areas. The main natural vegetation includes coastal shrubs, miombo woodland, coastal swamps and mangrove trees (Dar City Council, 2004).

3.1.2.3 Population

According to 2002 national census, Dar es Salaam had a population of 2 487 288 people. The Tanzania National Bureau of Statistics reported that the population was expected to rise to more than 3 million people by 2011 (NBS, 2006). Its population density is also reported to be 2238 per km² (Unhabitat, 2009).

3.1.3 Socio- economic activities

Dar es Salaam city accommodates about 40% of the total manufacturing industrial units in the country contributing about 45% of Tanzania's gross industrial manufacturing output (Unhabitat, 2009). The city is endowed with a major harbour and is considered to be an epicenter for manufacturing industry. The city attracts commercial and transportation activities from both formal and informal sectors. Increasing rates of unemployment and underemployment plays a great role in the growth of the informal sector and settlements.

3.2 Data collection

Data for this study were collected using questionnaires, one to one interviews as well as direct observation to collect information on the consumption of sawnwood and its substitution in the building industry. Buildings from both residential and non residential areas were sampled to assess the amount of sawnwood and non wood building materials used for construction and the extent of substitution.

3.2.1 Sampling procedure

The sampling was done with replacement depending on the availability of respondents and willingness to respond. From each municipality, records of registered timber traders and furniture makers were obtained. Building contractors and architects were identified through registers obtained from their respective registration boards, while house builders were identified at the building sites. The sample sizes were determined differently depending on the population of the target groups in these municipalities and the ease of accessibility. For small population comprising building contractors and public sector organizations, sample sizes of 100% were considered to increase precision. While in large population comprising traders in building materials a sample size of not less than 30% was considered as recommended by (Openshaw, 1971). In each municipality a list of Wards was prepared and 50% of wards from each municipality were sampled to ensure adequate representation of building categories. The buildings were sampled depending on their categories and the sample size ranged from 20-50% starting from lower to higher categories to increase reliability and precision.

3.2.1.1 Primary data collection

Primary data were collected using questionnaires, data sheets, checklists and direct observation. Sawnwood used and those substituted in building activities were assessed and the amount used were estimated. Sawnwood materials used in doors and window frames were estimated in terms of volumes (m^3). Nonwood building materials such as aluminium were quantified and reported in square meters (m^2). Sawnwood volumes required for 1 m^2 of a window (0.031 m^3) and 1 m^2 of a door (0.071 m^3) were established from different sizes. The volumes were used as standards for other windows and doors assessed in the field. The sizes of windows and doors were measured using measuring tapes. Factors underlying sawnwood substitution were identified from each targeted group using structured and unstructured questionnaires. Residential and none residential categories were the main building strata for this study. However, the main challenge for this building's stratification was the fact that most of the buildings had multiple use ie both residential and commercial purposes.

The classification of the buildings were based on their sizes and purpose to estimate the amount and type of sawnwood products and substitute materials consumed in each category. Furthermore, buildings with 4 storeys and above were under higher category while those with 1-3 storeys were under middle category. The lower category included all none storey buildings.

On the other hand, none residential buildings included commercial, education, health, industries and office buildings. These subcategories were also classified into retail and storey buildings depending on their sizes for easy estimation of sawnwood

products and substitute materials consumed. Sawnwood substitution were assessed in new dwellings and in joinery (doors and windows) to see which areas are significantly substituted and the amount used.

3.2.1.2 Questionnaires

Semi structured questionnaires with both open and closed ended questions were used to acquire both quantitative and qualitative information from each targeted groups. Questionnaires were pretested to municipal engineers of Ilala, Temeke and Kinondoni, National construction council, and Tanzania building agency leading to modification of questions number 10, 11 and 12 in questionnaire 1a to obtain reliable information. Data sheet was pilot tested to different types and size of doors and windows in all categories of buildings to prepare measurement standards for doors and windows respectively. In these questionnaires data on estimates of sawnwood products and building substitution materials, factors underlying sawnwood substitution, species, uses, availability, sources, preferences and prices of sawnwood products and substitute materials were collected.

3.2.1.3 Direct observation

Direct observations were used during the survey and it enabled the researcher to see to what extent substitution of building materials was taking place in the buildings. This was done through visiting the construction sites to the sampled wards and streets. Information on consumption of sawnwood products, species used, and substitute building materials were captured and recorded in special data sheet.

3.2.1.4 Checklists and Key Informants

The key informants in this study were construction engineers, building contractors, house builders, forest officers, town planners, quantity surveyors, site inspectors and land officers. Personal interviews were conducted to acquire more information on quantities, type of permits, size of plots, and building permits issued for previous years. Key informants were selected in a way that they can provide relevant information on rate of consumption and substitution, species used in the building construction and the factors underlying wood substitution in the building and construction activities. Tanzania building agency (TBA) offices which is responsible for building government houses were visited to obtain reliable information on use of sawnwood and other materials used in the buildings.

3.2.2 Secondary data collection

Secondary data on consumption of wood products, substitute building materials and factors underlying wood substitutions and consumption in the building sector were collected from the three municipalities of Ilala, Temeke and Kinondoni. Other secondary information was accessed from different documents available in the municipalities, official publications, reports and journals.

3.3 Data analysis

Both quantitative and qualitative data were, coded, checked and analysed using Statistical Package for Social Sciences (SPSS) and MS-excel computer programme. Verbal responses from key informants were analysed using content analysis to get the meaningful information. The output were summarized in a descriptive statistics

such as frequency, mean and sums especially on the uses, availability, sources, preferences, of wood products and substitute building materials. The mean and sums of quantities of sawnwood products and substituted building materials consumed and prices were also obtained.

3.3.1 Wood products consumption forecast

Forecasting consumption of sawnwood and the substituted materials in the building industry were done. Forecasting for years 2016, 2021 and 2026 were performed using the model that fitted the collected data. Before using any model the forecasting techniques were evaluated to get the appropriate forecasting model.

3.3.1.1 Smoothing (average) technique

Basing on the previous consumption of sawnwood products in the building industry single moving average and single exponential smoothing models were used. Single moving average technique was chosen to compute forecast for future periods because it fits with the limited amount of data obtained from the study. Data requirement for application of single moving average are minimal. The accuracy of this method in computing forecast for future periods is low compared to single exponential smoothing which gives more weight to the recent observations. Recent observations contain more information pertaining the future than older ones and therefore single exponential smoothing takes care of the weaknesses that are shown by single moving average technique. This technique can be developed starting from the single moving average equation as illustrated by Wheelwright and Makridakis (1985).

3.3.1.2 Income elasticity of demand model

Forecasting using income elasticity of demand model (IED) were performed to relate consumption of sawnwood to the population size, income (per capita GDP) and the rate of urbanization of Dar es Salaam city. The method was applied because the relationship required for forecasting future consumption was possible as it was also applied by Machumu (2008) in Arusha and Moshi Municipalities.

Income elasticity of demand model was established first before obtaining the future consumption of sawnwood for Dar es Salaam city. The basic relationship included population sizes, incomes and rates of urbanization which were extrapolated to the targeted years. Population changes over targeted years were extrapolated by the formula below.

$$P_t = P_0 e^{rt} \dots\dots\dots (27)$$

Where:

P_0 = Previous population size

P_t = Population at time t in years

e = Base of natural logarithm (2.71828183)

r = Average annual population growth

t = Time interval in years between two periods

One of the main assumptions in this study was that all the building permits issued by the three Municipalities in Dar es Salaam were implemented and no changes were made in those building plans.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSIONS

4.1 Consumption of building materials for doors and windows in 2011

Results in Table 3 show that a total of 2,078.6 m³ of sawnwood and 23,965.3 m² of aluminium materials were consumed by window frames and doors in the 732 buildings which were assessed. On average, the lower category (none storey) buildings consumed about 2.7 m³ of sawnwood per building while medium buildings (with 1 to 3 storeys) consumed about 3.1 m³ per building. On the other hand higher building category (with 4 storeys and above) consumed about 5.3 m³ per building. The difference in sawnwood consumption between lower building category and medium category is 6.4% while between medium and high building categories is 26.7%. The average consumption of sawnwood per building increased as the number of storeys increased. In other words, the larger the number of storeys the higher the consumption of sawnwood.

The report on the use of wood in housing by Unasyuva (1971) suggested that any amount between 0.5 m³ and 6 m³ of sawnwood per building unit would be a justifiable estimate. This suggestion is mainly for none wood houses with only roof structures, doors and windows made of wood. Apparently, the actual average wood quantities within this range will depend on local conditions (Unasyuva, 1971).

Table 3: Consumption of sawnwood and substitute building materials in different building categories

Building Category	Building units surveyed	Sawnwood consumption (m³)	Sawnwood weighted m³/building unit	Aluminium consumption(m²)	Aluminium weighted m² /building unit
Lower(none storey)	653	1756.6	2.7	16 170.1	24.8
Medium(1-3 storeys)	43	131.6	3.1	2965.1	69.0
High(\geq 4 storeys)	36	190.2	5.3	4830.0	134.2
Total	732	2078.6	2.8	23 965.3	32.7

The average aluminium consumption in the lower building category was estimated to be 24.8 m² per building while in medium building category it was 69.0 m². Also, in the high building category aluminium consumption was averaged to be 134.2 m² per building. Buildings in the medium category consumed more than twice compared to lower category buildings while in high category buildings, consumption of aluminium was equally twice of the medium category and consumed more than five times when compared to lower category buildings. This shows that average consumption of aluminium is higher in high category buildings and decreases significantly in the lower category buildings. Also, the rate of consumption of aluminium between building categories is higher compared to the rate of consumption of sawnwood as shown in Table 3.

Table 4 shows that per capita building sawnwood consumption in 2009, 2010 and 2011 were 2.6 m³, 2.5 m³ and 2.7 m³ respectively. Per capita building consumption in 2010 was low by 6% compared to the previous year and rose by 11% in year 2011. In 2010 there was less number of building units in the highest category which consumes large volume of sawnwood per building compared to the lower categories. Results also show that none storey buildings consumed most of the sawnwood, may be due to the fact that they constituted the majority of the buildings each year. Demand for houses is high for none storey buildings which are mainly occupied by low and middle income earners in the building industry.

Table 4: Per capita consumption of sawnwood in building units from 2009-2011

Building category	Years		2009		2010		2011	
	Sawnwood m ³ /unit	Building units	Sawn wood m ³ /year	Building units	Sawnwood m ³ /year	Building units	Sawnwood m ³ /year	
Lower	2.7	1815	4882.3	1580	4250.3	1439	3870.9	
Medium	3.1	790	2417.4	964	2949.8	1245	3809.7	
High	5.3	121	640.1	86	454.9	194	1026.3	
Total		2726	7939.8	2630	7655.0	2878	8706.9	
Population			3 040 118		3 118 132		3 194 903	
Consumption(m³) per capita (1000)			2.6		2.5		2.7	

Source: Field data 2011, DSM Municipalities, Economic Survey 2006

Note: Municipalities have indicated that between 30%-70% of buildings are in unsurveyed areas therefore no building permits were solicited. A correction factor of 50% was used to get the correct number.

The average per capita consumption of sawnwood and aluminium per year was observed to be high in Ilala with 3.7 m³ of sawnwood and 65.2m² aluminium from year 2009 to 2011 followed by Kinondoni with an average per capita consumption of 2.4m³ of sawnwood and 36.4 m² of aluminium per year while Temeke consumed 1.9 m³ of sawnwood and 23.3 m² aluminium per capita per year (Table 5). However, Kinondoni had the highest average consumption of total sawnwood consumed per year from year 2009 to 2011. It consumed an average of 40.4% of total sawnwood consumed yearly while Ilala consumed 36.3% of sawnwood and Temeke consumed an average of 23.3% of total sawnwood consumed yearly (Table 5). From year 2009-2011 Kinondoni had an average of 1.6% increase of sawnwood consumption each year while Ilala increased its consumption by 0.7% in the first two years and decreased by 2.6% in 2011. This shows that Kinondoni had a fair increase in sawnwood consumption each year compared to Ilala and Temeke municipalities.

On the other hand, results show that Ilala had the highest consumption of Aluminium consumed from year 2009 - 2011 compared to Kinondoni and Temeke (Table 5). Each year, Ilala had an average increase of 1.4% of Aluminium consumption while Kinondoni had an average increase of 0.9% of aluminium consumed each year from 2009 to 2011. This shows that Ilala had 0.5% more average increase of aluminium consumption each year compared to Kinondoni. Sawnwood consumed in Kinondoni district had comparatively more average increase each year than aluminium which was consumed in Ilala.

Table 5: Consumption of Sawnwood and Aluminium per district from year 2009-2011

DESCRIPTION	BUILDING	2009				2010				2011			
	MATERIAL	ILL	TMK	KNDN	TOTAL	ILL	TMK	KNDN	TOTAL	ILL	TMK	KNDN	TOTAL
Population		775 125	940 167	1 324 826	3 040 118	795 209	964 913	1358 004	3 118 126	815 313	988 809	1390 781	3 194 903
Total consumption	SW(m ³)	2913.5	1918	31 08.3	7939.8	2860.1	1748.4	3046.5	7655	3026.3	2006.3	3674.3	8706.9
Percentage (%)		36.7	24.2	39.1	100.0	37.4	22.8	39.8	100.0	34.8	23.0	42.2	100.0
Per1000 capita consumption	SW(m ³)	3.8	2.0	2.3		3.6	1.8	2.2		3.7	2.0	2.6	
Total consumption	AL(m ²)	45194.5	26 512.3	43 945.6	11 5652	48 889.3	22 190.6	46 056.9	117137	61 686.2	27 220.2	58 607.5	147 513.9
Percentage (%)		39.1	22.9	38.0	100.0	41.7	18.9	39.3	100.0	41.8	18.5	39.7	100.0
Per1000 capita consumption	AL(m ²)	58.3	28.2	33.2		61.5	23.0	33.9		75.7	27.5	42.1	

Note: ILL = Ilala, TMK = Temeke, KNDN = Kinondoni , AL = Aluminium, SW = Sawnwood

Consumption of building materials depends on the type of material used, architectural designs and size of the building and its associated parts. Results in Table 6 show that among 8973 assessed doors, 8760 (97.2%) consumed sawnwood and only 223 of the doors (2.8%) consumed aluminium materials. The consumption trend of sawnwood and aluminium materials in windows show that 10 869 (65.1%) windows out of 16 682 were made of sawnwood while 5813 windows (34.9%) were made by aluminium frames. This shows that the number of doors which consumed sawnwood was high in the none storey buildings and decreased gradually towards high building categories while the number of doors which consumed aluminium increased from none storey buildings to high storey buildings (Table 6). On the other hand, sawnwood framed windows decreased significantly from none storey buildings to high storey buildings while aluminium framed doors showed a significant increase (Table 6). This trend of consumption implies that the use of substitute building materials in doors increases moderately from none storey buildings to high storey buildings but with significant increase in window frames.

Results also show that none storey buildings consumed more sawnwood in doors and windows covering 99.9 % and 73.5 % respectively (Table 6). In the medium buildings category (1-3 storeys), 90.1% of the doors consumed sawnwood and the rest (9.9%) consumed aluminium materials. Most of the windows (72.6%) in medium category consumed aluminium materials while 27.4% consumed sawnwood. On the other hand sawnwood consumption in the highest building category covered 90.0% of doors and aluminium covered the remaining 10.0% of the doors (Table 6). Also, 78.2% of windows consumed aluminium materials while 21.8% of the

windows consumed sawnwood (Table 6) materials. This shows that in buildings, sawnwood window frames are the most affected by substitution compared to sawnwood doors in the building industry and its effect increases with the increase in the number of storeys.

Table 6: The trend of consumption of sawnwood and aluminium in doors and windows in different building categories

Building category	No of storeys	Sawn wood Doors assessed	Percent (%)	Aluminium framed Doors assessed	Percent (%)	Sawnwood framed windows assessed	Percent (%)	Aluminium framed windows assessed	Percent (%)
Low	0	6800	99.9	6	0.1	10 186	73.5	3676	26.5
Medium	1-3	837	90.1	92	9.9	328	27.4	869	72.6
High	≥ 4	1123	90.0	125	10.0	355	21.8	1273	78.2
	Total	8760	97.2	223	2.8	10 869	65.1	5813	34.9

These results indicate further that sawnwood windows are highly replaced by other building materials in the storey buildings compared to doors. In the long run the effect of sawnwood replacement in windows might be observed in none story buildings if construction activities in the city of Dar es Salaam and other parts of Tanzania will be taken by Parastatal organizations. During field survey it was observed that Parastatal organizations such as National Social Security Fund (NSSF), Public Service Pension Fund (PSPF) and National Housing Corporation (NHC) are constructing residential houses under mortgage financing where by seven Tanzanian banks have already signed contracts with NHC to implement mortgage financing scheme in various regions of the country.

Under mortgage financing, it was observed that it takes less than a year for a person to acquire a newly constructed house or apartment. Respondents revealed that it takes not less than ten years for an ordinary Tanzanian to construct a house using personal/family savings or other traditional ways. During field survey it was observed that NSSF had a project of about 200 affordable houses at Mtoni Kijichi in Temeke District while PSPF was constructing 500 low cost houses at Buyuni in Ilala District. Both projects were none storey buildings with doors made of sawn hardwood particularly *Afzelia quanzensis* while windows were made by aluminium frames and glasses. The organizations are also constructing commercial towers for renting in Dar es Salaam and other regions of Tanzania.

During personal interview with one of the government official, it was observed that the annual demand is about 200 000 houses but only 15 000 houses are constructed.

The housing shortage has been increasing as a result of the fast growing population in Tanzania. It is estimated that the shortage in urban areas is more than 1.2 million houses. Therefore, the mortgage financing is anticipated to affect sawnwood consumption if they will use substitute building materials especially for windows and doors.

4.2 Responses on sawnwood substitution in the building industry

About 84% (129 respondents) showed that there was substitution of sawnwood by other building materials. The rest 16% (24 respondents) were not aware of any substitution issues going on in the building industry.

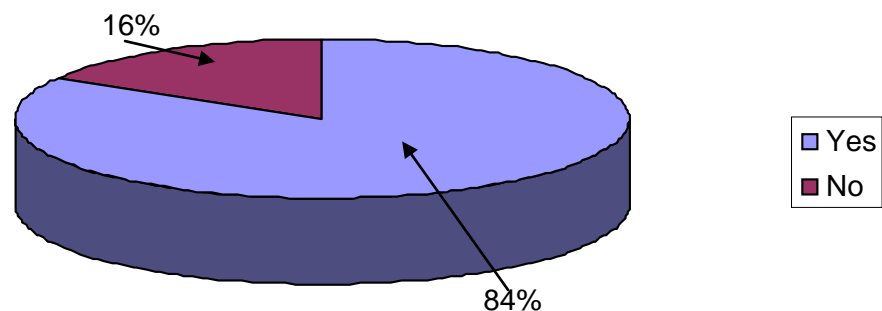


Figure 1: Response awareness on presence of sawnwood substitution in the building industry

During interviews most of the respondents showed that majority understands substitution of doors and window frames by none sawnwood building materials and not substitution by using sawnwood itself.

Surveys revealed that aluminium materials are currently popular in the building industry compared to Poly Vinyl Chloride (PVC) as most of the substituted sawnwood doors and window frames in new dwellings and renovated buildings were

made of aluminium. Steel were also observed during assessment though its substitution was low compared to aluminium materials. Results show that sawnwood is being replaced by aluminium, steel, PVC and other materials depending on the intended use and location of doors and windows (Figure 2).

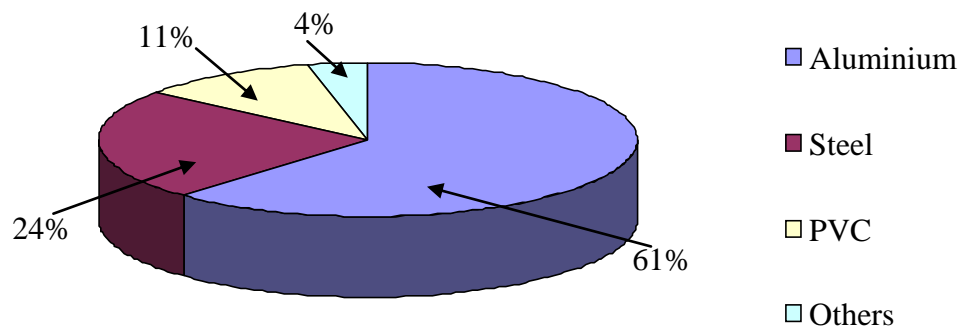


Figure 2: Building materials substituting sawnwood in doors and window frames

Aluminium has taken the largest share (61%) in substituting sawnwood materials in the building and construction industry followed by steel -24% (Figure 2). McGorman (2011) described PVC as one of the best and most appropriate materials for windows and doors purposes and is also cheaper than both sawnwood and aluminium. It is said to be the perfect replacement for old timber frames or inferior quality aluminium windows (ibid). Few workshops were observed to be dealing with PVC windows and doors compared to those dealing with aluminium windows and doors in Dar es Salaam probably due to little acceptance in the building and construction markets. During interview with experts at Tropical aluminium and Aluminium city who imports and distribute Aluminium and PVC materials, it was pointed out that PVC

are cheap and easy to apply compared to aluminium and sawnwood but its quality deteriorates fast when exposed to air for long time. Therefore aluminium was found to be the best substitute material replacing sawnwood in the building and construction works.

An interview with building contractors, architects and house builders revealed that aluminium is mostly preferred for the windows followed by doors and partitions (Figure 3).

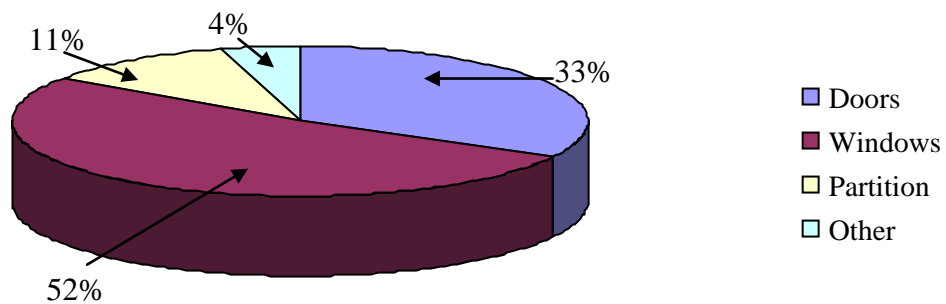


Figure 3: Responses on preferences for aluminium substitution

Figure 3 shows that aluminium was preferred and mostly substituted in windows (52% respondents). This shows that aluminium is mostly used to replace sawnwood in windows compared to doors and partitions. Only 4% of the respondents said that aluminium materials are being used to replace sawnwood sections other than windows, doors and partition. It was equally observed that in ongoing and completed buildings, most windows especially in newly built and or renovated buildings were made of aluminium materials while most of the doors were made of sawnwood.

Table 7: Estimates by respondents on percentage range on aluminium application and preferences

Type	Doors	Windows	Partitions
Range (%)	Frequency of responses		
0 - 25	51 (45.5%)	7 (6.3%)	108 (96.4%)
26 - 50	42 (37.5%)	18 (16.1%)	4 (3.6%)
51 - 75	0 (0.0%)	58 (51.8%)	0 (0.0%)
76 - 100	19 (17.0%)	29 (25.8%)	0 (0.0%)
Total	112 (100%)	112 (100%)	112 (100%)

Note: The highest range shows high preference

About 45.5% of respondents estimated that the rate of substitution ranges between 0-25 percent meaning that aluminium was less preferred in doors. On the other hand, 37.5% of respondents estimated substitution ranges from 26 - 50% while 17% of respondents ranged at the highest percentages (Table 7). The highest substitution percentage range estimates in windows was 51.8% implying that aluminium was mostly preferred in windows compared to other parts. Results also show that 25.8% of respondents consider substitution to range from 76 – 100% showing that aluminium is highly preferred in windows. Percentage range estimates for substitution by respondents also indicates that aluminium is less preferred in partitions as indicated by 96.4% of respondents (Table 7).

Findings from this study show that 34.9% of the assessed windows in buildings consumed aluminium while only 2.8% of the assessed doors consumed aluminium

(Table 6). These results supports those reported earlier (Table 6) that more than 50% of the respondents preferred aluminium materials for windows compared to doors and partitions. Majority (70%) of the respondents had the opinion that availability of aluminium was abundant in all Ilala, Kinondoni and Temeke municipalities (Figure 4).

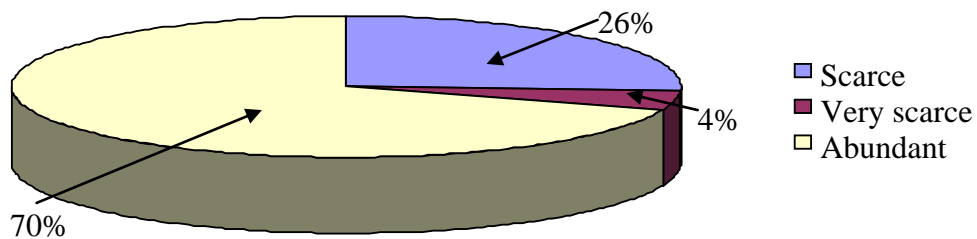


Figure 4: Responses on aluminium availability in Dar es Salaam city

An interview with Tropical Aluminium and Aluminium City Glass dealers in Dar es Salaam revealed that aluminium availability in the market is not a problem although in future its availability may be uncertain since the market is growing due to increasing number of customers from other regions. However, it was not evident to what extent the upcountry market for aluminium was growing to cause supply imbalance in the market. Some of the largest firms dealing with glass works considered Dar es Salaam as the biggest market for aluminium compared to other regions. This is caused by rapid increase in population and economic activities in Dar es Salaam and the neighbouring regions as opposed to other regions. The report provided by construction registration board in 2011 indicated that among 2635

building contractors country wide, about 1040 (nearly 40%) building contractors are based in Dar es Salaam. it was also reported that more than 300 commercial and residential construction projects were implemented in the same period of time each with a value of more than 2.1 billion TAS. The largest project in Dar es Salaam was a commercial building by the Public Services Permission Fund (PSPF), worth more than 100 billion TAS (CRB, 2011). During the survey it was observed that many projects were implemented at the city center and mostly being commercial multi storey buildings made by none wood materials including aluminium and glasses.

Table 8: Estimates by respondents on sawnwood substitution range in the building industry

Type	Residential		Commercial		Offices	
Substitution						
Range (%)			Frequency of responses			
0-20	72	(64.3%)	15	(13.4%)	33	(29.5%)
21-40	26	(23.2%)	18	(16.0%)	60	(53.6%)
41-60	7	(6.3%)	30	(26.8%)	18	(16.0%)
61-80	7	(6.2%)	47	(42.0%)	1	(0.9%)
81-100	0	(0.0%)	2	(1.8%)	0	(0.0%)
Total	112	(100%)	112	(100%)	112	(100%)

For residential buildings, 64.3% of the respondents estimated that the rate of substitution ranged between 0 - 20% implying that in residential buildings sawnwood are still being used in large quantities compared to commercial and office buildings (Table 8). In commercial buildings, 42% of the respondents estimated sawnwood substitution range between 61-80% while 26.8% rated between 41-60% respectively. On the other hand, 53.6% of the respondents showed that sawnwood substitution in

office buildings is low compared to commercial buildings but a bit high when compared to residential buildings (range between 21-40%). Since more than 60% of the respondents estimated the highest (from 41-80%) sawnwood substitution in commercial buildings than residential and office buildings, it is concluded that there is more substitution in commercial buildings.

Substitution of sawnwood by none wood building materials varies depending on the type of end use of the building and also the construction regulations (Unasylva, 1971). Most building code restrictions on the use of sawnwood arise from regulations designed to provide structural stability, durability and protection from fire. The extent of sawnwood substitution in commercial, residential and office buildings also differ depending on the regulations and the building uses. The corresponding responses from building contractors, architects and house builders on what type of buildings will sawnwood substitution likely to occur showed that commercial buildings were leading in sawnwood substitution by high percentage range compared to residential and office buildings. In order to assess sawnwood substitution in different building categories respondents estimated their percentage ranges of substitution to the three categories of buildings which aimed to provide a general picture of what is happening in the building industry with regard to sawnwood substitution by other building materials.

The majority of respondents (92.9%) revealed that substitution of sawnwood by none building materials in none storey buildings is very low (0-20%) (Table 9). In medium class category (1-3 storey buildings) about 73.2% of the respondents estimated a range of 21 – 40 % showing that substitution is still low while in high class category

about 65.2% of the respondents estimated at 41–60% (Table 9). The percentage estimates from respondents on probable substitution range increased as the number of storeys increased and therefore sawnwood substitution by other building materials is estimated to increase from none storey buildings to high storey buildings. These results are similar to those reported in Table 6 which showed an increase of sawnwood substitution from lower category buildings to high category buildings in the building industry. Multi-storey buildings consumes large amount of building materials which is also counted as sawnwood substitute materials than none storey buildings.

Table 9: Response on percentage estimates for sawnwood substitution in different building categories

Type	None-storey buildings	1-3 Storey buildings	>3 Storey buildings
Substitution			
Range (%)	Frequency of responses		
Very Low (0-20)	104 (92.9%)	5 (4.5%)	0 (0%)
Low (21-40)	8 (7.1%)	82 (73.2%)	5 (4.5%)
Moderate (41-60)	0 (0.0%)	24 (21.4%)	73 (65.2%)
High (61-80)	0 (0.0%)	1 (0.9%)	34 (30.3%)
Very High (81-100)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Total	112 (100%)	112 (100%)	112 (100%)

4.3 Sawnwood products use in building Industry

Findings from this study show that building industry uses both hardwood and softwood in different activities. During interview with building contractors, architects and house builders, it was revealed that both sawn hardwood and softwood

are being used extensively (Table 10). Among 112 respondents only 10.7% (12) preferred sawn hardwood and 8.9% (10) preferred sawn softwood while 76.8% preferred both for their building and construction activities. This implies that both softwood and hardwood sawnwood are important and intensively used in construction works.

Table 10: Response on sawnwood use preferences

Item	Building contractors		Architects		House Builders	
	No	%	No	%	No	%
Total sample of respondents	30	100	61	100	21	100
	Response frequency					
No response	2	6.7	0	0	2	9.5
Hardwood	3	10.0	8	13.1	1	4.8
Softwood	2	6.7	6	9.8	2	9.5
Both	23	76.7	47	77.0	16	76.2
Total	30	100	61	100	21	100

It was revealed that most of the customers use sawn hardwood in window frames and doors while softwood are mostly used for roofing, joinery, rafters and scaffolding. All sawnwood window frames and doors were found to be constructed using sawn hardwood. *Azelia quanzensis* and *Pterocarpus angolensis* were the main species used in window and doors frames because they are strong, durable and resistant to termites.

4.4 Sawnwood availability

Field survey show that many users get their requirements within Dar es Salaam and some get from outside the region (Table 11). Few contractors purchase sawnwood direct from the wholesale suppliers or sale traders while majority of them depends on the local dealers engaged in selling hard and soft sawnwood. It was observed during interview with building contractors, architects and house builders that 23.3% of the building contractors get sawnwood from Dar es Salaam while 30% purchased from other regions including Lindi, Mtwara, Morogoro, Rukwa and Tabora. On the other hand, 46.7% of the interviewed building contractors purchased sawnwood in the city depending on the availability. About 36.1% of architects who are the building designers and consultants revealed that hardwoods used in construction activities are obtained locally in Dar es Salaam because it is difficult to transport them from other regions due to high capital requirements and difficulties in obtaining transport permits. However, 52.4% of the house builders said that purchasing sawn hardwood from other regions is difficult and they normally strive to get from the retailers and whole sellers within Dar es Salaam.

Previous reports show that the main sources of hardwood timber mostly *Pterocarpus Angolensis* marketed in Dar es Salaam were the miombo wood land in Tabora and Rukwa regions, coastal forests such as Kilwa and Lindi regions, and some pockets of forests in highland areas of Morogoro and Tanga Regions (Wells *et al.*,2002). It is reported that, almost 90% of hardwood timber in the local market in Dar es Salaam are obtained illegally and the government is losing massive revenues due to the malpractice as a result investors are using imported timber from the Democratic Republic of Congo (DRC), Ivory Cost and Mozambique because they are of high quality and cheap (Daily news, 2011).

Table 11: Sawnwood availability in Dar es Salaam

Item	Building contractors		Architects		House Builders	
	No	%	No	%	No	%
Total samples	30	100	61	100	21	100
Sawnwood Availability	Response frequency					
Hardwood is abundant	5	16.7	20	32.8	3	14.3
Hardwood scarce	14	46.7	26	42.6	6	28.6
Hardwood is very scarce	11	36.7	15	24.6	12	57.1
Softwood is abundant	24	80.0	38	62.3	17	81
Softwood is scarce	5	16.7	14	23.0	3	14.3
Soft wood is very scarce	1	3.3	9	14.8	1	4.8
Total	30	100	61	100	21	100

Among 112 respondents, 46% said that hardwood is sometimes scarce while 79% of overall respondents on availability of sawn softwood stated that is always abundant (Table 11).

The trend of sawnwood availability is well explained in Figure 5 which shows abundance and scarcity of sawnwood in building and construction activities in Dar es Salaam city. Sawn softwood seems to be abundant compared to sawn hardwood. The scarcity of sawn softwood does sometimes increase due to increased demand resulting from the increased uses and population.

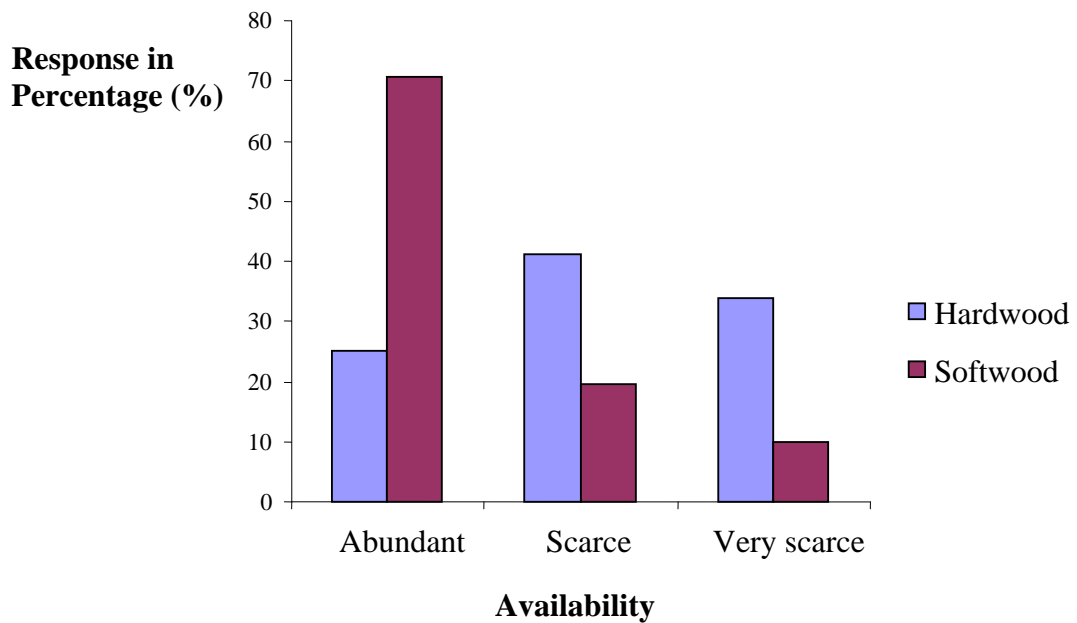


Figure 5: Responses on sawnwood availability in Dar es Salaam city

4.5 Sawnwood preference and demand in building industry in Dar es Salaam city

Results show that there are different consumers of sawnwood in Dar es Salaam city with different preferences between them. Majority (76.8%) of the respondents revealed that they prefer both hardwood and softwood in their building and construction activities (Figure 6). The preferences of sawnwood for structural applications were mainly driven by the availability, prices and the end use of the resources. During doors and windows assessment in the field it was observed that sawn hardwood were the main material preferred regardless of its scarcity and high prices compared to sawn softwood which were rarely used in doors and windows frames.

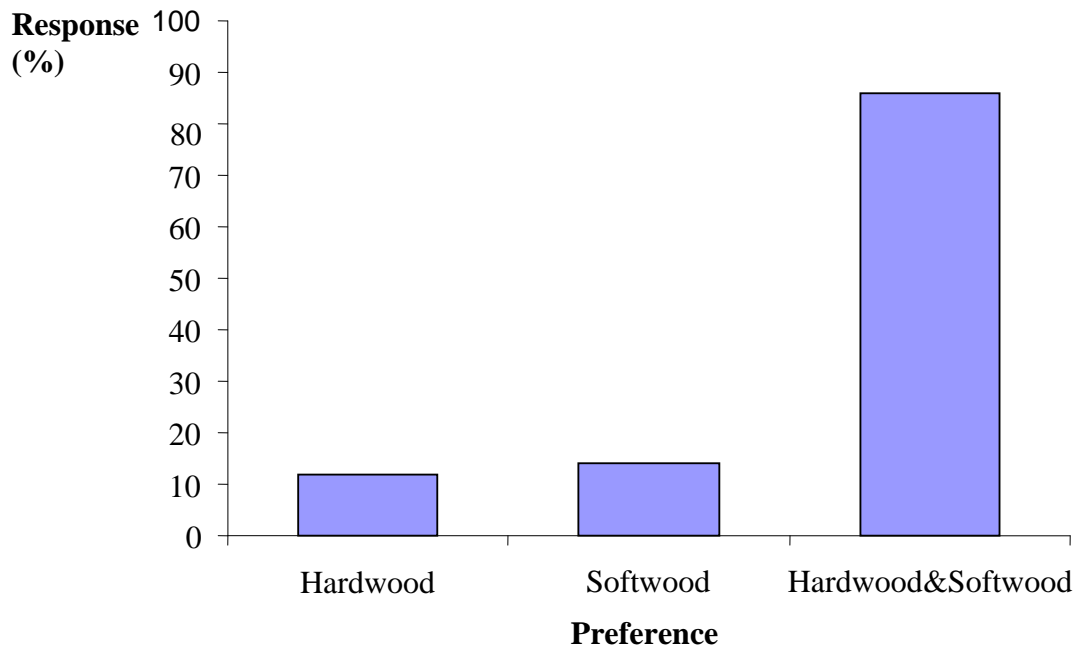


Figure 6: Sawnwood preferences in building industry in Dar es Salaam city

Results show that demand of sawnwood in building and construction industry is increasing (Table 12). This was revealed by building contractors (76.7 %), architects (55.7%) and house builders (66.7%). Increased demand of sawnwood is accelerated by the rapid increase in population in Dar es Salaam city which is currently estimated to have more than 3 million people (NBS, 2006). Sawnwood demand is a derived demand because it depends on the demand of other goods produced using sawnwood. Therefore, the demand for sawnwood is a function of activities in different sectors that use sawnwood and its utilization intensity.

Table 12: Responses on sawn wood demand in building and construction industry in Dar es Salaam city

Item	Building contractors		Architects		House Builders	
	No	%	No	%	No	%
Total samples	30	100	61	100	21	100
Sawnwood demand	Response frequency					
Increasing	23	76.7	34	55.7	14	66.7
Decreasing	3	10.0	10	16.4	2	9.5
Constant	4	13.3	17	27.9	5	23.8
Total	30	100	61	100	21	100

Building and construction industries are considered as demand drivers of sawnwood in the market because they serve as a basis for building and construction activities. In estimating the demand and market power of the firms dealing with sawnwood markets, Otto (2011) revealed that among other things, factors that affect the number of new constructed buildings or houses include economic activities, demographic factors such as the birth rate and the rate of immigration.

4.5.1 Sawn wood prices in Dar es Salaam city

The prices of sawnwood in Dar es Salaam city differ depending on the species and quality of wood/timber. Hardwood species are sold at higher prices compared to softwood species. High quality sawnwood fetch higher prices compared to poor quality sawnwood (Table 13). However, during field survey it was observed that there were few species of sawnwood hardwood such as *Pterocarpus angolensis*, *Azelia quanzensis*, *Milicia excelsa*, *Podocarpus spp* and *brachystegia spiciformis* in the market.

Table 13: Retail prices for hardwood sawnwood in Dar es Salaam city

Species		Retail prices/m ³ (TAS)		
		Year 2004	Year 2008	Year 2011
<i>Pterocarpus angolensis</i> (Mninga)	Current market price	740 000	1 000 000	1 500 000
	Real price	740 000	983 000	1 403 000
<i>Afzelia quanzensis</i> (Mkongo)	Current market price	650 000	900 000	1 500 000
	Real price	650 000	883 000	1 397 000
<i>Podocarpus spp</i> (Podo)	Current market price	400 000	610 000	970 000
	Real price	400 000	596 000	898 000
<i>Brachystegia spiciformis</i> (Mtondoo)	Current market price	-	590 000	800 000
	Real price	-	590 000	773 000

Results in Table 13 show that, in year 2011 *Pterocarpus angolensis* and *Azelia quanzensis* had the highest real prices per m³ compared to *Brachystegia spiciformis* and *Podocarpus spp.* From 2004 to 2011 the real prices of each sawn hardwood species increased significantly. The real price of *Pterocarpus angolensis* from 2004 to 2008 rose by 32% (740 000 – 983 000 TAS per m³). From 2008 to 2011, the real prices of *Pterocarpus angolensis* rose by 43% being higher by 11% compared to 2004-2008. The real prices of *Azelia quanzensis* rose by 36% from 2004-2008 and to 58% from 2008 to 2011. The real prices of *Azelia quanzensis* rose by 15% more compared to *Pterocarpus angolensis* from 2008-2011. This shows that the value and uses of *Azelia quanzensis* and *Pterocarpus angolensis* in the building industry has risen significantly in recent years. During site visits it was revealed that most of the building contractors used *Azelia quanzensis* species for doors compared to *Pterocarpus angolensis* with the reason that the former is often available in the market than the later.

In Tanzania the inflation rates for the year 2004, 2008 and 2011 were 4.1%, 6.7% and 12.7% respectively (<http://www.bot-tz.org/publications>). This indicates that the rate of inflation in 2011 increased twice compared to 2008. The comparison of price index showed a slight difference between real and market prices of the sawnwood species (Figure 7).

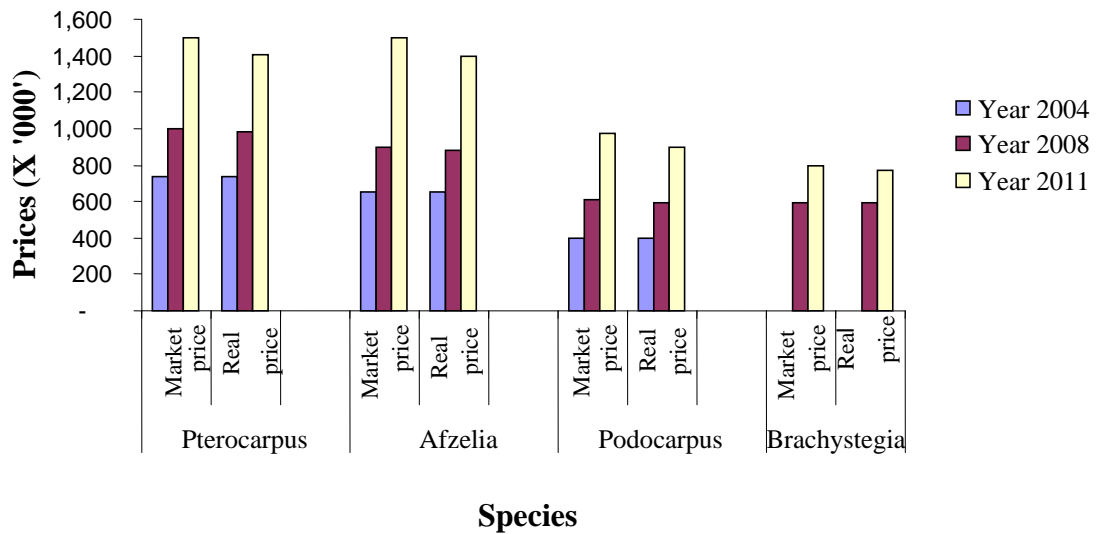


Figure 7: Differences between real and current market prices of sawn hardwood species in Dar es Salaam Market

The sharp increase of prices of sawn hardwood in recent year may be attributed by the increase in cost of logs, transport and inflation. During interview with different registered timber traders and end users it was observed that the prices of sawnwood are not stable. The prices may rise or fall within short period of times. Apart from availability, the majority of respondents argued that fluctuation of sawnwood prices in recent years has been accelerated by inflation which raised the transportation costs of goods due to increased prices of fuel and spare parts. Results also revealed that most of the sawn hardwoods are imported from Mozambique. The government royalty fee per m³ of timber doubled to 160 000 TAS thus making it difficult for small scale carpentry factories to invest in the sector. Some traders revealed that sawnwoods in Mozambique are being charged in dollars therefore the inflation of the Tanzanian shilling resulted into high sawnwood prices in Dar es Salaam.

Table 14: Stability of sawnwood prices in Dar es Salaam city

Item	Timber Traders		Timber end users		
	No	%	No	%	
Total sample	46	100	41	100	
Price instability	Frequency response				
	Yes				
		46	100	41	100
Transportation		6	13.04	4	9.75
Rise in Fuel price		14	30.43	13	31.70
Distance from source		4	8.70	8	19.51
Rise in price of Logs		13	28.26	11	26.82
Logging ban		9	19.57	5	12.19

Both timber traders and end users argued that the rise in prices of fuel and logs has greatly caused the instability in sawnwood prices since transportation is associated with fuels. Poor quality logs harvested produces few pieces of sawnwood that cannot easily bring return to compensate the processing costs and taxes. They also argued that frequent instability of prices are caused by distances from which sawnwood are being produced especially after banning logs production in Rufiji, Kilwa and Liwale districts (Millege *et al.*, 2007).

4.5.2 Doors and windows prices

Results show that the prices of doors and windows vary depending on the type of materials used, size, design and the amount of materials consumed. Window and door frames are commonly made using sawnwood, steel, aluminium and Poly Vinyl Chloride (PVC).

4.5.2.1 Sawnwood doors and windows

Field observation showed that doors and windows used in buildings have different prices depending on the sizes, species used, design, quality of sawnwood and the location. Complex designs consume large amount of sawnwood compared to normal doors hence higher prices. From 2008 to 2011, outer doors were highly priced (more than 30%) compared to inner doors because most of the outer doors are double in size and consumes large amount of sawnwood materials in shutters and frames (Table 14). Doors made from low quality sawnwood were observed to be cheaper than those made from high quality sawnwood. All sawnwood doors and windows made from *Pterocarpus angolensis* and *Afzelia quanzensis* species had no price differences. Also, doors were priced almost twice compared to window frames because doors constitute both frame and shutter. Factors causing changes in price for doors were also found to cause differences for window frames except that window frames have additional materials such as steel bars.

Table 15: Market price estimates for *Pterocarpus angolensis* and *Afzelia quanzensis* sawnwood doors and window frames

Item		Average Prices (TAS)			
		2008	2009	2010	2011
Door (Frame & Shutter)	Inner door	300 000	330 000	450 000	530 000
	Outer door	460 000	490 000	650 000	710 000
Window	Frame	200 000	220 000	240 000	330 000

Figure 8 show the trend of price change between doors and window frames from 2008 to 2011. There was a very slight increase in the price of doors from 2008-2009, and increased fairly from 2009 - 2011. From 2008 to 2010 the price of window frames showed a very small increase until 2011 where the rate of increase was high (38%) compared to 9% in 2010.

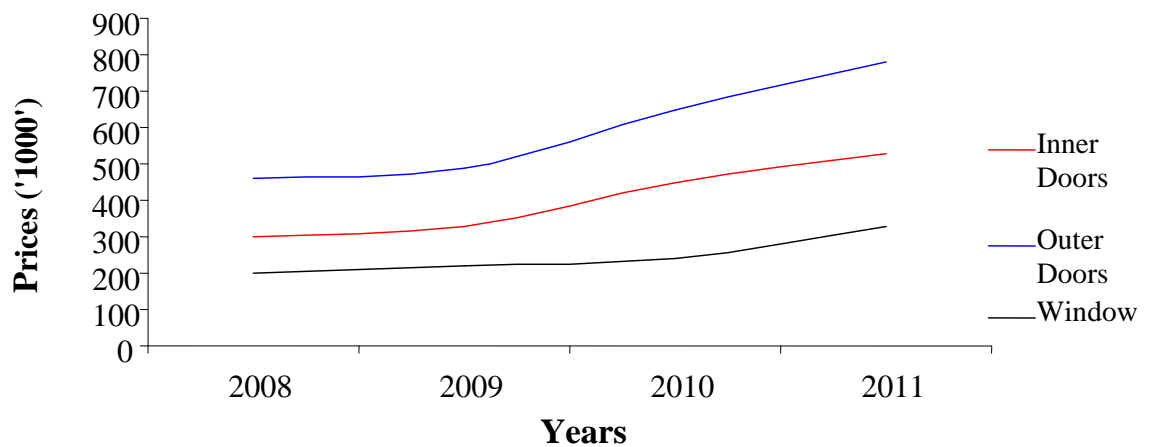


Figure 8: Sawnwood doors and windows price changes from 2008-2011

4.5.2.2 Aluminium doors and windows

During field survey it was observed that aluminium doors and windows have different prices depending on size and raw materials used. Like sawnwood, aluminium has good and poor quality raw materials hence customers choose material that are affordable to them depending on their income and preferences. Aluminium doors and windows have extra charges including labour for fitting the door or window unlike sawnwood doors and window in which the charges are for the finished item and if the same technician is consulted for fitting the customers will incur extra costs. The price of aluminium window frame per square meter (TAS/m²)

ranges from 125 000 TAS to 142 000 TAS depending on the quality of aluminium materials used. An assessment on the window covering 2.1 m by 0.9 m revealed that windows with vent were charged about 300 000 TAS and none vented windows were charged about 270 000 TAS. It was further observed that for windows with clear mirror, the charges were 250 000 TAS and 270 000 TAS for none vented to vented windows respectively. Aluminium doors had different prices depending on the quality of aluminium material used, mirror and size similar to aluminium windows. The prices varied from 300 000 TAS to 350 000 TAS for standard inner doors while outer doors estimates ranged from 550 000 TAS to 650 000 TAS. The outer doors were mostly found in commercial buildings than office and residential buildings. Most of the doors identified in offices were inner doors covered with clear or tinted glasses. The majority (82.9%) of carpenters said that there is still a potential market for doors and window frames although the market fluctuate over time in terms of the number of customers.

Comparing the availability of market for doors and window frames respondents revealed that doors have large market compared to windows. It was noted in the field that there was a large number of readymade sawnwood doors than window frames. They further revealed that it takes long to get customers for window frames than for doors.

An assessment on various commercial apartments in the city center revealed that many doors and windows are made by aluminium materials. Aluminium materials are preferred because they are more attractive and that it helps them to display their

businesses for customers to easily identify what is inside their shops. However, the situation changes as you move from the city center to peripherals where most people use sawnwood doors and windows strengthened by iron bars. This may be due to the fact that there are many customers in the city center where shops are concentrated and the market is competitive compared to peripheral areas where the population is small and higher risky for burglars. On the other hand, during conversation with house builders it was observed that their income increases when they deal with houses that use sawnwood doors and window frames rather than aluminium due to some additional income for fitting charges in their contracts unlike using aluminium where by fitting charges are paid to the experts who prepares aluminium doors and windows.

4.5.2.3 PVC windows and doors

The survey on prices of PVC windows and doors in Dar es Salaam showed that there was a significant difference in prices. The prices of PVC windows and doors depended on quantity of items a customer wanted to purchase. The prices ranged from 98 dollars (150 000 TAS) per square metre of door or window frame to 105 dollars (170 000 TAS) per square metre. These prices include other items that complete the window or a door except fitting charges. Observations show that PVC windows and doors were priced high compared to aluminium. The prices were charged in dollars because business men preferred dollars which was stable compared to Tanzanian shilling which fluctuated over time.

4.6 Factors underlying sawnwood substitution in the building industry

Product preferences are constantly changing due to new product innovation and changing consumer preferences. UNECE (1999) mentioned some of the factors that could result in loss of market share for sawnwood products and included product price, purchasing cost, maintenance cost as well as the quality of the product.

Evidence from the survey indicates that, there are several factors underlying substitution of sawn products in the building industry. Some of the factors mentioned by respondents include fluctuating sawnwood prices, availability of sawnwood products especially sawn hardwood compared to substitute materials, emergence of new technologies that provides access to new design structures, appearance of substitute materials, quality and durability of the substitute materials. Increased supply of steel, aluminium, PVC and concrete industries have also taken the market share of timber framing hence causing some market erosion and possibilities of some substitute materials replacing sawnwood.

It was observed during the survey that it is not only aluminium materials that are substituting sawnwood in window and door systems but also plastic materials. Plastic frames construction is gradually gaining popularity in Dar es Salaam as some importers and manufactures were located in the city. For example, Mar-kim Uni Plast Co. Ltd is one of the manufacturing companies situated at Ubungo along Morogoro road dealing with the supply of PVC materials and plastic frames.



Plate 1: Mar-kim Uni Plast Co. Ltd and workshop located in Dar es Salaam city



Plate 2: Different designs of plastic window frames at Mar-kim Uni Plast Co. Ltd

PVC material, readymade window and door frames for retail and whole sale are becoming common in Dar es Salaam. The marketing officer from Mar-kim Uni Plast Co.Ltd explained that PVC is not new in construction activities since it has been working for many years and is now penetrating markets in developing countries including Tanzania due to globalization and technology advancement which gives

people more choices and preferences for building materials. Beside Mar-kim Uniplastic Company Limited, there were also other companies dealing with similar products including Dolphin Water Company situated at Mikocheni area and within Dar es Salaam city. However, the efficiency of PVC material depends on its plasticity and dimensional length. Some of the interviewed technicians revealed that PVC material deteriorates fast when exposed for a long time to the air compared to aluminium and other building materials like sawnwood.

4.7 Future sawnwood consumption in Dar es Salaam City

Sawnwood data collected from Dar es Salaam city were used to extrapolate the future sawnwood consumption after identifying factors that determine sawnwood consumption in the municipality. The data collected from the field were used for testing the suitability of models and the best model was chosen for forecasting future consumption of sawnwood in doors and windows for Dar es Salaam city. Different factors were used to determine future sawnwood consumption. Some of these factors are social while others are economical. The factors considered were population, economic attributes and urbanization.

4.7.1 Population

Dar es Salaam is among the cities with the rapid increase in population. According to 2002 census, the population was around 2.5 million with a growth rate of about 4.3% per annum and a population density of 2238 people per square Kilometer. The city's population grew from only about 3500 in 1857 to 128 742 in 1957, to 272 821 in 1967 and to 843 000 in 1978. In the 1988 census the city population was recorded to

be about 1 360 850 while in 2002 census the population doubled to about 2.5 million (NBS, 2006).

Despite of the factors that tend to balance the population including mortality, fertility, migration and HIV/AIDS, the population of Dar es Salaam City is always increasing. The migration rate for permanent dwellers is estimated to be 10% annually and for transient population the rate is about 1 000 000 per annum. The crude birth rate is recorded to be 40/1000 showing that for each one thousand women there are forty births (NBS, 2006). On the other hand, projections made in 2006 by National Bureau of Statistics (NBS) show that Infant Mortality Rate (IMR) is expected to decline from 80 deaths per 1000 live births in 2003 to 49 deaths per 1000 live births in 2025. Under five mortality (U5MR) for both sexes is expected to decline from 122 in 2003 to 71 deaths per 1000 live births in the year 2025 while life expectancy for DSM will decline from 55 years in 2003 to 52 years in 2025 for both sexes (ibid). This shows that the population of Dar es Salaam will continue to grow rapidly for a number of years in future and hence increase in demand for housing, commercial activities and other basic social services.

4.7.2 Economic attributes

The economic situation in Dar es Salaam differs from other regions in various aspects making the city an attractive investment destination for many different stakeholders. Being the major commercial, administrative and industrial centre, it has some favorable economic and fiscal policies as well as, attractive package of investment incentives offered through the Tanzania Investment Center (TIC) which

provides import duty relief on raw materials, zero rated VAT on goods manufactured for export, depreciation allowance on capital goods, fast track to obtain other permits such as residence/work permits, industrial and other trading licenses. The city is also favored by its location hence easily accessed by all parts of the world through port and rail connection providing transport access to neighboring countries including Congo DRC, Malawi, Zambia, Burundi, Rwanda, and Uganda.

Statistics (NBS, 2006) projected that the GDP of DSM in 2010 will be Tsh 1 459 013 million representing 16% of the National GDP and per capita income which was estimated to be Tsh 584 086 with 35% of the population earning an average low income of Tsh 387 319 per annum. The Regional Gross Domestic Product (RGDP) at current prices for DSM Region amounted to Tshs 5 428 503 (16.81%) in 2010 compared to 4 848 914 million shillings in 2009 representing an increase of about 12.0% and its respective per capita GDP was Tshs 1 740 947 compared to 1 594 976 Tshs of 2009 in current prices (NBS, 2011).

4.7.3 Urbanization rate

The rate of urbanization in Dar es Salaam for year 2002 was 7.1% and this was greater than the country's rate of 6.6%. It was estimated that the city needed 200 000 new plots per year to meet the housing demand (UNHABITAT, 2010). From 2002 to 2009, only 40 000 plots were surveyed which is an average of 5000 per year. This was 160 000 plots less than the needed plots hence contributing to the continued growth of slam areas in the city.

4.8 Forecast models chosen

Time series forecasting and income elasticity of demand models were used to forecast the sawnwood consumption for Dar es Salaam.

4.8.1 Time series Models

Time series models use historical information to perform the forecasting. There are two categories within time series models which are smoothing models which bases on the principle of averaging (smoothing) past errors by adding a percent of the error to the percent of the former forecast and Linear time series methods which require data with trend and systematic differences between the actual and the forecasted value. The amount of data obtained in the field were few in such a way that not all time series models could be selected hence only smoothing methods were considered. Single smoothing and exponential smoothing models were selected among the three smoothing methods leaving behind linear smoothing models to forecast future sawnwood consumption. These smoothing methods differ in the way they over come limitations that arise due to the nature of the information available. Therefore, results obtained from time series model were compared with results obtained using other forecasting methods that fits the data and come up with real estimates of future sawnwood consumption. The results provided by smoothing methods do not show real estimates since the two methods (single average smoothing and exponential smoothing) provide less estimates compared to the current consumption (Table 16). The methods give constant estimates for many coming years deviating from the real situation of Dar es Salaam city as explained in 4.7.1 to 4.7.3.

4.8.2 Income elasticity of demand model

Income elasticity of demand model depends on the relationship between the present sawnwood consumption, income and population growth using income elasticity of demand. Sawnwood consumption data were used to calculate the income elasticity of demand. The information on income per capita of Dar es Salaam region was not available and therefore the regional GDP per capita had to be used instead (Table 17).

Table 16: Sawnwood consumption forecast using time series methods

Year	Time period	Observed values (per 1000 capita consumption) m³	Single moving average (per 1000 capita sawnwood consumption, m³)	Single exponential smoothing(per 1000 capita sawnwood, m³) $\alpha = 0.1$
2009	1	2.61		
2010	2	2.46		
2011	3	2.73		
2012	4		2.60	2.61
2016	9		2.62	2.66
2021	14		2.62	2.69
2026	19		2.62	2.69

Table 17: Sawnwood consumption forecast in building and construction industry for Dar es Salaam from 2012-2026.

2011 per 1000 capita sawnwood consumption	Population growth per year (%)	GDP growth per year (%)	GDP growth rate per year (per capita) %	Income elasticity (EID)	Per 1000 capita increase in consumption	Estimator	2012 (per1000 capita) m³	2016 (per 1000 capita) m³	2021 (per 1000 capita) m³	2026 (per 1000 capita) m³
2.73	4.3	6.0	1.7	1.2	2.04	(1.02)	2.78	3.01	3.33	3.67

4.9 Forecasted sawnwood consumption

Results on sawnwood consumption for Dar es Salaam using single moving average and single exponential smoothing methods show that 2.6 m³ and 2.7 m³ per 1000 capita sawnwood will be consumed in the year 2026 respectively. Using Income Elasticity of Demand, it is estimated that sawnwood per capita consumption in 2026 will be around 3.7 m³ (Table 18). The IED method gave high estimates compared to single moving average and single exponential smoothing. The 2026 consumption estimates by IED future consumption forecast differed by 1.1 m³ per 1000 capita with Single moving average and differed by 1.0 m³ (15.4%) with single exponential smoothing. Between these three forecasting methods only IED method showed a reasonably steady increase in sawnwood consumption in each period forecasted compared to the other two models. Smoothing methods have shown very little change in consumption compared to the present consumption and the final forecast period 2026 meaning that it does not show any change in consumption for the next 10 years unlike IED forecasting method which show significant changes.

Being a commercial city, Dar es Salaam has a lot of commercial activities and facilities therefore its economy is expected to grow year after year due to high rate of population growth and urbanization. Most of the investments require premises and people need settlements therefore the demand for sawnwood is inevitable and is expected to increase if limiting factors such as substitution remains unchanged. From economic point of view, the income elasticity of demand of 1.2 indicates that change in income has a positive response on demand of sawnwood. In any developing economy it is rare to separate it with the building and construction

activities which consume a lot of building materials including sawnwood. Statistics show that, the economy of Dar es Salaam has been growing fairly fast compared to other regions contributing about 15% to 16% in the country's GDP (NBS, 2006). The city is favored by harbour for import and export of goods earning a substantial amount of foreign currency. It is easily accessed due to availability of important services as it accommodates most of the government offices and other associated agencies involved in decision making in both government and private sector. Studies on sawnwood consumption (Ngaga, 1991 and Machumu, 2008) show that income has a significant effect on the demand of sawnwood. Results from these studies indicate that, sawnwood were highly demanded and consumed within the forecasting period. Ngaga (1991) established an IED of 1.4 while Machumu established an IED of 2.5 each with his own information available at that particular study period hence the IED of 1.2 established for Dar es Salaam is less compared to those established in Arusha though all of them were elastic. The world economic crisis and continued inflation of goods in the country between recent years and substitution could have slowed down the income per capita of the people in Dar es Salaam hence less demand and consumption of sawnwood than expected.

Table 18: A summary of sawnwood consumption forecasts using different models

Forecasting model	2012 per 1000 capita sawnwood consumption, m ³	2016 per 1000 capita sawnwood consumption, m ³	2021 per 1000 capita sawnwood consumption, m ³	2026 per 1000 capita sawnwood consumption, m ³
Single moving Average	2.60	2.62	2.62	2.62
Single exponential smoothing $\alpha = 0.1$	2.61	2.66	2.69	2.69
Income elasticity of demand	2.78	3.01	3.33	3.67

4.9.1 Forecasting substitution

Results in Table 19 show that at the end of 2026 about 364 386 m² of aluminium will be consumed in the building activities in Dar es Salaam especially for window and door fitting. This is an increase of about 216 957 m² of aluminium building materials consumed between 2011-2026 in doors and window frames. This is an average of about 9.8% increase of building materials substituting sawnwood annually. Also, in the next 15 years, per capita consumption of substitute building materials is estimated to rise from 46.2 m² to 86.8 m² of aluminium which is an increase of 88%. This substitution considers only aluminium materials but there are other sawnwood substitutes emerging in Dar es Salaam city including PVC which may probably substitute both sawnwood and aluminium in some of the areas. Therefore if these types of substitute building materials prevail in the market sawnwood substitution may increase causing shifting of demand at different levels.

The rate of substitution will depend on types and categories of buildings or the types of activities being undertaken. It is expected that most of the substitution will likely occur in commercial and office buildings with the assumption that the current situation will prevail in future. On the other hand substitution in residential houses/building will depend on the income status of the people and other factors like availability and accessibility of the building materials. The current initiative through government agencies and parastatal organization in constructing residential houses will significantly reduce the consumption of sawnwood in general. All houses which are built by these agencies and organizations were observed to have more than 90% aluminium windows and few doors were made of aluminium unlike individually

constructed houses (especially non-storey buildings) which most of their doors and windows were made of sawnwood.

4.9.2 Total sawnwood consumption in the future

Three different models were used in the forecasting and they showed different results where by IED estimated the highest estimate (15 406 m³) compared to single exponential smoothing which amounted to 11 292.6 m³ while single moving average estimates were 10 998.7m³ (Table 19). IED is argued to be the best model in the study for forecasting the future consumption of sawnwood because it depends on the population, income and current consumption which definitely changes over time. The consumption forecast of sawnwood for 2026 will therefore be 15 406 m³ showing that sawnwood consumption in windows and doors will increase by more than 75% from the current consumption of about 8706.9m³. The mushrooming commercial storey buildings in urban areas including Dar es Salaam will moderately increase sawnwood consumption in building industry in future.

Table 19: Forecast of Aluminum Consumption based on IED

2011 (Per 1000 capita Aluminium consumption m²)	Population growth per year (%)	GDP growth per year (%)	GDP growth rate per year (per capita) %	Income elasticity	Per 1000 capita increase in consumption	Estimator	2012 (per1000 capita)m²	2016 (per1000 capita) m²	2021 (per1000 capita) m²	2026 (per 1000 capita) m²
46.17	4.30	6.00	1.70	2.50	4.25	1.043	48.2	57.0	70.3	86.8
Total consumption forecast (m²)										
147 513								202 635	272 553	364 386

Table 20: Total sawnwood consumption using different forecasting models

Forecasting model	2016			2021			2026		
	Per 1000 s/w consumption, m ³	Population (000)	Total s/w consumption m ³	Per1000 s/w consumption, m ³	Population ('000)	Total s/w consumption m ³	Per 1000 s/w consumption, m ³	Population ('000)	Total s/w consumption m ³
Single moving average	2.62	3555	9 314.10	2.6	3877	10 157.7	2.6	4198	10 998.8
Single exponential smoothing $\alpha = 0.1$	2.66	3555	9 456.30	2.7	3877	10 429.1	2.7	4198	11 292.6
Income elasticity of demand	3.01	3555	10 700.5	3.3	3877	12 910.4	3.7	4198	15 406.7

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Basing on the results and discussions of this study, it is concluded that:

In the building industry, sawnwood is much consumed in none storey buildings and its consumption per building unit is minimal compared to high storey buildings. The consumption of sawnwood is high in doors for both none storey and storey buildings compared to window frames where by sawnwood consumption seems to decrease with an increase in number of storeys in the building. Therefore, consumption of sawnwood in none storey buildings will still grow fairly fast because majority of the buildings in urban centers particularly Dar es Salaam are being built by low and middle income people for residential purposes.

In building activities, both sawnwood and substitute building materials are highly preferred and, substitution is greatly taking place in storey buildings compared to none storey buildings with window frames being more affected than doors.

Only few species of sawn hardwood are available in the building industry for manufacturing of door and window frames while substitute building materials other than aluminium are emerging in Dar es Salaam city. This observation indicates that competition between building materials and sawnwood substitution in the building industry will persist.

Sawnwood substitution by other building materials was observed to be induced significantly by various factors such as fluctuating sawnwood prices, availability of sawnwood products especially sawn hardwood compared to substitute materials, emergence of new technologies that provides access to new design structures, appearance of substitute materials, quality and durability of the substitute materials providing demand options for building materials to customers in the building industry and consequently sawnwood substitution.

Forecasting shows that consumption of sawnwood in Dar e s Salaam will grow gradually and reach 15 407m³ by year 2026 and that aluminium is dominant compared to other substitute building materials which is a challenge to building and construction industry.

5.2 Recommendations

Based on the conclusions above, the study recommends the following:

- i. There is a need to publicize the commercially unknown and underutilized sawnwood species on their strength properties, resistance to weather and durability so that architects and building contractors becomes aware of these species for future consumption in the building industry.
- ii. For the purpose of forest conservation substitute building materials need to be promoted in forest depleted areas and in various building and construction activities to reduce pressure on these forests resulting from high demand of sawnwood.

- iii. Since this study covered only sawnwood consumption and substitution in windows and doors in Dar es Salaam city only, more researches on sawnwood consumption and substitution in the whole building and construction industry are needed to other places for future development of forest sector and consumption initiatives.
- iv. Efforts to increase plantation should be made to enhance the supply of softwood sawnwood.

REFERENCES

BusinessTimes (2011). Housing Finance in Tanzania: Fears, challenges, prospects and catid.

[http://www.businesstimes.co.tz/index/php?option=com_content&view=articles&id=1528]Site visited on 19/06/2012.

Contractors Registration Board-CRB (2011). *Capacity and competence of contractors: A key to sustainable infrastructure development*. Annual report. 82pp.

Dar es salaam city. [[Http://en.wikipedia.org/wiki/Dar es Salaam](Http://en.wikipedia.org/wiki/Dar_es_Salaam)]. Site visited on 10th July.2013.

Dar es Salaam City Council (2004). Dar es Salaam City profile.98pp.
[<http://www.dcc.go.tz>]Site visited on 22/06/2012.

Dailynews (2011). Business and Finances; construction sector survives economic slump with sustained growth.

[<http://www.dailynews.co.tz/business/?n=26712&cat=business>]Site visited on 22/06/2012.

Development Partner Group (2007). Bilateral and Multilateral partners that provide development assistance to Tanzania.

[<http://www.tzdac.or.tz>] Site visited on 18/02/2011.

Food and Agricultural Organization (2007). Forest Products and Services, international. [www.fao.org/forestry/site/trade/en]. Site visited on 22/02/2011.

Food and Agricultural Organization (2011). State of the world's forests.164pp. [www.fao.org/docrep/013/i2000e/2000e.pdf]. Site visited on 22/02/2012.

Forestry and Beekeeping Division (2000). Forestry for poverty reduction and economic growth. National forest programme formulation in Tanzania (Draft). Forest and beekeeping division, Tanzania.28pp.

Forestry and Beekeeping Division (2005). Forest Inventory Reports. Districts of Rufiji, Liwale, Kilwa, Mkuranga/Kisarawe, mvomero, Tunduru, Kilombero, Mpanda, Nachingwea, Ulanga,and Handeni/Kilindi. Ministry of Natural Resources and Tourism, Forestry and Beekeeping Division, Dar es Salaam.

Forestry and Beekeeping Division (2011). Private forestry and Carbon Trading Projects. *Timber Market Dynamics in Tanzania and Key Export markets*. 193pp.

Gregory, G.R., Dwight. H., Josephson, H.R., Holopaine, V., Mantel.K., Pringle, S.I., Riihinen.P., Saether.R. and Vaux, H.J. (1971). Forecasting in forestry and timber economy. Folia forestalia101. Preliminary report, IUFRO, section 31, working group 4, Helsinki. 49pp.

Ilala Municipal Council (2012). District information.

[<http://www.imc.go.tz/2/index.php/component/content/article?layout=edit&id=8>] Site visited on 10th July, 2013.

International Plant Protection Convention (2010). International standards for phytosanitary measures. ISPM No5. 27pp.

[<http://www.eppo.int/quarantine/ISPM05.pdf>] site visited on 1st July 2013.

Ishengoma, R.C., Gillah, R.P., Amartey, S.A. and Kitojo, D.H. (2004). Physical, mechanical and natural decay resistance properties of lesser known and lesser utilized *Diospyros mespiliformis*, *Tyrachylobium verrucosum*, and *Newtonia paucijuga* timber species from Tanzania. Holz als Roh- und Werkstoff. 62:387 – 389.

Kinondoni district, (2008). Kinondoni profile.11pp.

[[Http://www.unicef.org/Tanzania/advocacy_brief_kinondoni.pdf](http://www.unicef.org/Tanzania/advocacy_brief_kinondoni.pdf)] Site visited on 10th July, 2013.

Kinondoni Municipal Council, (2013). District information.

[<http://www.kinondoni.go.tz/>] Site visited on 10th July, 2013.

Levin, J. and Milgrom, P. (2004). Consumer theory. 33pp.

[http://www.stanford.edu/jdlevin/econ202/consumption_theory.pdf] site visited on 1st July, 2013.

Machumu, R.T. (2008). Present consumption and forecast of sawntimber in Arusha and Kilimanjaro. MSc thesis, Sokoine University of Agriculture.101pp.

Mankiw, N.G. (2001). *Principles of economics*: Second edition. Harcourt College Publishers, USA. 837pp.

McGorman (2011). PVC windows and doors.

[<http://www.mcgormanwindowsblog.info/pvc.vs.wood/>] site visited on 17th August, 2012.

Milledge, S. A. H., Gelvas, I.K. and Ahrends, A. (2007). *Forestry, Governance and National Development: Lessons learned from a logging Boom in Southern Tanzania*. TRAFFIC East / Southern Africa/ Tanzania Development Partners Group/Ministry of Natural Resources and Tourism, Dar es salaam, Tanzania. 252pp.

Ministry of Natural Resources and Tourism (2005). *Evaluation of Sawmills and other primary wood industries in Tanzania*. Ministry of Natural Resources and Tourism, Dar Es Salaam, Tanzania.64pp.

Mwampamba, T.H. (2007). Has the woodfuel returned? Urban charcoal consumption in Tanzania and its implications to present and future forest availability. *Energy policy*, volume 35(8): 4221-4234.

National Bureau of Statistics (2006). Dar es Salaam Regional and District Projections. Volume XII. 137pp.

National Bureau of Statistics (2011). National Accounts of Tanzania Mainland 2000-2010. 49pp.

Ngaga, Y.M.(1991). Future consumption of Sawnwood for Arusha and Dodoma Msc thesis, Sokoine University of Agriculture 187pp.

Openshaw,K. (1971). Present consumption and future requirement of wood in Tanzania. FAO technical report no3, s f / TAN 15, Rome.47pp.

Otto, O. (2011). Estimating the demand and market power of a firm in sawnwood markets. Case:UPM-kymmene. 97pp.

Shayo, H. (2006). Forestry governance in limbo in Tanzania. A case study of a supply chain of the indigenous hardwood timber, timber trade and procurement codes. RICS Research Paper Series, Vol.6 (5):42pp.

TanzaniaInvest, (2009). Tanzania construction investments create sector growth.

[www.tanzaniainvest.com/tanzania-construction-and-real-estate/news/362] Site visited on 11th June 2011.

Temeke Municipal Council, (2012). District information.[<http://www.tmc.go.tz>] Site visited on 10th July 2013.

Ujenzisolutions, (2005).Construction statistics; Informal sector statistics.

[www.ujenzisolutions.co.tz./statistics.asp] site visited on 11th June 2011.

Unasyuva (1971). World consultation on the use of wood in housing. *Food and Agriculture Organization of United nations Journal* 25:11-159.

United Nations Economic Commission for Europe (1999). The competitive climate for wood products and paper packaging: the factors causing substitution with emphasize on environmental promotions.

[Website:<http://www.unece.org/fileadmin/DAM/timber/docs/dp/dp-16.pdf>] site visited on 9 June, 2012.

Unhabitat (2010). Citywide Action Plan for upgrading unplanned and unserved settlements in Dar es Salaam .78pp.

[Website:<http://www.unhabitat.org/publications>] site visited on 19 June, 2011.

Unhabitat (2009). Tanzania: Dar es Salaam city profile 36pp.

[Website:<http://www.unhabitat.org>] site visited on 19 June, 2011.

United Nations (2011). Population distribution, Urbanization, Internal migration and Development: An International Perspective. Department of Economic and Social Affairs Population.Division. 378pp.

United Nations Environment Programme. (2002). Assessment of trade liberalization and Trade related policies. *A country study on the forestry sector in Tanzania*. 74pp.

United Republic of Tanzania (2013). Population and housing census 2012, population distribution by administrative areas. 264pp.

[http://www.nbs.go.tz/projections/dsm_projects.pdf] site visited on 10th July 2013.

Wells, J. and Mlinga, R. S. (2002). Collaboration between formal and informal enterprises in the construction Sector in Tanzania, *Habitat International*, 26 (2002).

Wheelwright, S.C. and makridakis, S. (1985). *Forecasting Methods for Management* 4th edition. John Wiley and Sons. New York 404pp.

Zziwa, A., Kaboggoza, J. R. S., Mwakali, A., Banana, A. Y. and Kyeyune R.K. (2006). Physical and Mechanical Properties of some less utilized tropical timber tree species growing in Uganda. *Uganda Journal of Agricultural Sciences* 12(1):29-37. [http://www.iflea.uni-bonn.de/lit/Zziwa-Paper_on_hysical_properties.pdf]. Site visited on 26th March, 2011.

APPENDICES

Appendix I: Questionnaire



**SAWNWOOD PRODUCTS CONSUMPTION SURVEY IN BUILDING AND
CONSTRUCTION INDUSTRY**

BUILDING CONTRACTORS/HOUSE BUILDERS/ARCHITECTS

QUESTIONNAIRE 1a

General information

Name of Individual/Organization/Company.....Date.....

- 1. Address.....**
- 2. Type of enterprise/Firm**
- 3. Municipal.....**

Consumption of Sawnwood products in building and construction industry

- 1. How long have you been in the building and construction industry?.....**
- 2. What are the types of sawnwood products do you use in your building and construction works? Please Tick A) Hard wood (), (B) Soft wood (), (C)Both**

3. What type of sawnwood species currently used in the building and construction works (e.g.Mkongo, Mninga, Cypress)

.....

4. Where do you get these sawnwood products? Please Tick

(A) Dar es Salaam () (B) Other regions () (C) Both ()

5. What is the state of availability of sawnwood products (S = Scarce, V = Very scarce,

A = Abundant)? (A) Hard wood () (B) Soft wood ()

6. Among your preferred sawnwood products in the building and construction works which is the most demanded? (A) Hard wood () (B) Soft wood (), (C)

Both ()

Why?.....

7. Is the demand of your preferred sawnwood products Increasing (), Decreasing (), Constant ()?

SUBSTITUTE MATERIALS

8. Do you use aluminium materials in the building and construction works as a substitute of sawnwood products? If yes, in what percentage is aluminium most preferred? (A)Doors, (B) Windows, (C) Partition....., (D) Other

.....

9. What is the state of availability of aluminium materials? Please tick (A) Scarce (),

(B) Very scarce (), (C) Abundant ()

10. What are the factors underlying substitution of sawnwood products by aluminium

And other materials? (Please rank according to your preference e.g 1, 2, 3, 4, 5, 6, 7).

1= Strong factor, 7- Weak factor

Please tick (A) Availability (), (B) Durability(), (C)Quality (), (D)Appearance (),

(E) Technology advancement (), (F) cost of Sawnwood (), (G) Other ...

11. In what type of buildings does the substitution of sawnwood by aluminium occur mostly? (Please rank in percentage e.g. residential x%, commercial y%, offices z %) (A) Residential..... , (B) Commercial , (C) Offices.....

12. In which categories of buildings do the consumption of aluminium materials occur mostly? (Please rank in percentage e.g. Lower = x%, medium = y%, High = z %)

(A) Lower, (B) Medium, (C) High

(i.e. Lower category= 1 floor, Medium category=2-4 floors, High category= 5 and above floors)

13. From your experience in building and construction industry mention any other building materials that substitute sawnwood?

14. What is your comment on the future of Sawnwood products in the building and construction Industry compared to other building materials?.....

QUESTIONNAIRE 1 b

General information

1. **Name of Individual /Contractor**
/Firm/.....Date.....

2. **Municipal.....**

3. **Building / House use (e.g.**
residential/commercial/office).....

4. **Number of Storeys/Floor.....**

5. **Number of rooms.....**

6. **Construction activity (e.g. renovation/rehabilitation/new**
building).....

7. **Year of renovation/rehabilitation/new building**

Questionnaire 1 b: Data collection sheet

Item	Length(m)	Width(m)	No. of Doors/ windows	Material used(sawnwood /Aluminium)	Area (m²)	Volume (m³)
Doors						
Windows						

Checklist**Forest officers**

1. Do you have forest product register?
2. What quantities of timber registered in the municipal for previous five years?
3. Timber exported in five previous years?
4. How many timber processing industries are available in the municipal?
5. How many timber dealers do you have?
6. How many furniture makers do you have?

Timber traders

7. What are the timber prices for current and five previous years?
8. What are the causes of price fluctuation in the market?
9. Are the lesser known tree species timber do you have?

10. Are there any price differences between famous and lesser known timber?
11. What types of species are available in the market (Hardwood and Softwood)?
12. Who are the customers of your timber products?
13. What is the state of the market of your business?
14. Where do you source timber?

Furniture makers

15. What are the prices of Doors and Window frames?
16. Do these prices fluctuate? How?
17. What were the prices in five previous years
18. What are the preferred timber species for Doors and Windows? Why?
19. Who are the customers of Doors and windows?
20. Which is most preferred between Doors and windows?
21. What is the state of the market of your business?
22. What are the causes of fluctuation?
23. Do Aluminium Doors and frames affect your business? How?

Aluminium dealers

24. What are the prices of aluminium frames and windows?
25. Does the price of Aluminium fluctuate? How?
26. What was the price in two past years?
27. Who are the customers of your products?
28. What is the state of the market?
29. Which is most preferred between Doors and windows?
30. Does Timber Doors affect your business? How?
31. Which is durable between Aluminium and timber in the building and construction activities?

Appendix II: List of respondents

II .a. Architects and Architectural Firms

1.	Aru-Architecture Unit	Architectural Firms
2.	Claus Bremer Associates	Architectural Firms
3.	Arch Plan International ltd	Architectural Firms
4.	Cons-Africa ltd	Architectural Firms
5.	B.J. Amuli Architects	Architectural Firms
6.	Envirolink Architects Ltd	Architectural Firms
7.	Design Solutions	Architectural Firms
8.	G. K. Architects	Architectural Firms
9.	Hab Consult Ltd	Architectural Firms
10.	K&M Archplans (T) Ltd	Architectural Firms
11.	Interconsult Ltd	Architectural Firms
12.	Kapwani Architects	Architectural Firms
13.	In-House Projects Consultants	Architectural Firms
14.	Landplan-Icon Architects Ltd	Architectural Firms
15.	MD-Consultancy Ltd	Architectural Firms
16.	Mekon Arch Consult Ltd	Architectural Firms
17.	MOD Architectural Unit	Architectural Firms
18.	Ramani Consults Ltd	Architectural Firms
19.	P.S.M Archtechts Co.LTD	Architectural Firms
20.	Plinth Design Workshop Ltd	Architectural Firms
21.	N. H.C. Archtechts	Architectural Firms
22.	OGM Consultants	Architectural Firms

23.	Space in Place Archtechts	Architectural Firms
24.	Sumar Varma Associates Ltd	Architectural Firms
25.	Y&P Architects (T) Ltd	Architectural Firms
26.	SKY Architects Consultants	Architectural Firms
27.	Designs and Services Ltd	Architectural Firms
28.	Nedco ltd	Architectural Firms
29.	Sephania Solomon	Architects
30.	Gasper Zulu	Architects
31.	Philip Tesha	Architects
32.	Joseph Ringo	Architects
33.	Traseas Ngugo	Architects
34.	Josephat Peter	Architects
35.	Fatuma Ngwale	Architects
36.	Isaac Mwilongo	Architects
37.	Octavian Mtaro	Architects
38.	John Mponeja	Architects
39.	Rwehoshora Munyaga	Architects
40.	Yusuph Mlimakifi	Architects
41.	Miraji Mkupete	Architects
42.	Hassan Mohamed	Architects
43.	Jimmy Mkenda	Architects
44.	Jeremia Manyanga	Architects
45.	Nicodemus Lukindo	Architects
46.	Engelbert Lipambila	Architects
47.	Robert Kintu	Architects

48.	Anold Lyatuu	Architects
49.	Novat Ludovick	Architects
50.	Fanuel Kingu	Architects
51.	Edwin Lyimo	Architects
52.	Felix Kuyela	Architects
53.	John Kitundu	Architects
54.	Marko Kinyaha	Architects
55.	Josephat Kalwera	Architects
56.	Henry Kavishe	Architects
57.	Fulgence Kibiki	Architects
59.	David Kibebe	Architects
60	Thomas Kalugula	Architects
61.	Maurus Baruti	Architects

II. b. Construction Companies

1. China Railway Jianchang Engineering co.tz.ltd
2. Estim Construction co.ltd
3. Kams Construction Company
4. Masasi Construction co.ltd
5. Herkin Builders ltd
6. Quality Building contractors ltd
7. R & A Works Company ltd
8. R.T. Construction ltd
9. Tommy Building & Civil Engineering contractors co. ltd

10. Holtan Builders ltd
11. Ramada investment .ltd
12. Chibago Investment co.ltd
13. Pattyinterplan ltd
14. Y.N. Investment
15. Skywards Construction co.ltd
16. N.W. Builders co.ltd
17. Amar Builders.ltd
18. Lucky Construction ltd
19. Serico Company ltd
20. Elcon Contractors ltd
21. Kikim Contractors
22. Vika Construction co.ltd
23. Mainland construction company
24. V&K holdings
25. Emirates Construction co.ltd
26. Universal Engineering ltd
27. Jemason Investment
28. Oswald Construction Company
29. Kiure Engineering Ltd
30. Aquifer Construction ltd
31. Shibati construction co.ltd

II.c Timber Dealers

1. Suleiman Said
2. Hemed Rashid
3. Yusuph Amri
4. Raymond William
5. Enock Sanga
6. Gebu Mchome
7. Arizona Enterprise
8. Sambuo General Enterprise
9. Micco Import and Export
10. Boniphace Martine
11. Charles Silayo
12. Astrida Ikenda
13. Shaluwa Timber
14. Mheka General supplies
15. Salum Mwamba
16. CET Timber and General supplies
17. Mang'ana Timber supplies
18. Tanganyika wattle Company. LTD
19. Wajasiri Investment LTD
20. Kitundu Enterprises
21. Mathebe General Supply
22. Masawe Hardware
23. Upendo Group
24. Mwanzo mzito Cooperative

25. Salum Ally
26. Issa John
27. Kemondo General Supply co.ltd
28. Hosea Siwonile
29. Nuru A. Mandela
30. Joseph K. Joshua
31. Thermo co. ltd
32. Mpala kyala general supply.ltd
33. Fortunatus Haule
34. Giliard C. Kimambo
35. Abdullahman Salum
36. Mdogo A. Juma
37. Prolina M. Tairo
38. Emmanuel L. Kilawe
39. Messon Company ltd
40. Wilson Michael
41. Iman Super dealer
42. Libent Kalikawe
43. Jimmy M. Kivuyo
44. Joel Msambichaka
45. Alison Y. Sewa
46. Shio enterprise

II.d. Timber end users

- | | | |
|-----|----------------------------|--------------|
| 1. | Nurdin | Omary |
| 2. | Mwakitope | Family |
| 3. | Kassim | Hemed Kitoch |
| 4. | Beatus L. | Asenga |
| 5. | Benedictine | Fallin |
| 6. | Omary | Salim |
| 7. | Juma K. | Karatwa |
| 8. | Haridi M. | Karanji |
| 9. | Uwesu | Mbamkio |
| 10. | Harid | Karanja |
| 11. | Rashid | Ngonyani |
| 12. | John | Clement |
| 13. | Ndesiamoke | Kimaro |
| 14. | Salum N. | Omary |
| 15. | Juma | Hassan |
| 16. | Elisha K. | Selemba |
| 17. | Mengisen | Kwayu |
| 18. | Mwasilu wood works | |
| 19. | Ridhika wood works | |
| 20. | East African Hardwood .ltd | |
| 21. | Timber impregnation ltd | |
| 22. | Kaka building material | |
| 23. | Arizona Enterprise | |
| 24. | YGF Investment | |

25. Segerea Enterprises
26. P&P share Trading co.ltd
27. Hainan International ltd
28. Saohill Industries ltd
29. Huixin feng International
30. C.M. Multworks ltd
31. Hassan Ahmed Mrimbo
32. Seed Shamba ltd
33. Reliable wood works
34. Kisinga timber wood works
35. T&T construction co. ltd
36. Kaburu S. Tande
37. African Hardware Traders
38. Rotalice co.ltd
39. Tanland company
40. Ecophilic co.ltd
41. Zigma ltd