DEMOGRAPHIC PATTERNS OF SOCIO-ECONOMIC NEEDS; INFORMING PUBLIC RESOURCE ALLOCATION CRITERIA IN KENYA

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DECLARATION

I proclaim that this work of research is neither formally submitted nor ratified for the award of a degree by others, this or any other University. To my utmost knowledge the research submission accommodates no materials previously published or written by another person except where due reference is made in the thesis itself.

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This project has been presented for certification with my approval as the appointed supervisor.

Signed:…… Date: 29/11/20---

Dr. Samuel Nyandemo

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1 INTRODUCTION

1.0 Background Information

Resource allocation is an applied economic concept that emanates from the scarcity of resources due to limited supply has given the need to meet unlimited population needs and wants. Various means are used in allocating resources, including markets in free economies and planning through political processes in mixed economies. Modern macroeconomic theory and policy rest on the assertion of John Keynes's mixed economic system on the role of government in solving market problems and promoting welfare. Harvey, J. (1981), through his analysis of the relationship between public sector growth and labor force expansion, acknowledges economies embracing the case for public sector spending in providing adequate interventions to access public goods.

The government in a mixed economy is constantly under pressure to quench the ever-growing demand for public goods and services to improve society's welfare level (Montibeller & Franco, 2011). The paradox of efficiently allocating public resources rests on fiscal budgets as a tool for public sector spending and determining the services' value for money financial expenditure avenues (Barroy & Gupta, 2020).

The unique nature of a government in mixed economies is in its combination of markets and planning considerations in allocating resources to public goods and services, including healthcare, education, defense, and fire emergency services. According to (Nafziger, 2021), sufficient food, entrance to primary education, basic health services, adequate and consistent water supply, proper sanitation, and safe and affordable housing is the set of basic needs of a population fulfilled through public service in mixed economies. However, the considerations and deliberations that inform public resource allocation and distribution decisions vary from different factors that come into play to the weights attached to the mandatory and essential variables (Kakungu, 2013).

Over time, empirical studies and rigorous research activities have been aimed at generating and improving existing resource allocation avenues to achieve more effective and efficient public spending within the government, the New Zealand (Treasury, 2018) study.

Different governments have explored different approaches to allocate resources efficiently (Allain et al., 2015). The standard cost approach in resource allocation utilized in Australia is anchored on total expenditure broken down by function and jurisdiction; calculations on the average cost per capita of providing a particular service across different locations form the public resource allocation basis. Modifications of this approach have been applied in Japan and Sweden.

Local authorities in the United Kingdom apply a regression-based approach, an improved standard cost approach in resource allocation. A model of public resource allocation is determined by performing a regression analysis on explanatory variables such as population size, deprivation, and others that portray regional differences, which are viewed as needs indicators to explain past public spending variations (Dolan, Layard, & Metcalfe, 2011). Different approaches utilized include the Outcome-based method that is applied by Wale and the Bottom-Up cost approach for the Netherlands.

Despite these deliberate efforts, no unanimous concession has been reached on how governments can efficiently resource allocation to maximize societal welfare.

1.1 Public Resource Allocation in Kenya

Kenya's 2010 Constitution has been deemed a well-sought-after solution to attaining equity in public resource distribution (Kinuthia & Lakin, 2016). It appeared to debunk the proposal of allocating public resources to areas with a comparative advantage as proposed by the 1965 Sessional Paper 10 ("African Socialism and its Application to Planning in Kenya"). Although those mentioned above diverged in the approach, they both pointed to addressing some socioeconomic inequities for "less developed areas in the country" and "for marginalized groups and areas."

Deliberate efforts have been channeled to shape public resource allocation in Kenya. These efforts include the Development Fund allocated to constituencies, various active schemes for cash transfers, Equalization Fund disbursed to counties to address marginalization, and county conditional water and health grants.

Public resource allocation in Kenya conforms to the 2010 Constitution. The Commission of Revenue Allocation (CRA) recommends the basis for horizontal public resource sharing of national government revenue between County and National Governments as articulated by Article 216 of Kenya's 2010 Constitution.

It is a long-established principle that the citizens in Kenya have a right to equal access to public services, and relative needs should inform public resource allocation. The CRA formulas were generated and have evolved to facilitate equitable resource sharing and to ensure inclusivity in attaining economic growth and development. The formulas transitioned from the first to the third Generation, with the changes seeking to incorporate socioeconomic variables deemed vital in

bolstering economic growth and improving human welfare in our country. These details are shown in table 1 below:

Table 1: Commission for Revenue Allocation Formulas since Devolution

Index	1st Generation	2nd Generation	3rd Generation	Deviation from 2nd	Deviation from 3rd
Population	0.45	0.45	0.18	-0.27	-0.27
Equal Share	0.25	0.26	0.19	-0.06	-0.07
Poverty Gap	0.2	0.18	0.14	-0.06	-0.04
Land Area	0.08	0.08	0.08	0	0
Fiscal Responsibility	0.02	0.02		-0.02	-0.02
Development Factor		0.01			-0.01
Health			0.17		
Agriculture			0.1		
Public Administration			0.01		
Urban Services			0.05		
Rural Access			0.08		
AGGREGATE	1	1	1	-0.41	-0.41

Data source: Commission for Revenue Allocation

The explanatory variables incorporated in allocating public resources include the size of the population, land area occupied by counties, and poverty gap, among other variables deemed to portray need.

Over time, the population proportion has been a significant factor in all the generational formulas despite its 60 percent[1] decline in the weight attached to the third formula. The population index has been inferred from the county's population relative to the country's (see figure 1 below). This definition biases these allocations towards counties with larger populations.

$$P_i = \text{Population of County, } i \,/\, \text{Summation of Population in County } i$$

Data Source: Commission for revenue allocation

[1] The percentage is expressed based on the initial first-generation weight of 0.45 as compared to 0.18 of the third generation.

1.2 Statement of the Problem

The resource allocation criteria in Kenya have been slowly evolving and seem to take baby steps at fulfilling global and regional principles and practices that define resource allocation and distribution (Kinuthia & Lakin, 2016). Devolution was a major change ushered in by the 2010 Constitution of Kenya. Although the people attached great expectations to the era of Devolution, the socioeconomic aspirations seem to be out of their reach with the slow transfer of resources to the counties (Ngigi & Busolo, 2019). The flow of public resources through budgets has been slow and disbursements lesser. The current trends in inflation and cost of living (KNBS monthly inflation reports) seem to be quickly deteriorating the welfare levels of the population. Whereas the Civil Society Groups and local and international donors have united with the government in their complementary role of attaining the SDG 2030 dream of promoting welfare and enhancing livelihoods, deliberate allocations by the government to needful and socioeconomically deprived counties are yet to be seen (Kayode, Muhammad, & Bello, 2021).

The undesirable microeconomic outcome of Kenya's resource allocation criteria through the increasingly wide discrepancy between the rich and the poor and the deprived and privileged households cannot be overlooked. More Kenyans daily are increasingly unable to afford their basic needs and sustain themselves in the unprecedented harsh macroeconomic environment (see Kenya Food Security Outlook 2022) (Kumar, 2021). Poor access to basic needs leads to indebtedness which tends to hinder welfare improvement (Chamboko & Guvuriro, 2021). In the wake of these developments and socially undesirable outcomes, this study seeks to develop a resource allocation framework to address the needs and gaps of the socioeconomically deprived in Kenya.

1.3 Significance of the Study

There have been multiple research works explaining public resource allocation criteria in Kenya. Nevertheless, most of these studies failed to utilize the population census data to offer a viable alternative criterion that provides a more descriptive population characteristics perspective. The current research will lay the groundwork for a debate on utilizing socioeconomic characteristics in determining a deprivation index that biases more allocations towards socioeconomically deprived counties. It seeks a more comprehensive population index recommendation informed by demographic characteristics detailing counties' basic population needs (Krebs & Levy, 2020).

In addition, the findings of this study will help inform policies aimed at improving the welfare of socioeconomically deprived populations in Kenya. While this research may not solve the myriad development challenges facing the socioeconomically deprived populations, it will attempt to establish a public resource allocation criterion informed by the demographic patterns of socioeconomic needs. It will consistently pave the way for more elaborate deprivation-sensitive indices in public resource allocation in public service (Haase, Steinführer, & Kabisch, 2013).

The CRA formula has focused on a non-disaggregated index which may not favor allocations that address the pertinent issues facing the deprived and marginalized population. This study seeks to offer a new approach to addressing the socioeconomic deprivation of the Kenyan population by generating a more disaggregated index that reflects existing patterns in socioeconomic needs, in place of the population index, thus contributing to a relatively new alternative method in Kenya.

1.4 Research Questions

i. Do the socioeconomic needs of a population in Kenya determine a subsequent public resource allocation criterion among counties in Kenya?
ii. Do the socioeconomic needs of a population in Kenya predict the individual level of population deprivation among counties?

1.5 Objective of the Study

The primary goal of the research is to use demographic patterns of the socioeconomic needs of Kenya to inform and improve public resource allocation criteria.

The specific research objectives are:

1. To determine public resource sharing model for counties in Kenya informed by their populations' socioeconomic characteristics.
2. To determine the counties' deprivation index in Kenya based on socioeconomic characteristics.
3. To inform policy favoring need-based socioeconomic planning and public resource allocation sharing among counties in Kenya.

2 LITERATURE REVIEW

2.0 Introduction

2.1 The Theory

2.1.1 Malthusian Population Theory

The Malthusian theory was developed by Robert Malthus in 1798 in the work, "Essay on the Principle of Population," and he shared his views on how future improvements of any society are largely influenced by population. According to Malthus, the amount of food yielded per head exhibits an inverse relationship with an aggregate population (Chowdhury & Hossain, 2018, pp. 2- 3), a premise that he attributed to the Law of Reducing Yields. This theory states that population and food supplies are growing, but that population is growing faster than food supplies. A disclaimer is posited on the entry of vice and misery if these growths are not monitored. Thus, Malthus' theory explained the relationship between an increase in food supply and population. However, this theory asserts growth in food production is a limiting factor to an increasing population (Rahman, 2019, p. 14).

The theory, the first systematic attempt to explain economic development and determining an individual's income (Ehrlich & Kim, 2015, p.2), is founded on a wide range of household (microeconomic) factors relating to fertility levels and death rates and macroeconomic production. The model formulated explains the circumstances under which a population automatically balances itself to include zero changes in technology or agricultural land. The model further divulges that an increase in available resources in an economy may not translate to a change in the level of per capita income (Galor & Weil, 2006, p.140).

Malthus appreciated the consistent efforts needed by the people to facilitate the process of economic development, as opposed to an automatic process, and observed that an economy slumps severally before accomplishing an exceptional level of development (Varian, 2018). Hence, the economic development process is a rough one on economic activity (Rahman, 2019). He emphasized maximizing production activities and optimally allocating resources to increase a country's opulence in the short run.

This theory supports the study in promoting economic development as it favors a more unbiased dispensation of landed possessions that would increase effectual demand and production (Rahman, 2019). The theory proponent notes that if the land divided into small possessors is carried to an extreme, it would negatively affect production.

According to Malthus (2018), wage tends to sustain the living standard stable so that families of workers can survive on this. Whenever the salary rate is more than the minimum, the working citizens tend to increase because of the growth experienced by the labor power, which ultimately raises the living standards (Hagerty, Vogel, & Møller, 2002). Ultimately, the propensity of diminishing returns will apply, and the demand and supply victual level.

The theory contributes to the current study in determining the resource allocation models by the socioeconomic characteristics in the modern population phenomenon as it is considered a driving force for the countries' economies and influences economic achievement, which depends on population variables including age. The impact of technological advancements in various sectors particularly the health sector has facilitated continuous population increase overtime (Simon, 2019).

2.1.2 The Optimum Theory of Population

Postulated by Edwin Cannan in 1924 in the book "Wealth", the Optimum Theory of Population idea became popular on accounts of Robbins, Dalton, and Carr-Saunders (Cannan, 2019). The optimum theory is more focused on the relationship linking the population's size and the production of wealth. (Carrington, 2018), describes the optimal population as the perfect population, which, merged with the other resources availed to them available or the country's production means, will capitulate the maximum returns or income per head. Similarly, (Dasgupta, 2018) states that optimal population is the hypothesis that the human population can be stabilized by maintaining a maximum population size with an optimal standard of living for all.

According to Coale and Hoover 2019, a rise in the population size above or below the prime level will lower income per person. They further assert that if the rise in population increases per capita income, the population density within the country is lower than expected, and it may succeed in increasing the population until it reaches an optimal level. (Coale & Hoover, 2019). Conversely, an increase in population would lead to a decrease in per capita income, and the country would become overpopulated and would have to be depopulated to maximize per capita income.

According to the theory, the prime level is not a rigid point; it changes with variations in any element, like methods and techniques of production. It further premises that the median product of labor might rise and push the level of per capita income upward to raise the optimum point. (Cannan, 2019) assures that an increase in population is safe and suitable, considering the actual

population is less than the optimum to cover for the newly born child. He avers that increasing population raises the labor force, which assists in raising the optimum expansion of the country's natural resources; this is crucial as it supports the current study on how a country can sustain resource allocations equitably to the counties.

The theory further contributes to the current study as it relates the population's problem to the country's total production. It is an opportunity that allows the country to tap into the available resources and balance the region's priorities of needs on allocations. The optimum theory is also dynamic as the per capita income may increase over time with the augmentation in production due to improvements in knowledge, skill, capital equipment, and other elements in output (Dunsdorfs, 2014).

2.1.3 The Household Economic Model

Becker 1965, propounded the modeling of household verdicts and resource allotment in a model where a household is both a producing and consuming unit. The theory states that the household's output is consumed firsthand without being sold in the market (Muth, 2020). Becker suggested that the high-yielding household model was a significant advance in understanding household conduct proportionate to models that treated households as purely consuming units (Varian, 2018, pp. 77-98).

Chiappori 2019, notes that the Gari Beckerian household considers the family the most fundamental societal institution in society and that his theory—the new household economic theory—was initially adopted to describe resource allocation, decision- making and utility maximization processes of households. The theory later extended to developing countries and particularly to the analysis of agricultural households (Fulop, 2019). Under this model, total income is split among household members based on a sharing rule, and each maximizes its use on its own. The sharing rules are the foundation behind decisional processes (Chiappori, 2019).

A contemporary study by Hamermesh 2019 is established on household production theory in his factual study of demand for food-at-home and away-from-home and time issued to eating by married couples in 2005 and 2015. He further argues that improving the household's well-being (including all members) does not rely on applying the market economy's principles. Non-market behavior, including security, closeness, humanity, and social connections, is just as important.

Thomas 2018, in his findings on the dispensation of Income and Expenditure within the Household, argues that Becker's approach brings meaningful new insights to the traditional consumer theory; for example, he considers the household as both a consumption and a production unit. The study findings note that the features, or want-fulfilling qualities, of the commodities used and produced, can define households' production and consumption technology (Becker, 2017). Households still change expenditures like in theory used earlier, even with the alterations made in incomes and prices. However, in the new theory, households alter their behavior patterns in discovering new products and their importance in household production procedures (Hamermesh, 2019).

According to Gronau 2020, the household production function does not bring new elements to the science of political economy. Any utility gained by spending time on everyday activities would only be a by-product of the pursuit of money income. It means that events within the household and the primary commodity production are assumed only; to improve efficiency and gain income from work in the labor market. Additionally, Becker notes that Household work only performs the labor reproducer and the purchaser of market goods (Becker, 2003). Household members are taken care of within the household sphere in order for these members to be efficient servants of the market economy.

The study adopts the Household Economic model to interpret the need for the policymakers on resource allocations to the counties to consider to a greater extent, the individual member of the household and their production and consumption levels. In addition, it sets precedence on how to assign resources to counties while uplifting the well-being of the members of the communities. As Gronau 2020 notes, Economic theories of the household made efforts to encompass the compound structures of households and their characteristics. Details on the societal structure, decision-making process, resource allocation, income earning mechanisms, and gender division of labor are required to comprehend the impacts of public or private sector intercessions at the micro level and their macro-level reverberations.

In the population theory, Malthus did not consider the economic development process as automated. Instead, consistent efforts were required on the people’s part (Weir, 2018). He viewed the development process as one of the uncertainties of economic activity and considered production and distribution as "the two grand elements of wealth." If merged into proper segments, they can raise the wealth of a country in a short duration. So, Malthus foregrounds maximum

production and optimum allocation of resources for increasing the opulence of a country during the short run.

In 1973, economist Robert Willis and sociologists Becker and H. Gregg Lewis analyzed the quality—quantity model further, explaining the discrepancy between the size of the income influence on birthrate and the quality of offspring. A kid's quality determines the marginal cost in this model, whereas the total number of children affects the marginal cost per child. As a result, the marginal cost of producing an extra unit of a given quality is proportional to the quality-to-quantity ratio. Substitution effects strengthen the change in whether these features of children have more significant income flexibility. The marginal cost of quantity over quality shifts in the benevolence of whichever has the more significant income elasticity. If this is the case, a rise in wealth has two effects: one that increases quality per kid due to the income impact plus the induced substitution effect, and another that decreases fertility due to the income effect minus the induced substitution effect.

Robbins, Dalton, and Carr-Saunders helped spread the word about Edwin Cannan's optimal theory of population, first proposed in his 1924 book Wealth. Unlike the Malthusian idea, the optimal theory does not establish a link between population increase and food availability. Instead, it emphasizes the correlation between economic growth and population size (Fulop, 2019).

Economists have long focused their attention on the consumption and labor supply choices of one-person families, as this is the most basic unit of analysis in the economic theory of the home. Also, the household's choices may be characterized by a utility function whose maximization is constrained by the available funds. Intriguingly, this approach produces observable limits on domestic conduct. For instance, according to consumer theory, zero-homogeneity, symmetry, and semi-negativity are necessary properties of household needs. If these conditions are met, the econometrician can investigate how economic policies affect people's well-being by retracing their preferences from data collected on the whole spectrum of household needs. However, it is essential to note that recent developments in family economics, following in the footsteps of Gary Becker's seminal writings, have adopted a more holistic perspective of household behavior, encompassing non-market activities like reproduction, education, and time allocation. Consequently, the family is shown as a production unit that combines the agent's time with market commodities to generate the outputs, and this agent eventually seeks to address these concerns.

The consumer model may easily be adapted to decisions about the supply of labor, and to demonstrate this, one must assume that one individual possesses a set.

2.2 Previous Studies

Fifty Years after the Social Indicators Movement (*Land, & Michalos, 2018)*: Has the Promise Been gratified? An Assessment, an Agenda for the Future, acknowledges the deliberate mass efforts made in arriving at a social, economic index that addressed the quality-of-life conversation during the nineties including, "Assessing Quality of Life and Living Conditions to Guide National Policy, edited by Hagerty, Vogel, and Møller (2002), Barometers of Quality of Life Around the World edited by Møller et al. (2008) and Millennium Development Goals (MDGs) in Retrospect edited by Andrews et al. (2015)" works that shaped the famously known social indicator movement. He identified six components that defined the level of living concept as one that "directs and restricts information to the areas where the political mechanism is by some degree of consensus used to influence the living conditions through social policy", "organizes the information into areas or levels of living components, by the sector divisions used in social policy", offers "a unitary measure of welfare, a GWP, is rejected in favor of separate indicators to be assigned relative weights through the political process", "it is primarily concerned with the individual's command over resources with which he can act rather than with individual need satisfaction", "political resources are included as a level of living component", and "We would not attempt to specify 'a model for the good life', thus summarizing and making explicit all value premises in some neat formula from which we could then go on to specify indicators. Also identified are the Better Life Index and how is Life? Measuring Well-Being as the two core products for better life initiative addressed their eleven significant areas of concern in OECD activities. In addition, Lands 2018, recognized that there was no unanimity on what countries considered the quality of life in government manipulations. A list of nine components was developed to capture the level of living. "It included work and working conditions, economic resources, political resources, schooling, health and the use of medical care, family origin and family relations (social resources), housing, nutrition, leisure time and pursuits."

Kakungu 2013 modeled a resource allocation model for constituencies in Zambia using the principal component analysis method on 2010 census data to address socioeconomic disparities through need-based resource allocation. The study suggested that relative disadvantages existed

among constituencies determined by varied types of deprivations consolidated into a composite deprivation that was to form the basis of Constituency Development Fund Allocation. The composite deprivation index (Kakungu, 2013) was determined by the use of socioeconomic variables, including access to clean water, improved energy sources, environment-friendly solid and human waste disposal methods, and internet connectivity; knowledge deprivation, quality of housing and ownership of lifestyle assets such as mobile phones, radio, TV, fridge, motorcycles, vehicle, and computer. The findings of this study explained that 60% of the Zambia population was most deprived, 15% moderately deprived, and 25% most deprived. This study will greatly use Kakungu's 2013 approach to generating a composite index to develop an index that will determine counties' public resource allocation criteria. The predictor variables will mirror the same study.

2.2.1 Variables relating to Access Deprivation

1. The proportion of households without access to improved sources of water supply
2. The proportion of households without access to improved sources of energy for lighting, heating, and cooking

Maurya & Pandey 2010 study mentioned earlier also examined the deprivation from a decent standard of living in India using the UNDP Human Development Index. The study defined this deprivation as the percentage of the population without access to safe drinking water, energy supply per 100,000 people, number of electrified villages, and other variables. The study explains the presence of a decent standard of living across all the states in India (Chen, J. T., & Kriege, 2021). In addition, approximately half of the population proportion in India was exposed to over 40 percent of decent housing deprivation. The definition of water deprivation used in the Indian study will be replicated in this research work, as well as the concept of energy deprivation.

3. The proportion of households without access to solid waste collection
4. The proportion of households without access to human waste collection
5. The proportion of households without a toilet

(Akoteyon & Soladoye, 2021), Used descriptive statistics and the slum deprivation index on randomly sampled 1,398 households in 16 settlements to explain deprivation in slums in Nigeria. The study analyzed WaSH, dwellings, and the physical environment, including the presence of stagnant or sewage water near the dwelling, the presence of solid waste piles near the dwelling,

the availability of waste bins in the household, the type of waste bin, and method of waste disposal components to explain deprivation. Akoteyon & Soladoye 2021 established that 18.7% of the slums in Nigeria are highly deprived. Deprivations in water, sanitation, and hygiene indicators showed slum deprivations levels of 37.5, 12.5, and 56.25%, respectively. Moreover, 50, 37.5, 43.75, and 31.25% of the slum are highly deprived based on dwelling, waste disposal, waste pile, and stagnant water, respectively. 57.5% employed proper waste disposal methods on waste disposal methods, and only 47.5% of the households had solid waste piles around their dwellings. This study only focused on slums as a jurisdiction for analysis. The research study will focus on a larger area, an entire country while considering a socioeconomic approach.

6. The proportion of households without access to the internet

World Health Organization and UNICEF attach great importance to access to clean water, adequate sanitation, and hygiene. Lack of basic drinking water services, especially in rural areas, open defecation, and other forms of poorly managed sanitation show the global need to address such socioeconomic attributes of populations WHO, 2021

(Shandler & Canetti (2019) uses a controlled randomized experiment on a sample of 60 comprising partly of students and community members to test the consistent effectiveness of individuals to politically express themselves, associating with others, and sought for political information in the presence or absence of internet access. The authors found that internet deprivation had significant (medium to large in magnitude) negative repercussions on an individual's ability to exercise basic political rights. Under Internet access, 61%, 93 %, and 71% of participants were able to express themselves politically, exercise civic association, and access political information, respectively, compared to 29%, 47%, and 44%, who lacked internet access. (Shandler & Canetti (2019) did not have an avenue for correcting this deprivation beyond exhibiting the social-political costs of a deprived population. This study considers internet access as a human right that influences government trends in public resource allocation.

Kumar 2021 observed that poor households in India faced high deprivation levels compared to the non-poor, especially in the rural areas. He used the Modified Sopher’s Disparity Index to explain the stark differences in access to basic public goods between the poor and non-poor household classification, livelihood categories, religious groups, caste, and ethics groups. Kumar's 2021 study used the probit model to explain the high deprivation patterns among poor households, agricultural laborers, households historically influenced by caste and ethnic-based organizations, and those in

minority religions in India. He showed the existence of a similar pattern in accessing basic amenities among the mentioned social groups. This study will extrapolate the observation of socioeconomic patterns among the various groups to model a deprivation index for the various counties in Kenya.

2.2.2 Variables relating to Knowledge Deprivation

7. The proportion of persons without any formal education

(Maurya & Pandey, 2010) utilized the UNDP Human Poverty Index on state data from Economic Survey-2009-10 to explain deprivation from access to knowledge in India. This study defined knowledge access through literacy rate and gross enrollment ratio in class I-VIII classes for ages 6 to 14. The study established that all the states in India are significantly deprived of knowledge access, and out of the 27 states, 24 states had a deprivation index of beyond 30 per cent. The Maurya and Pandey study conducted in 2010 used the estimated composite deprivation index to estimate an individual's deprivation. The study's definition of knowledge access was subjective to the case of India. This study will utilize varying definitions to estimate the knowledge deprivation index and the average individual deprivation per county.

2.2.3 Variables relating to Housing Deterioration

8. The proportion of households whose roofs are made of poor quality material.
9. The proportion of households whose dwelling's wall is made poor quality material.
10. The proportion of households whose dwelling's floor is made poor quality material.

The aforementioned (Akoteyon & Soladoye, 2021) slum deprivation index study defined dwelling type by housing unit types and the total number of residents per dwelling. The study proved that approximately 80.0% of slum residents occupied a one-room apartment, 16.5% a room-parlor apartment, and 3.9% flat dwelling units; less than 1% lived in duplex dwelling units. Environmental conditions pointed at approximately 55.0% of slum households having stagnant water around their dwellings.

The Kenya National Bureau of Statistics has released the most recent research on child poverty in Kenya across several dimensions (2017). Using data from the 2014 Kenya Demographic and Health Survey (KDHS), this study analyzed child poverty in Kenya with a method called multiple overlapping deprivation analysis (MODA). Deprivation rates were 29% higher for children aged

12–59 months than 12% for children aged 0–11. Between 12 and 59 months, 37% of children were undernourished, but between 0 and 11 months, that number dropped to 17%. Children between the ages of 0 and 11 were most likely to be without basic sanitary facilities (54%), followed closely by inadequate shelter (53%). Similarly, among five and 14-year-old children, the largest deprivation rate was seen in housing (52%), followed by sanitation (58%). Disparities in access to healthcare, schools, and knowledge were 38%, 37%, and 27%, respectively. Child poverty was evaluated but solely using data from the 2014 KDHS. The study uses the normative method and globally acknowledged characteristics of child well-being to analyze child deprivations over five waves of the KDHS from 1993 to 2014.

2.3 Overview of the Literature

It is without a doubt that various socioeconomic characteristics have been used to explain non-monetary deprivation from the literature. Even though the conversation on composing an appropriate deprivation index is far from over, any deprivation measure should flexibly accommodate the varied views on welfare. This paper has deliberately attempted to construct a robust deprivation index that integrates the mass effort made by earlier research on welfare patterns. While most of these socioeconomic characteristics seem to be fundamental in influencing a deprivation index and, ultimately, a public resource allocation criterion, the relative scale in the magnitude of influence is unequal (BocquetAppel, & Naji). Different models, including profit, multivariate analysis, controlled random experiments, and component analysis, have been used to predict the influence of single socioeconomic characteristics and jointly analyzed socioeconomic patterns on welfare levels, deprivation trends, and public resource allocation. In Kenya, a single component index, the population index, has been used to inform public resource allocation. People may be counted in one or more of the domains, depending on the number of types of deprivation that they experience." Karadimitriou et al., 2021. It is doubtful that a single component can sufficiently predict deprivation and ultimately influence resource allocation. In light of this observation, this study will utilize a robust Kenya dataset drawn from the 2019 Population Census Reports.

3. RESEARCH METHODOLOGY

3.0 Introduction

In this section, the methodology incorporated for this study was coherently described with a deliberate focus on the study area, the data sources, the empirical model and its analysis, and the indicators under consideration.

3.1 Conceptual Framework

The central idea behind public resource allocation was to effectively maximize the welfare of a population in a given society while conforming to the global principles and good practices attached to sharing resources. The option chosen by a government or state depends on the level of welfare it intends to achieve for its population. Explaining public resource allocation, therefore, required making several assumptions about a society's social welfare function or assuming that the decision is anchored on a government's relative financial position (Kabubo-Mariara, Wambugu, & Musau, 2011). In either case, a government out to maximize social welfare while minimizing costs will pick a public resource allocation criterion that yields better social welfare.

Public resource allocation offers a government multiple options for maximizing societal welfare. In this research, the socioeconomic characteristics of a population offered a tangible basis for resource allocation. These portrayed the population proportions that have access to essential public goods and view them as privileged. Populations without access to these public goods were deemed deprived, from which the deprivation index is obtained. It followed that a sound government will channel the flow of more public resources to deprived populations compared to those with access.

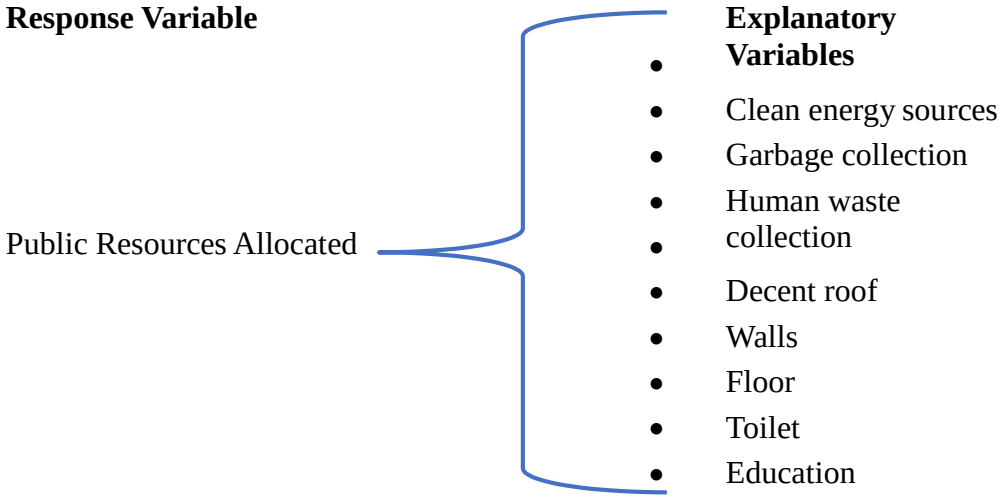

Figure 1: Conceptual Framework

3.2 The Theoretical Model

In making a societal welfare choice, a government picks an alternative that makes its population better off with minimal possible costs. The public resource allocation criteria encompass variations in socioeconomic characteristics and address societal deprivation issues is preferred if it takes society to a higher or maximum social welfare curve while minimizing country expenditures. The demand for public goods and services reflects both the direct and indirect benefits perceived by individual households and society (Carrington, 2017). The decision maker in the allocation of public goods is assumed to be the government or government agencies. Moreover, the government or its agency is assumed to find efficient and effective public resource allocation beneficial to society.

Public resource allocation is assumed to be directly influenced by a population's social and economic characteristics. Given Xi-n being a list of socioeconomic variables 1-n

Let Pk Public Resource Allocated

Di be Composite Deprivation Index and

d(X1) be deprivation of socioeconomic variable 1;

Deprivation Index=f (Socio-economic Characteristics)

$Di = f\{d(X1), d(X2), d(X3), \ldots d(Xn)\}$ ……. *i*

Public Resource Allocation= f (Deprivation Index)

$Pk = f(Di)$…… *ii*

Public Resource Allocation= f (Deprivation Index) =f (Socioeconomic Characteristics)

$Pk = f(Di) = f\{d(X1), d(X2), d(X3), \ldots d(Xn)\}$ ……. *iii*

Public Resource Allocation = f (Socioeconomic Characteristics)

$Pk= f\{d(X1), d(X2), d(X3), \ldots d(Xn)\}$ ……. *iv*

3.3 The Empirical Model

The framework for this research analysis builds up from the previous section.

The expression of Linear Model (equation iv);

$Pk= f\{d(X1), d(X2), d(X3), \ldots d(Xn)\}$

The particular econometric linear model to be estimated is

$P \quad = \beta_0 + \beta_1 . X1 + \beta_2 . X2 + \beta_3 . X3 + \ldots + \beta_n . X \quad + \epsilon)$ v

Where Pk denotes the public resources allocated, β_0 β_1, β_2, β_3, β_n denote the various weights attached to the population variables and ϵ is the error term.

3.4 Composite Deprivation Index Design

Principal components analysis (PCA) is a technique that has been used to illustrate the minimal number of elements that will account for the maximum variance in the socioeconomic data used in getting a composite index for deprivation for counties in Kenya. PCA follows several steps in examining the magnitude of the correlation between variables and comparable contribution to the deprivation index as will be shown in the next steps below (see Kline 1994).

3.4.1 Initial Identification of Variables for possible inclusion in the PCA

The table 2 below shows the demographic and socioeconomic variables from Kenya's 2019 census that captures characteristics of Kenya's counties that were contemplated for insertion in the PCA. The choice of these variables was illuminated by the methodical knowledge of deprivation factors that have proved to be paramount in contributing to impoverishment in households across the globe, as well as basic services that are well captured in the 2010 Constitution of Kenya, such as shelter characteristics, education, water, and sanitation, etc. All of the variables noted above may be thought of as measures of socioeconomic status that potentially mark household conditions that affect individuals' health.

Selected variables were presented as segments of individuals or households in each county who possessed certain characteristics or did not have certain basic servicess. The use of proportions is important because districts have different household populations and reflect the degree to which individuals or households within a district exhibit certain characteristics.

Table 2: Overview of 2019 Census Variables considered for inclusion in the PCA

Serial	Variable	Description
1	Water	The proportion of households without access to improved sources of water
2	Energy	The proportion of households without access to improved sources of
3	Garbage	The proportion of households without access to solid waste collection
4	Human waste	The proportion of households without access to human waste collection
5	Toilet	The proportion of households without a toilet
6	Internet	The proportion of households who don't have access to the internet
7	Education	The proportion of persons without any formal education
8	Roof	The proportion of households whose dwelling's roof is made of poor
9	Walls	The proportion of households whose dwelling's walls is made of poor
10	Floor	The proportion of households whose dwelling's floor is made poor quality

Source: 2019 Kenya Population and Housing Census Report

3.4.2 Variables for inclusion in the PCA

A bi-variate Pearson correlation was applied to the variables to establish the strength of the correlation of the variables listed, as shown in the illustration below.

The variables included in the PCA analysis were cramped to those indicating interdependence coefficients significant at the 5% level to ensure conformity to existing PCA guidelines. The variables were filtered to retain variables that only had a strong correlation in an effort to obtain a composite index made up of variables with similar patterns.

The table below summarizes the variables chosen for inclusion in the PCA and shows their interrelationship coefficients. All variables have more than one correlation coefficient of greater than 0.70 see (Alkire et al.,2015) with other variables such that:

Let the cutoff be Zi such that Zi=0.7 and the indicator Xi be the population indicators used in this study. Then Xi > Zi and therefore Xi > 0.7.

```
. correlate schoolgoing roofingmaterial humanwaste lighting
(obs=47)

             | school~g roofin~l humanw~e lighting
-------------+------------------------------------
 schoolgoing |   1.0000
roofingmat~l |   0.9055   1.0000
  humanwaste |   0.9144   0.9613   1.0000
    lighting |   0.8219   0.7822   0.8120   1.0000

.
```

Figure 2: Correlation coefficients of socioeconomic variables

3.4.3 Identifying the Principal Component or Main Factor

As mentioned above, composite indices are generated from PCAs derived from a set of closely related variables. PCA accomplishes this by creating new variables that focus on variations in a set of pronounced variables within the sample. In this case, the index (the deprivation index) is the variable derived from the pooled variation of the four variables. The PCA procedure achieved a single element or component that explained 90.05% of the variance of the remaining six variables across all constituents. The factor loadings shown in Table 4 represent the relative influence of each variable on the generated factors. In other words, the degree of association that associates each variable with the generated factor is a measure of factor loading. Factor loadings are constrained on a scale from zero to one (0-1). A value closer to 1 represents a higher level of relevance or influence.

3.4.4 Calculating the Composite Index

The index derived from this factor are shown below in untangled form. Each variable label represents the z-score for that variable, and the number is the relative weight for that variable. These points can be explained as follows.

The Z-score is the standardized deviation of each variable (for each county) from the overall mean of the variable.

The comparative weights for each variable are the coefficients derived from the regression equation estimates of the factors using the six variables. In effect, it transforms the relative influence/importance (such as factor loadings) of each variable into computable weights applied to all constituent characteristics. Variables with higher factor loadings have higher weights.

3.5 The Study Area

The area under focus for this study is Kenyan counties; these are all the devolved units in the country. Since independence, Kenya has experienced an expansive population of approximately 56 million in 2022 (see Worldometer). The economy expanded by 7.1 percent, according to the latest World Bank reports, and was majorly driven by industry and service sectors recording a respective growth of 7.2 and 9.5 percent, respectively. The proportions of the spread of county populations across the country differ according to square kilometers, and so do their socioeconomic characteristics. World Bank medium-term forecasts place economic growth at a high of 5.3 percent. The selection of this study is premised on the fact that since Devolution, the government is mandated to attain balanced economic growth and offer sustainability and inclusivity for its population through the devolved structures (Ehrlich & Kim, 2015). This is only possible when public resource allocation is consistent with the people's socioeconomic characteristics, needs, and deprivation. The study focused on Kenyan counties to enable thorough investigation and analysis of critical policy issues.

3.6 Data Sources

The study used the 2019 Kenya Population and Housing Census (KPHC), made up of 12.2 million households with indicators that are the component of analysis required to formulate the public resource allocation criteria based on the multidimensional deprivation index. The Census report is the source for reliable countywide indicators on the state of access to public goods, knowledge, and housing status. UNDP 2020 advocates using the same survey when analyzing households as a mandatory requirement for modeling a multidimensional index (Russ & Jones, 2017). Our unit of analysis is the household. The household will identify particular characteristics as a basis for identifying the deprivation indicators (Gumede, 2018). The inter-county analysis on access to public goods, knowledge, and housing status to signal population deprivation is based on

secondary data from the 2019 Kenya Population and Housing Census Reports. In addition, the data will be vital in informing relevant policy directions and giving more insights into the current levels of access to basic public goods and infrastructure (Zelinsky, 2017). The data was reorganized into various subsets, filtered, transformed, and computations on the indicators of interest. Data analysis was conducted using tables and expressive statistics to direct the study objectives. Principal Component Analysis was utilized to compute the composite deprivation index, thus informing a public resource allocation criterion.

4 RESULTS

4.0 Outcomes predicting County Household Deprivation

The Principal Component Analysis, conducted using 2019 Census data, created a composite index of deprivation that reflected these key socioeconomic characteristics i.e., non-school going population, roof type of housing, access to clean and environment friendly human waste disposal methods, and access to clean and affordable lighting as essential in signaling household disparities as shown in table 4 below.

As predicted in figure 2, the composite deprivation index is given as follows

Deprivation Index = School going population*0.5061 + Type of roofing material* 0.5076+ Mode of human waste disposal *0.5128 + Source of lighting*0.4725

County Allocation= f*Deprivation Index

Where County allocation = *Funds allocated to a county*

f = Total resource allocation to the population index in the budget each year Deprivation index = household deprivation index weight for a county (i = 1, 2, 3, …, 47) Essentially, poor human waste disposal methods was established to be the greatest predictor of household deprivation across counties; an increase in population proportion with poor human waste disposal methods increased a county's household deprivation index by 51 percent as compared to a 50 , 50 and 47 percent increase by both population proportion that does not attend school, population proportion with poor roofing material and population proportion with poor access to lighting respectively.

In addition, demographic factors such as improved water access, improved energy access, waste collection, internet access, informal education were equally important in predicting deprivation.

4.1 County Classification

Counties in this study were ranked in order of deprivation score. The deprivation scores were used to identify regions with relatively high levels of deprivation. Table 3 shows the deprivation index for each county in Kenya as predicted from the composite deprivation index. The index scores ranged from 1.44 for the least advantaged county to 0.13 for the most advantaged. The mean deprivation index for all the counties was at 0.543 a figure that points at moderate deprivation across the country.

The table below also ranked the counties into quintiles, with each county ranked in a quintile. Most quintile 1 counties were observed to be from the northern region with two from the coast of Kenya, and quintile 5 counties were those counties with large cities including the two largest cities Nairobi and Mombasa. This confirms the assumption that more public resources are allocated to urban counties as compared to rural despite the relatively high deprivation levels faced by the rural communities.

Table 3: County Classification according to Quintiles

County	Deprivation	County	Deprivation	County	Deprivation
TURKANA	1.44	BARINGO	0.70	MIGORI	0.45
WAJIR	1.35	NAROK	0.63	BUNGOMA	0.43
SAMBURU	1.31	LAMU	0.61	MERU	0.41
MANDERA	1.28	KILIFI	0.61	TRANS	0.41
MARSABIT	1.14	ELGEYO/MARAKWE	0.53	HOMA BAY	0.40
GARISSA	1.13	NYAMIRA	0.47	LAIKIPIA	0.40
WEST	1.09	BUSIA	0.47	SIAYA	0.39
TANA RIVER	1.00	KISII	0.47	VIHIGA	0.39
ISIOLO	0.79	KITUI	0.46	KAKAMEGA	0.39
KWALE	0.77	THARAKA-NITHI	0.46	KAJIADO	0.37

County	Deprivation	County	Deprivation
MAKUENI	0.37	MACHAKO	0.29
EMBU	0.36	NAKURU	0.26
NANDI	0.35	UASIN GISHU	0.24
TAITA/TAVETA	0.33	MOMBASA	0.23
BOMET	0.33	NYERI	0.23
KERICHO	0.32	KIAMBU	0.16
MURANG'A	0.31	NAIROBI CITY	0.13
KISUMU	0.30		
KIRINYAGA	0.30		
NYANDARUA	0.29		

The distribution of deprivation across counties is shown in the figure 3 below. The chart below shows a classification of Kenyan counties based on the deprivation index that was deprived from the PCA. It shows that 17 percent of the countys' population is highly disadvantaged, majorly found in the first quintile. 15 per cent are moderately disadvantaged, mostly in the second quintile while 68 percent are portrayed as the least disadvantaged are found in the 3rd to 5th quintile,

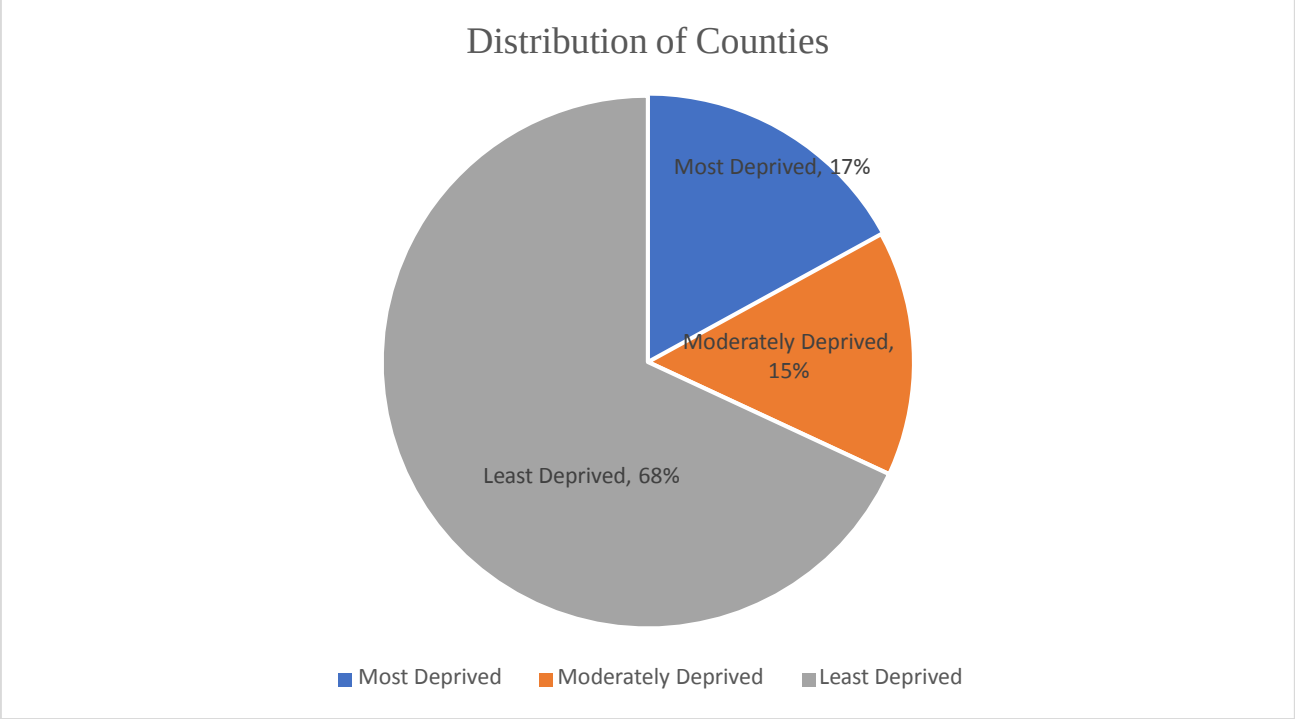

Figure 3: Classification of Kenyan counties based on the deprivation index

4.2 Deprivation and Resource Allocation

The Deprivation Index score can be used when considering the allocation of public resources between counties. In a country like Kenya, where there are wide disparities in income distribution, socioeconomic status and access to essential social services, focusing human development benefits on the most disadvantaged is the appropriate approach. There are two important ways that the deprivation index can be used to inform resource allocation patterns. The first way is to include the index in the resource allocation expression. A second way is to use the deprivation index to inform resource allocation is simply to use it as a guide for marginal resource allocation rather than including it in the formula. For example, the results shown in Table 6 can be used to guide the allocation of additional resources as they become available, prioritizing counties with higher levels of deprivation. This is the approach taken in New Zealand, where instead of using the actual

index value for each region, it is based on whether the region belongs to one of the most unfavorable deciles in resource allocation and planning decisions. (Crampton et al.2000).

The Population Index that is currently defined by population size can transition from an index that echoes deprivation in a society based on socioeconomic characteristics. Since people are at the center of all planning activities, the weight attached to the population index should be heavily weighted as envisaged in the first allocation formula (a weight of 0.45 attached to the formula) and the weight eventually transferred to the deprivation index.

5 CONCLUSION

The study reported in this paper used data from the 2019 Kenya Population and Housing Census to calculate a composite index of deprivation, drew on similar initiatives in other countries, and used internationally recognized statistical methods. The index highlights the sociodemographic variables that have the greatest impact on predicting deprivation and also indicates the relative importance of each variable in contributing to deprivation. It clearly shows that the Turkana, Wajir, Samburu, Mandera, Marsabit, Garissa and Tana rivers counties are most affected by deprivation. The research findings have potential uses in providing decision makers with information on resource allocation, planning, and budgeting.

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