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Barbed Wires Against Children's Transition Into Secondary Education in Kenya

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Abstract

Children's transition into secondary education process in Kenya has received numerous national policy interventions, in an attempt to minimize the transition inequalities between social groups; and to enhance free universal access to secondary education. Despite these efforts, thousands of children remain systematically entangled in various family-related and socio-economic *'barbed wires'* that thwart their timely transition into; and lock them out of secondary education. And understanding how such factors join forces to derail children's timely transition remains a critical challenge. Guided by Bronfenbrenner's Ecological Systems Theory (1986); and drawing on recent policy analysis data; and lived out-of-school life-experiences from rural settings, this mixed-methods study sought to investigate how the interactive forces of family types and socio-economic background turn into ***Barbed wires against children's transition into secondary education in Kenya.*** It used a semi-structured questionnaire to collect data from 315 Form I students, sampled from a population of 1490. It corroborated students' data with views from KIIs and FGDs. Numerical and qualitative data were respectively analyzed using descriptive statistics and themes. The results reveal a disintegrating family-unit and a weak family socio-economic-capital base as key factors behind children's transition disparities. This paper underscores and calls for a people-centred, more-inclusive and context-sensitive approach to education policy-reforms: one that eliminates existing *'barbed wires'* and heals the wounds left behind.

Key words: primary-secondary-education transition, education-policy-reforms, out-of-school experiences, *lull-transition period*, family-type, socio-economic background, family-support, Kenya.

Introduction

In its commitment towards free universal education, Kenya introduced free primary education; free secondary education; and the 100.00% primary-secondary-education transition policies, together with bursaries. This is to ensure a-100.00%-transition of children from all backgrounds, particularly the needy ones (GoK, 2007), into secondary education (GoK, 2012; UNESCO, 2017). However, measures to enhance children's transition into secondary education, between social groups, are undermined by certain family-related and socio-economic constraints. Consequently, thousands of children in

Kenya today, most of them poor, remain locked-out-of-secondary-education.

In Ugunja Sub-County, the reformed-education initiatives have indicated progress by increasing the enrolment of poor children at primary school level. Similarly, an increased number of children from poor families have managed to go through the previous *'barbed wires'* and joined secondary schools (Oketch, & Somerset, 2010). As soon as they do so, however, they immediately meet another '*barbed-wire'* ahead of them: only tuition fees has been waived but boarding fees is retained. This often compels many of those children, whose parents cannot raise money for boarding fees, uniform and other school requirements, to forfeit their admissions in respected national and county boarding secondary schools. Some of these children eventually experience transition inequality by ending up in cheap nearby day secondary schools, where the fees are relatively lower (Oketch, & Somerset, 2010), while the rest remain locked-out. A huge gap, therefore, exists between the high enrolments in primary schools and the number of children, who actually join secondary education (Ugunja Constituency, 2018).

Meanwhile, much of existing transition research literature largely focuses on children's life-experiences during their primary and secondary school education cycles. This practice creates knowledge gaps in children's 'transition processes outside formal educational institutions,' like in family-settings (Fabian & Dunlop, 2007). The many children's out-of-school life-experiences and challenges, during the *lull-transition period,* a recess in-between the two education cycles, are over-looked and largely remain unknown. This is so despite the fact that some of those out-of-school life-experiences often turn into *'barbed wires'* against children's timely transition into secondary education. Likewise, the contributions various families, as key providers of children's most immediate living environment, make to children's out-of-school life-experiences, remain downplayed in much of transition research literature and the reformed education policies. These omissions create knowledge gaps, which not only block the full understanding of children's transition process, but also inhibit the initiation of possible corrective measures, to redress the widening transition-gaps between social groups.

This article highlights study findings on 'ways in which family-types and family socio-economic background factors turn into '***Barbed wires against children's transition into secondary education in Kenya.'***

1.1 Conceptualizing Children's Transition

The term *transition* is conceptualised in this paper as, a child's upward mobility from primary to secondary school. One of the concerns in contemporary sociological debates, in both developed and developing countries, is about the fast rising out-of-secondary-school population (GEM/UIS Report, 2025b). According to that report, globally, over 194 million children, with 58.0% of them coming from poor families in Sub-Saharan Africa, are reportedly out-of-secondary-education (UIS, 2018; 2019; GEM/UIS Report, 2025b). The recent revelation that education systems in many countries are becoming more exclusive (UNESCO, 2021), like in Afghanistan, where girls are already barred from attending secondary education (GEM/UIS Report, 2025a), further exacerbates this

concern. The fast rising out-of-secondary-school population; the widening transition inequalities; and the emerging exclusivities; all seem to undermine one long standing critical role of education: fair social mobility of all social groups in society (Kim, Sherraden, & Clancy, 2012), and enabling individuals and families to take control of life-choices that can improve their social status (Iannelli & Paterson, 2005). This fast rising out-of-secondary-school population raises more concerns, particularly in Sub-Saharan Africa, which already hosts 58.00% of the global out-of-secondary-education population (UIS, 2018, 2019, p.7).

In Kenya, children's transition is measured in terms of a child's age, at different levels of education. This is based on Kenya Education Act 2012 (GoK, 2012), which stipulates 14-15 years as the official Form I entry-age. Thus any child aged 16 years and above in Form I, is regarded as a late entrant. Age aside, the sheer thought of making a transition into secondary school can, by itself, be both exciting for many children and quite intimidating for others (Maher, 2010). However, children do not normally complete their primary education in the evening and join secondary schools the following day. Instead, children go through a *lull-transition period*, during which time, most children who have completed primary education, stay with their families. During this time, children go through different out-of-school life-experiences, as shaped and defined by the characteristics of their family-types. Some of these experiences can, however, at times be disturbing for many children, especially by frustrating their dreams of making a transition into secondary education.

Family, taken here in terms of parents' marital status: whether it is a one-parent family; a two-parent family; or a polygamous family (Elliott & Gray, 2000), has been suggested as a key determinant in children's educational progress (Akpotu, Omotor & Onoyase, 2007; Cavanagh, Shiller & Riegle-Crumb, 2010). According to Sottie and Awasu, (2011), one of the variables behind the continued transition disparities between social groups in Ghana, despite the education-reforms initiated, is weak family-support. That family-support does not, however, always have to be in material form. As Bronfenbrenner's ecological systems theory (1986) suggests, at its micro-system level, the more freely parents interact with their children, the warmer their relationship grows. Similarly, the far away parents are from one another and from their children [physically or emotionally], the more detached their relationships become.

For a long time, families are recognised in society as the first point at which children are socialised and educated on the social responsibilities, expectations and obligations of their wider society (Morrish, 1967). A family has been identified as the heart-of-the-world and a key determinant in children's growth process, through education (Akpotu, et al., 2007, p. 127). However, the life-styles parents in different family-types live; the choices and decisions they make; and the activities they engage in, can affect children's transition into secondary education (Cavanagh, et al., 2010). Furthermore, family characteristics and behaviour can lead to delayed, unequal or missed children's transitions into secondary education (Cantillon & Van Lancker, 2013). Similarly, the geographical locations, where parents stay with their families, can equally reveal factors behind the inequalities in children's transition (McGee, Ward, Gibbons & Harlow, 2004).

What emerges is that the support of children's preparation for transition into secondary education rests more on every family's social capital levels, which varies across social groups. Many times, however, the level of poverty in families and the value parents attach to education, determine whether a child will receive adequate family-support to access secondary education or be compelled into child-labour, to earn extra income to support the family. That ambivalent situation, in which many poor families often find themselves, tends to push more children into child-labour, at the expense of their transition into secondary schools (Sottie and Awasu, 2011, p.133).

However, in family-types where parents are warm, sensitive and show reciprocal parent-child interactions, children are more often socially competent, self-confident and interact freely with their peers. This easily enhances children's transition into secondary education (Evangelou, Taggart, Sylva, Melhuish, Sammons & Siraj-Blatchford, 2008). Bronfenbrenner's ecological systems theory (1986) also suggests that a strong nurturing relationship between child and parent creates strong parent-child bonds, while distant, remote and non-affectionate parents often create parent-child detachment. One study suggests that disparities in children's transition be traced back to "the accident of originating from an advantaged or under-privileged family (Cantillon & Van Lancker, 2013, p. 558). The thesis in this paper is that the way parents, across social groups, interact, relate and bond with their children and between or among themselves; can affect their decisions on allocating family-resources to children's transition into secondary education. The extent to which family-support variables enhance or undermine children's transition, during the *lull-transition period*, therefore, calls for more understanding.

In addition, the number of income-earning persons, in any family-type, can limit or enhance the value of family-resources families invest in children's secondary education (Akpotu, et al., 2007, p. 130). Similarly, the number of secondary school-going-age children in a family, can significantly destabilise the fair distribution of family-resources for children's secondary education (Eshiwani, 1993; Evans, Kelly, Borgers, & Dronkers, 1995; Mare, 1980). At the same time, the quest for children can change family-types, like monogamous-marriage unions into polygamous ones, especially where the first wife 'fails' to give birth to a son (Elliott & Gray, 2000; Wamanya, 1987). This quest for sons can cause confusion, stress, segregation and unfair allocation of family-resources for children's transition into secondary education, especially that of the girl-child (Sarsour, Sheridan, Jutte, Nuru-Jeter, Hinshaw, & Boyce, 2010). The existence of such variables in a family more often interferes with the direction and timing of children's transition into secondary education. Whereas this is so, the views of children regarding the out-of-school life-challenges they go through, during the *lull-transition period,* remain unheard. In the case of Ugunja Sub-County, hardly any information exists on how variables, in different family-types, could be derailing children's transition into secondary education. That was one of the knowledge gaps which this study sought to address.

Literature has also identified family socio-economic background, measured in terms of parents' education levels and their occupations, as critical in addressing the

high cost of education: a key '*barbed wire'* obstructing the transition of many children into secondary schools in Sub-Saharan Africa. Marks, McMillan, Jones, and Ainley (2000), recognises parents' education as an internationally stable variable for measuring children's socio-economic background that does not change with time. It suggests that parents' social status, derived from their educational levels, increases the reliability and confidence in drawing conclusions. Highly educated parents, in well-paying jobs, generally interact more closely with their children, participate in school activities and easily pool their resources to support the education of their children, which they constantly monitor (Steinberg, Lamborn, Dornbusch & Darling, 1992). Such active parental involvement creates a warm social climate in the home; and motivates children to pursue secondary education.

On the contrary, parents with less or no academic attainments, more often find themselves compelled into "low quality" jobs, with low pay; unreliable work schedules; and little flexibility (Dodson & Albelda, 2012). Most of such jobs, found mainly in the informal sector, are often of few or no terminal benefits or career images. Many in those jobs work longer hours to earn their small salaries, come home late, tired and at times, carrying with them stress and short temper from the work place. That denies such parents the opportunity to engage and interact with their children, or attend to children's personal, social and educational needs. In addition to disrupting peace in children's living environment, such tempers also undermine and interrupt children's effective preparations for secondary education. Many of these parents are often pessimistic, indifferent, and have apathy towards secondary education; and may even pressurise their children not to acquire secondary education (Jabor, Machtmes, Kungu, Buntat, & Nordin, 2011; Jacob, 2010). More often, these parents are uncertain about their children's secondary schools of transition; will delay their children's transition and frequently change schools of admission. They are often unable to pay the costs associated with quality schools (McGee, et al., 2003) and their children are often compelled to join sub-standard, poor quality and ill-equipped secondary schools (Conchas, 2006; Argy, 2007; McGee, et al., 2003).

The two parallel parental socio-economic positions, call for empirical evidence to provide a clear understanding of children's out-of-school life-experiences. The link between family-types; parents' education, occupations, income; and children's transition prospects: suggests that children from educated and better off the parents stand higher prospects of making timely transition into secondary education. In Ugunja Sub-County, hardly any documented information exists on how these particular variables could be affecting children's transition into secondary education. This constitutes another knowledge gap that the study sought to address.

This article highlights the voices of Kenyan children and other stakeholders, as they share their experiences, regarding various '*barbed wires'* that shaped and defined children's transition prospects into secondary school education.

2.0 Theoretical Framework

This study was anchored upon Bronfenbrenner's Ecological Systems Theory (1986), which posits the parent-

child interactions and relationships, as ultimate guides to effective children's growth process, including their education. Underscoring the family as the key social institution that provides children's most immediate living environment, together with their basic personal and social needs, the theory at its micro-level, recognises that the more freely parents interact with their children, the warmer their relationship grows. Similarly, the far away parents are from one another and from their children [physically or emotionally], the more detached their relationship becomes. At its macro-level, the theory stresses that for children to grow up, like any others in the wider society, their interactions, experiences and activities have to blend with those of their peers in other social institutions outside the family. The theory, however, cautions that any family-disruptions can seriously incapacitate family-support needed in children's growth and education process.

The theory guided this study to a multi-perspective examination of various dynamics in different family-types, including parents' characteristics that created out-of-school experiences, which turned into '*barbed-wires'* against children's transition into secondary education in Ugunja.

3.0 Methodology

This mixed-methods research, with quantitative and qualitative approaches, was conducted in Ugunja Sub-County, Siaya County, in west Kenya. The study population consisted of Form I students; their teachers; parents; government officials; and community elders. It used a semi-structured questionnaire to collect data from 315 Form I students, randomly sampled from a population of 1490 in 20 public mixed-secondary schools. The researcher also collected qualitative data, through non-structured face-face interviews with purposively sampled 12 KIs, 40 Form I students from socio-economically deprived backgrounds, and 10 youth who did not join secondary schools. Additional qualitative data were collected through 3 FGDs of 10 persons each. Secondary data, which laid grounds for this study and supplemented the primary data, were sourced through a desktop review of related literature from libraries, magazines, journal articles and publications, computerised databases, statistical abstracts and websites.

All numeric data from the questionnaires' were separated from qualitative ones, edited, coded, categorised into response groups and presented in frequency-tables for statistical analysis, interpretations, generalizations and conclusions. χ^2 test was used to determine the statistical significance of associations between variables examined. For qualitative data, the researcher assembled field notes and transcripts; read them through; synchronised and coded them *in vivo* into themes; before categorising; interpreting and translating them into participant cases/narratives. Finally, the researcher placed quantitative and qualitative results side by side, with qualitative data, in forms of self-narratives and voices, reinforcing, supporting and explaining the trends observed in quantitative results.

This article highlights the voices of Kenyan children and other stakeholders, as they share their experiences, regarding various '*barbed wires'* that shaped and defined children's transition prospects into secondary school education in Ugunja Sub-County.

3.1 Ethical Considerations

Aware that most of the respondents targeted were students below the age of independent consent (below the age of 18 years), the researcher complied with ethical requirements by first explaining to all school-authorities, parents, guardians and the intended participants, the purpose and key objectives of the research, sought and received their verbal consent before collecting data from those sampled for this study. Second, the researcher assured all participants that their participation in the study was purely voluntary; that they would be free to withdraw from the study, should they choose to do so; and that nobody would be victimized for declining to take part or to answer any particular question(s). The researcher further assured participants of their anonymity in the study; that any information they gave out would remain strictly confidential; would not be identified with any particular respondent; but be used only for study purposes. Furthermore, this study has used *pseudo* names to protect the identities of informants, especially in respect to characters named in the narratives and voices featured in this article. The next section of this paper highlights study findings of a study on: '***Barbed wires against children's transition into secondary education in Kenya.'***

4.0 Study Findings

First, the study findings revealed delayed entry into Form I, characterized by over-age, as a major transition problem in the study area. Data in Table 1 show that of the 315 students, sampled for the study, 81.3% had experienced late entry into Form I. The student-respondents' ages stretched from 14 to 21 years, giving a statistical age-range of 7 years, and an overall mean age of 16.63 years. Similarly, the data revealed a mean age of 16.69 years for males, against that of 16.57 years for females.

The study findings revealed delayed entry into Form I, characterized by over-age, as a key transition problem in the study area. Data in Table 1 show that more than four-fifth of the 315 students, sampled for this study, were aged 16-21 years, which, according to the Kenya Education Act 2012 (GoK, 2012), meant that they were late Form One entrants.

Table 1: Students' age groups by gender

	males		females		totals	
age-group	No.	%	No.	%	No.	%
14-15	24	15.894	35	21.34	59	18.73
16-17	86	56.954	92	56.10	178	56.51
18-21	41	27.152	37	22.56	78	24.76
totals	151	100/00	164	100.00	315	100.00

χ^2 of 2.92 at *df* 3 not significant. (.at 0.05 χ^2 should be 5.991).

Source: Form I School Registration Records

Overall, the ages of the sampled students ranged from 14-21 years, giving a statistical range of 7 years; an overall sample mean age of 16.63 years; a mean age of 16.69 years for male students; and 16.57 years for females. The same results in Table1 also show that late entry into Form I was more pre-dominant among males (84.1%) than females (78.8%). That suggests that,

whichever way one looks at it, the sampled students were largely over-aged.

Table 2: Respondents' family-type by age group

Family type	respondents' age in years				totals	
	14-15 [early entrants]		26-21 [late entrants]			
	Number	%	Number	%	Number	%
single-parent	26	20.15	103	79.85	129	100.00
two-parent	28	17.07	136	82.93	164	100.00
polygamous	5	22.73	17	77.27	22	100.00
totals	59	18.73	256	81.27	315	100.00

However, a χ^2 test revealed no significant statistical association between age and gender on entry into Form I. That aside, an age-gap of 7.00 years is relatively large and raises concern, as it can negatively affect the academic performance of older students, especially where their younger counterparts out-shine them.

Furthermore, the study findings in Table 2, show that, of the 256 late entrants in Form I, more than 50.0% were from two-parent families, around two-fifths were from one-parent families, while the rest came from polygamous families. However, the study finding that more than half of the late entrants were from two-parent families differed from and seemed to contradict results of some past studies (Clutter, 2010; Sottie & Awasu, 2011; Coleman, 1988; Walker, McGregor, Himes, Williams & Duff, 1998), which suggest that children from two-parent families, unlike those from other family-types, usually stood better prospects of going to school.

That apparent contradiction indicates that understanding how various factors join forces to derail the transition of children from different family-types is still a critical challenge that calls for more research.

Several KIs interviewed identified a number of factors accounting for variations in students' late entry into Form I. Children's stay-away from their own biological parents, during the *lull-transition period* (school holidays), is a key factor behind children's delayed entry into secondary education. Data in Table 3, for example, indicate that nearly 50.0% of children did not stay with their biological parents, during the school holidays. More than a majority of children from two-parent families and close to 60.0% of those from polygamous families had stayed with third parties.

Table 3: Child's family-type by member child spent the *lull-transition period*

family type	persons child spent school holiday with					
	parents		relatives & friends		totals	
	number	%	number	%	number	%
single-parent	70	54.26	59	45.74	129	100.00
two-parent	81	49.39	83	50.61	164	100.00
polygamous	9	40.91	13	59.09	22	100.00
totals	160	50.79	155	49.21	315	100.00

χ^2 is 1.612, df 2, not significant

The same data, in Table 3, also suggest that

although roughly 60.0% of all children from polygamous families stayed away from their parents, their number was statistically insignificant, having constituted only 8.4% of all children, who spent the *lull-transition period* with relatives and friends. On the other hand, children from two-parent families constituted the highest share (53.5%) to that total number of children, while those from single-parent families were 38.1%. Although those study findings were instructive, a χ^2 test of 1.612 at *df* 2 was not statistically significant and indicated a weak relationship between persons children stayed with and their age on entry into Form I.

On the other hand, additional views from KIs and FGDs, together with voices from students reveal that limited parent-child interactions and weak family-relationships did create parent-child detachment, which ended up derailing children's timely transition into secondary schools. The voice of a 16 year old Akuyo, in Case One, was instructive:

Case One: Akuyo's voice

> My mum Nyapap was a working-single-mother. I had all the food and everything else I needed in the house but my mum was always out, from dawn to dusk. Sometimes she would come in at dusk, only to refresh, change clothes and go out again. I never had good times with my mum. I needed someone I could talk to about secondary education; someone I could confide in about my personal issues; someone I would feel OK with, but my mum was always away. I was always home alone. I had sat for my KCPE examinations at 14 years, passed well, but when a letter came inviting me to Form I, my mum could not raise school-fees for me. I felt sad, lonely and was hospitalized for depression. I lost my Form I place in that boarding school and only joined this day school two years later, after my mother borrowed some money from relatives.

The voice reveals how a single-mother's obsession with her occupation, detached her away from her daughter. The story also shows that children brought up alone in closed family settings, during the *lull-transition period* suffered social exclusion, which drove some of them into stress that became *'barbed wires'* against their timely transition into secondary education. The parent-child physical and emotional relationships grew weak and remote. Akuyo' description explained how her mother's life-style; the way she behaved; the decisions she made; and the activities she engaged in; distorted her relationship with her daughter. Akuyo's story points to a weak and disintegrating mother-daughter emotional and physical relationship.

Another group of children, who equally suffered the impact of parent-child detachment, was that of orphans. The life-experiences of Alando, who never had a mother or father, in Case Two represented the voices of other orphaned children, who had gone through similar life-experiences.

Case Two: Experience of Alando

> When my parents died, I moved to stay with my paternal aunt, whose daughter was ten years as I was. My cousin and I attended the same school, did KCPE examinations the same year and both passed well enough to join secondary schools, though I had five points higher than

my cousin did. In January, we both received letters inviting us to different boarding secondary schools. My aunt, a primary class three-leaver, told me she did not have enough money to pay school fees for both of us, at the same time. She sent her daughter to Form I and left me in the house, doing household chores. I felt excluded and suffered a lot as I did not have parents to help me. When my aunt finally took me to school one year later, she could only afford a place in this day school.

Whereas Akuyo experienced both late and unequal transition, for other children like Alando, their survival and late transition into secondary education, largely depended on their ability to balance the grief of having lost their biological-parents and the patience to tolerate the pains of frustrations encountered in their new 'families.' Alando, who eventually joined Form I at 15 years and nine months, experienced both late and unequal transition.

Additionally, the study findings reveal that, even though the aim of free secondary-education and the 100% primary-secondary transition policies was to reduce transition inequalities across social groups; it did not address equity or inclusivity of children in secondary schools.

To many poor children, certain socio-economic circumstances prevailing in their families became '*barbed wires'* against their timely transition into secondary education. Indirect costs towards: uniforms; building funds; activity fees; examination fees; fares to and from school; and purchase of textbooks ….borne by parents, undermined the timely transition of more than 80.0% of children from different family-types into secondary education. As a 45-year-old parent, called Odundu, narrated:

> When I went to look for a Form I place for my son, I was told to buy a 4-litre tin of wall-paint, as a contribution towards a school construction project. In the list of other requirements, I was to buy a lockable desk; a mattress, two pairs of school uniform; a geometrical set; one ream of photocopying paper, pens, textbooks as well as several exercise books. I was unable to buy all these items, together with the transport costs, considering that I already had another child in Form III. I opted to send my son to a nearby day secondary school, which I allowed me to pay fees in bits.

These study findings suggest that families' socio-economic status had some links with students' ages on entry into Form I. Data in Table 4, also reveal that around 85.6% of children with fathers of primary-school-education level or less had joined Form I late, compared to 76.1% of those whose fathers were of secondary education and above. Similarly, of all children, who had joined Form I late, nearly two-thirds were from fathers with primary education or less.

Table 4: Fathers' education by students' ages

	age range in years							
	14-15		16-17		18-21		totals	
fathers' education	count	%	count	%	count	%	count	%
primary& below	25	14.45	102	58.96	46	26.59	173	100.00
secondary & above	34	23.94	74	52.12	34	23.94	142	100.00
Totals	59	18.73	176	55.87	80	25.40	315	100.00

χ^2 of 4.92 at *df* 3 is not significant. (.at 0.05 χ^2 should be 5.991).

Interviews with KIs revealed that in many households, where parents were of less education, adults' interests and priorities more often stifled those of children. A number of parents were indifferent towards secondary-education and not keen to support children's transition. Such parents wanted their children to start earning money immediately. One such child was Jakinda, whose case is explained by his class-teacher below:

Case Four: An account about Jakinda

> Jakinda could at times be a little distracted, and be in a 'world of his own' in school. Many times in the afternoon he would be dozing in class. When Jakinda was five years old, his parents separated and he was left to live with his father, Sudhe: a known shrewd rich businessman, who always put money first before anything else in life. Sudhe, who never went beyond primary Class Four, owned several sets of discotheque instruments which he used to operate in funerals, (locally referred to as disco *matangas*). Jakinda's father withdrew him from standard six and recruited him into operating the disco instruments. He stopped going to school and worked with his father up-to the age of 16 years, when he asked his father to let him go back to school, sit for his examination and have a certificate. Reluctantly, his father allowed him to go back to school, and Jakinda joined Class Five. Three years later Jakinda did his KCPE examinations, passed well and was admitted to Form One in a reputable secondary school. Jakinda's father did not, however, allow him to join secondary school, retorting that he had already *completed*

> school and should focus on family business. The two differed and Jakinda was chased away from his family home, went to live with his widowed maternal grandfather and failed to take up his slot in Form One. To support the ailing old man, Jakinda got himself a house boy job in one rich man's home nearby. When this new boss realised a year later that Jakinda had qualifications to join secondary school, he sponsored him to join Form One, in a nearby mixed-day secondary school at 21 years.

The account shows that Sudhe's low educational attainments; and his quest for money, created in him indifference; apathy towards education and a powerful negative attitude that became a strong '*barbed wire'*, which distorted parent-child relationship that obstructed a child's several attempts to go to school. Jakinda did not only experience late entry into Form I, but also had several dropouts in his earlier life. Jakinda's several struggles to go to school demonstrated the many '*barbed wires',* which children of less-educated parents, had to meander their way through, before they joined secondary education.

Study findings, however, reveal that Sudhe had not been the only community member, with such pessimism and apathy towards education. According to KIs, a significant number of parents had high quest for money and did not attach much value to secondary education. As *Mzee* Ojwando puts it, during one of the SGDs, secondary education does not bring in quick money:

> …secondary education just teaches literacy, numeracy and not practical skills, which can take children to direct employment or entrepreneurship. Children always still need extra practical training before they can start making money and that costs us additional money….

KIs cited the high unemployment rates, poverty and the thirst for quick money for immediate survival, as factors pushing many less-educated parents into apathy and negative attitudes towards secondary education. Children from poor households, in particular, were more likely to venture into child-labour that brought in 'quick money' than the long-term investments required for secondary education. *Peng* riding-business and prostitution, were cited as popular quick income options for boys and girls respectively. This was so, often at the expense of children's education.

Additional study findings, however, reveal that even poor parents, with low education, can support children's transition. The case of a 14-year-old Othwele, the eldest son of a third wife in a polygamous family, demonstrates that despite having an illiterate mother, he still received the support he needed to make a timely entry into Form One.

Case Twenty-One: The story of Othwele

> Othwele came from a socio-economically deprived mother. His mother was illiterate and unemployed. Despite her background, Othwele's mother gave him full support and encouragement for his education. Her constant

> message to her son always was: 'you must work hard in school, so that we too can one day live like the Gogos. a neighbour who used to be very poor in the past but whose status changed once the children went to school, got employed and built a big house for their parents. Othwele recalled that the evening he was revising for his KCPE examinations, and did not even have kerosene for his *nyangile* (a locally assembled cheap source of light, it was his mother who devised for him an alternative source of light, from dry castor-oil-seeds, lined up in a piece of wire, which acted as a candle. Though very smoky, the devise enabled Othwele to prepare for his KCPE examinations, which he later passed quite well. Othwele was 14 years 5 months and in Form One at the time of the study.

Othwele's story demonstrates that a child-friendly living environment does not always have to be measured only in terms of parental material wealth or education level. Parental moral support, love, care, good parent-child relations and encouragement, as witnessed here, equally works effectively.

Despite those study findings, a χ^2 test result of 4.92 at *df* 3, suggested a non-significant statistical association between fathers' educational attainments and students' age on entry into Form I. The verdict about mothers' educational qualifications was almost similar.

Another factor that interfered with children's timely access to secondary school was parents' irresponsible life-style and failure to provide for the family. Such cases, more common among two-parent families, resulted into parent-child detachment, which pushed some children away from their homes. The case of Gangla, narrated by his former primary school head-teacher in Case Five, was instructive:

Case Five: A story about Gangla

> Gangla, who had already done his KCPE examinations and waiting for his results, kept on coming to school every day, even long after schools had closed. He would come to school in the morning and stay up to late in the evening, before he reluctantly walked back home. When his teachers talked to him, Gangla confessed that the conditions at home were so hostile that he could not face them. His parents were always drunk and fighting each other and not providing food. It was too painful for Gangla to watch and go through all that every day. In sympathy, his previous school gave him a temporary job as a day watchman. When the KCPE examination results came out, Gangla, had passed well and was invited to join Form I. However, Gangla said there was no point joining secondary school, as his parents were not likely to raise the required school fees.

Gangla's case shows how an unsupportive home environment distorted parent-child relations and created parent-child

detachment. Unable to brave his way through the tensions created by his parents' behaviour, Gangla opted to forego his secondary education and kept off his parents by taking up employment pre-maturely. Gangla's loss of interest in education and failure to join Form One constituted a transition disparity, in form of a missed opportunity.

Similarly, in Case Six, explains how another youth was compelled to defer his admission and support the family, when his father was incapacitated:

Case Six: The voice of Owitti

> Three weeks earlier, my father, the breadwinner in our family, was involved in an accident that left him unable to provide for us. Due to lack of food in the house, one night my parents quarrelled with each other and the following day, my mother ran away, with my little brother. My younger sister and I were left alone at home with our sick father, who could not provide the basics we needed in the house. We did not know who else to approach for assistance. We needed the support of our mother but she was not there. We felt distressed, disappointed and sad. Many times, we would spend the whole day hungry. I opted to do some unskilled jobs, like sand harvesting and helping in building-sites, at least to bring in food for the family. By the time, my father recovered well enough to provide for us, I had already lost an opportunity to join Form I in the school that had selected me. I joined this school at 17 years, two years after my KCPE examinations, through the assistance of NGCDF sponsorship.

After the accident, Owitti's mother deserted the family and Owitti had to engage himself in income-earning activities, in order to feed the family. That case demonstrated how the sickness of one parent, in the absence of another, became a strong '*barbed wire'*, which Owitti had to push his way through by resorting to child-labour, so as to feed the family. The case further shows the extent to, which family disruptions, uncertainties and challenges some children had to put up with, once parents were not available, turned into obstacles, which greatly disrupted their timely transition into secondary education.

In polygamous families, when family-resources were limited but the number of secondary-school-going children high, some fathers discriminated against the education of their daughters, as Adipo explains:

> When I passed my KCPE examinations, I got admitted to a girls' boarding school but I never joined. My father had four other children invited to Form I that same year. Only the first three children, all boys, joined secondary schools. One other daughter and I did not.

Focusing largely on continuity of family lineage, as a priority, fathers with limited resources but high numbers of secondary-school-going children, opted to educate sons and left out daughters.

5.0 Discussions

The study findings in this article, as supported by the cases cited, will go a long way to reinforce those of other previous studies. The results show that children's transition into secondary education in Ugunja was basically determined by two key factors: parental level of interaction within and outside the family; and the socio-economic resource-base of the family. First, the extent to which parents interacted not only between themselves and with their own children; but also with members of the surrounding community, as well as external social institutions had some effects on children's transition into secondary education. As Bronfenbrenner's Ecological Systems Theory (1986) suggests, the closer the parents interact with their children, the stronger their relationship grows and the more they support children's transition. Study results, however, show that many single parents, as sole income earners, became too pre-occupied searching for livelihood; interacted less with their children and relatives; got more isolated from their children, who suffered parent-child detachment and loneliness. In a number of cases, these parents were not able to raise the required fees in time and that became an obstacle against the timely transition of their children into secondary education. In other cases parents got too preoccupied with their own divertive activities, away from home, compromising the social and emotional security of their children, and finally failing to make adequate provisions for such children's timely transition into secondary education. There were also cases where parents had developed apathy and indifference towards secondary education; failed to provide the basic family needs; and were not keen to support children's transition into secondary education. There also cases where the number of secondary-school-going-age children overwhelmed the available family resources and children had to compete for such limited resources. In most of these cases, children's transition into secondary education became less of a priority; gender-based child-discrimination at times came into play; and delayed or missed transitions were common. On the other hand, where parents interacted widely and freely, children's transition was facilitated, at times even through joint efforts by nuclear families and their consanguine and affine relatives.

Second, a number of students' transition was disrupted due to financial difficulties, as demonstrated in a number of cases cited. The results show, for example, that most children from various family-types were compelled to join neither their chosen nor selecting secondary schools. The reason was that many of those parents were socio-economically deprived and could not afford meeting the cost of sending their children to far away schools. Similarly, over 80.0% of all students from two-parent families experienced late entry into Form I, largely because their parents failed to provide for the family, due to lack of money. That scarcity of funds also led to strained family-relations; common household feuds; distorted family social-interactions; and at times separation of parents, all at the expense of children's prompt transition. It also came out that those family instabilities, which came about due to lack of money, had compelled a number of children into child-labour to earn extra income for their households; a move that derailed their timely transition into secondary education.

On the other hand, in families where the resource-base was strong, children's transition into secondary education was

enhanced. There were, however, other cases where the family financial resource-base was strong but parents' education low and children's transition was destabilised. A good example of this is that of Jakinda. Here was a case where all the money needed was available, but no parental support. Such cases confirmed that the availability of money, on its own, did not guarantee children's timely transition into secondary education. This point was further demonstrated in the case of Othwele, where the strength of parent-child love, moral support, care, positive parent-child relations and constant encouragement provided a child-friendly living environment that surpassed the value of money. Othwele did not only make a timely entry into Form One but was also a good performer in class, despite his socio-economic background. His motivation to pursue education, with vigour, was propelled more by a success story in a neighbour's homestead, proving that where many success stories exist, children's transition is likely to excel.

Finally, study findings reveal how the personal urge, interest, bravery and resilience to break through the '*barbed wires'* blocking their way to secondary school, motivated some youth to bounce back to secondary education one , two or so years later. The case of Owitti was a good example, where self-determination, resilience and the courage to overcome adversities, became critical factors behind his eventual transition into secondary education. Those cases could provide valuable learning lessons and encouragement that other children in similar circumstances elsewhere can also overcome obstacles and join secondary education.

6.0 Conclusion

This study contributes to knowledge by providing an insight into how out-of-school life experiences can impact on children's transition into secondary education. By showing how various out-of-school life-challenges inter-locked into *barbed wires* to obstruct children's timely transition in Ugunja, this study highlights the big difference that can be made by incorporating such experiences in transition studies and education policies. The out-of-school life-experiences in Ugunja had arisen largely because majority of parents were of less education, indifferent, socio-economically deprived and less concerned about the value of education.

Recommendations

This study has raised some very fundamental factors, which have been and continue to act as '*barbed wires'* against children's transition into secondary education across social groups in Ugunja Sub-County. In particular, children's transition has basically been undermined by non-interaction and poor sharing of information, in a situation of socio-economic deprivation. There is urgent need to remove these '*barbed wires'* so that children in Ugunja Sub-County can have timely access to secondary and higher education; and also enter and gainfully participate in the open labour market. Key stakeholders in family welfare and children's education are called upon to initiate appropriate corrective measures to improve the resource-base of families; and address the ramifications of low socio-economic deprivations in households. Accordingly, it is recommended that:

- appropriate measures be initiated to raise the economic resource-base of families in Ugunja Sub-County;
- workable measures be initiated to ensure a sustainable food security in the Sub-County;
- families in the Sub-County be encouraged and supported to actively engage in sustainable food production; and income generating activities;
- parents with children in schools be encouraged and empowered to enrol and participate in community cooperative movements, which provide soft loans, secured through joint activities;
- allocation of bursaries and scholarships be expanded to cover more bright but needy children;
- annual awards be created to reward and motivate parents who excel in supporting children's transition;
- to redress the fast-disintegrating family relations, community members in Ugunja Sub-County, be sensitised on the virtues of a cohesive family unit; and the importance and value of harmonious family relations, through workshops, seminars and public meetings, including public clinics;
- an inclusive family social welfare policy be enacted to enhance family-cohesion; bring parents closer to their children; and more involved in such children's activities;
- to redress the increasing negative effects of parental apathy, negative attitude and little interest in secondary education, workshops, seminars and public meetings, including public clinics be mounted to sensitise parents and the wider community in Ugunja Sub-County on the value and importance of education; as well as the benefits of having educated children;
- local area chiefs and education officials be supported to enforce the current education policy, which requires every child to go to school.

Recognising that children's transition has basically been undermined by less interactions and poor sharing of information, in a situation of socio-economic deprivation, this study also recommends that:

- capacity building **Resource and Information Centres** be established in Ugunja Sub-County to enhance public access to and dissemination of information;
- collaboration be created between primary and secondary schools to enhance regular visits and tours by children for purposes of sharing information and to build familiarity;
- encourage the creation/revival of old school students associations and local area students associations as motivators to school children;

We strongly believe that effective implementation of these recommendations stand higher prospects of success and enhancement, where external cooperation and partnerships can be established with local and regional universities, international donors and agencies, with interests in child and family welfare and development. The said co-operations and partnerships could be aimed at starting and supporting complementary projects in such areas as: harnessing natural resources for family economic empowerment; sustainable food security; poverty eradication; as well as youth health, education and development. This will go a long way in creating well integrated families, and cultured children, as crucial elements for a happy and fulfilling family life in Ugunja Sub-County.

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Kindly take note that I am a self-sponsored candidate, pursuing this study purely due to my personal interests in the subject area. No institution or organization has provided me with any financial support towards the pursuit of this study.

Kenya's Internet of things Landscape: Data Practices, Governance, and the Politics of Digital Sovereignty

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ABSTRACT

Kenya is experiencing a rapid surge in Internet of Things (IoT) adoption, reshaping sectors such as agriculture, healthcare, energy, and urban planning through data-driven innovations. Despite these benefits, the heavy reliance on foreign-manufactured IoT devices and cloud services presents critical challenges for national data governance and digital sovereignty. This study examines the consequences of unregulated IoT deployment on Kenya's control over its digital ecosystem. We argue that the widespread use of commercially available IoT devices, which often transmit sensitive data to external servers, creates opaque transnational data flows that limit national oversight and heighten security risks. To explore this issue, we adopt a mixed-methods approach. The central question guiding our analysis is: *How does the unregulated adoption of IoT technologies affect Kenya's control over its data and digital ecosystem?* Our research begins with an infrastructure mapping exercise to identify the intersections between local IoT deployments and foreign data infrastructures. We then conduct a policy analysis of Kenya's ICT laws, data protection regulations, and related governance frameworks. Finally, a systematic review of academic, governmental, and grey literature provides insights into the political, economic, and technological implications of a foreign-dominated IoT ecosystem. Our findings reveal substantial gaps in legal, regulatory, and technical frameworks, enabling unrestricted data extraction and external surveillance. Drawing on theories of digital sovereignty and postcolonial technopolitics, we highlight the urgent need for reform in Kenya's IoT governance strategies. We propose a roadmap focused on fostering domestic IoT innovation, regulating cross-border data flows, and establishing enforceable standards for data localization. These recommendations offer actionable insights for Kenya and other emerging economies striving to reclaim control over their digital futures.

Key words: Internet of Things, Data governance, **Digital sovereignty, Cross-border data flows, Digital colonialism, Postcolonial techno politics**

Introduction

Internet of Things has emerged as a transformative force in modern technology, enabling the integration of the physical and digital worlds. This is changing how we use and interact with devices (N V, 2024). By 2027, there will be over 27 billion connected devices, significantly transforming how businesses operate and how people interact with their surroundings (Coughlin, 2024).

Globally, the rapid adoption of IoT is

reshaping key sectors. In Kenya, IoT is transforming agriculture, healthcare, energy, manufacturing, urban planning, and security (Ellie, 2023). While these technologies offer significant efficiency and data-driven innovation gains, much of the data they collect is transmitted to foreign-owned cloud platforms. These raises pressing concerns about data sovereignty (Mathew, 2024).

Digital sovereignty is particularly urgent in postcolonial contexts like Kenya. The widespread dependence on foreign IoT infrastructure reinforces asymmetric power relations, as locally generated data remains subject to external control and commercial exploitation (Couldry & Mejias, 2019; Hutchinson et al., 2024). This dynamic exemplifies digital dependency and infrastructural inequality, rooted in broader patterns of digital colonialism—a neo-colonial practice in which the Global South is exploited by both Western and Eastern powers through control over digital infrastructure and data (Dahiya, 2023). It also reflects technopolitical subordination, where modern technologies, such as the Internet and computing systems, are used to advance political agendas (Schaupp, 2021), often replicating historical patterns of marginalization and control.

Despite increasing global attention to data governance, there is limited research exploring how unregulated IoT ecosystems affect sovereignty in African contexts. Existing studies tend to focus on cybersecurity or infrastructure development, often overlooking the geopolitical risks of externally controlled data architectures.

This paper addresses that gap by analysing IoT-enabled data flows in Kenya through policy analysis, infrastructure mapping, and review of public discourse. Grounded in theories of digital sovereignty and postcolonial technopolitics, the paper emphasises the urgent need to develop local IoT and cloud capabilities, particularly through stricter regulations on cross-border data flows, to safeguard Kenya's national interests and digital future. The paper will seek to achieve the following objectives: to analyse IoT data collection practices in Kenya, to investigate the impact of IoT-enabled data flows on Kenya's sovereignty and to propose actionable recommendations to strengthen IoT regulation, digital sovereignty and data governance.

Methodology

This study adopts a qualitative, desk-based research approach combining policy analysis, infrastructure assessment, and an extensive review of secondary literature. It examines how conflicting data protection frameworks, global digital infrastructure dependencies, and emerging IoT ecosystems impact national sovereignty and data governance in Kenya.

Literature for this study was accessed primarily through Google Scholar and various institutional research databases. Search queries included terms such as "IoT and digital sovereignty in Kenya," "IoT data collection in Kenya," "Foreign tech companies data control Kenya," "Cross-border data flows regulation Kenya," "IoT cybersecurity risks," "Data localization policies East Africa," and "data governance in Kenya,".

The sources drawn upon fall into three broad categories, each explicitly aligned with the study's objectives:

Grey Literature: This includes policy briefs, white papers, reports from advocacy organisations, media analyses, and insights from technology summits. These sources inform Objective One by providing empirical and contextual insights into IoT

data-collection practices in Kenya and the market forces shaping them.

Primary Doctrinal Sources: These consist of key legal and regulatory texts such as the Data Protection Act (2019), the Computer Misuse and Cybercrimes Act (2018), relevant judicial decisions, and official government directives. They support Objective Two by enabling a critical examination of how IoT-enabled data flows intersect with national sovereignty and how existing regulatory infrastructures mediate these tensions.

Secondary Academic Sources: Peer-reviewed journal articles, scholarly books, and comparative policy analyses on digital sovereignty, governance, and IoT ecosystems inform Objectives Two and Three. They provide theoretical frameworks for assessing sovereignty implications and guide the formulation of recommendations to strengthen IoT regulation, digital sovereignty, and data governance in Kenya.

Literature Review

Understanding the Internet of Things (IoT)

The Institute of Electrical and Electronics Engineers (IEEE) IoT Initiative defines the Internet of Things as "a network that connects uniquely identifiable 'things' to the internet." These 'things' refer to smart devices embedded with sensors, actuators, and processing capabilities that allow them to interact with their environment and communicate with other systems (Minerva, Biru, & Rotondi, 2015). IoT is envisioned as enabling ubiquitous connectivity, "anything, anywhere, anytime, anyway, and anyhow", within an interoperable ecosystem (Elksasy, 2023), underscoring the central role of embedded systems in linking the digital and physical realms.

The defining feature of IoT lies in its ability to create a dynamic ecosystem where devices, people, organisational processes, infrastructure, and natural systems continuously share and respond to data (Choudhary, 2024). As IoT technologies scale in scope and sophistication, they are poised to reshape a broad spectrum of human and societal functions (Perera et al., 2014).

Core Components of the IoT Ecosystem

Figure 1 shows the essential components of the Internet of Things

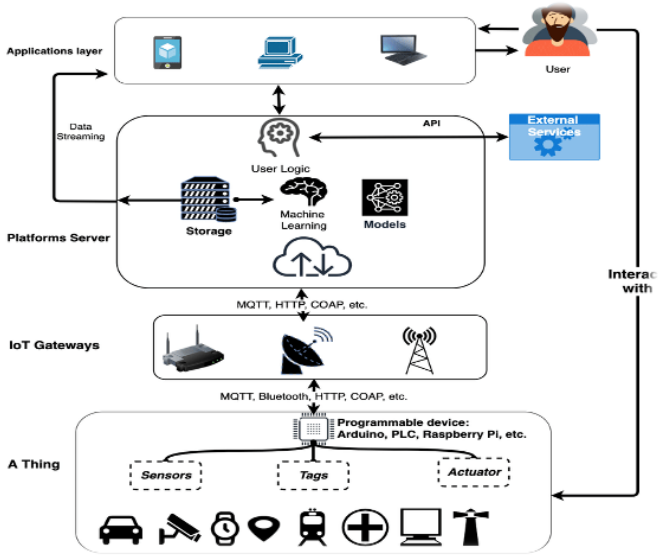

Figure 1.
Components of the IoT Ecosystem.
Source: Ihirwe, F., Di Ruscio, D., Mazzini, S., Pierini, P., & Pierantonio, A. (2020). Low-code engineering for internet of things. In *Proceedings of the 23rd ACM/IEEE International Conference on Model Driven Engineering Languages and Systems: Companion Proceedings.* https://doi.org/10.1145/3417990.3420208

The Cloud Infrastructure provides storage and computing resources for data processing and analysis (Kumar & Mallick, 2018).

IoT Building blocks	Devices	Features
Things	Devices, Sensors, Actuators	Enable communication and data collection from targeted objects or environment without human intervention
Gateways	Smart hubs (Alexa)	Act as an intermediary between 'Things' and the cloud infrastructure, enabling pre-processing and connectivity; data aggregation and filtering, protocol translation, security and edge computing
Network infrastructure (NI)	Router, Gateways Aggregators, Repeaters	Provides control over data flow from 'Things' to the cloud infrastructure and ensures security during transmission
Cloud infrastructure (CI)	Virtualized server (VS) Data Storage Units (DSU) Application Layer	Enables data storage, analysis, logic processing, and advanced computing capabilities. The Application Layer provides user interfaces for monitoring, control, and decision-making

The table above expounds on the key features of the IoT architecture.

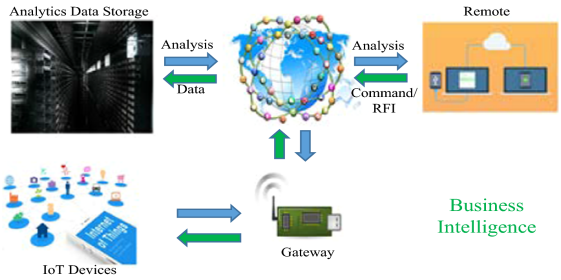

Figure 2. Data Movement in the IoT Ecosystem**.**
Source: Kumar, N., Tiwari, P., & Zymbler, A. (2019). Internet of Things is a revolutionary approach for future technology enhancement: A review. *Journal of Big Data, 6*(1). https://doi.org/10.1186/s40537-019-0198-4

How IoT Works

IoT devices connect to the internet via Internet Protocol (IP), receiving unique identifiers for global communication. Equipped with sensors, they automatically capture real-time data such as temperature, motion, or sound. This data is then

transmitted through networks like Wi-Fi, Bluetooth, or cellular to cloud servers for processing (Kuchuk & Malokhvii, 2024). Specialised software on these servers analyses the data to generate meaningful insights or trigger alerts which are delivered to users through interfaces like mobile apps or web dashboards. This automation enables quick, informed decision-making with minimal human input (Zaoui et al., 2023).

Voice assistants like Google Home and Siri illustrate how devices can interpret commands, retrieve information, and respond in real-time (Tuli et al., 2023). To support such responsiveness, IoT systems increasingly use edge and fog computing, which process data closer to the source to reduce latency. Edge computing handles data directly on devices (e.g., phones or fitness trackers). Fog computing adds a layer between devices and the cloud, like a local router that filters data before sending key information onward (Naha et al., 2018; Kuchuk & Malokhvii, 2024).

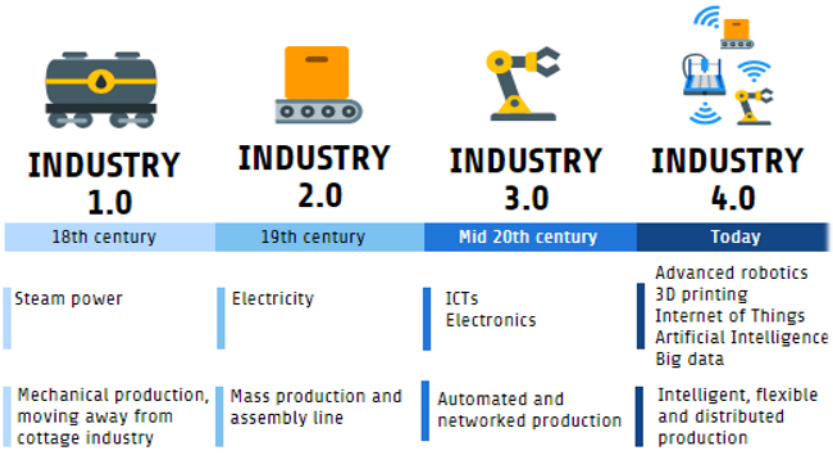

Figure 3.
Industrial Revolution.
Source: Lasi, H., Fettke, P., Feld, T., & Hoffmann, M. (2014). Industry 4.0. *Business & Information Systems Engineering, 6*(4), 239–242. https://aisel.aisnet.org/bise/vol6/iss4/5

IoT as an Enabler of the Fourth Industrial Revolution (4IR)

Industry 4.0 or the fourth industrial revolution (4IR), integrates digital technologies, automation, and connected data to enhance manufacturing processes. Its primary aim is to boost efficiency, flexibility and connectivity, enabling smarter, faster decision-making (Weathersby, 2024).

Central to this transformation are big data, artificial intelligence (AI), machine learning and Internet of Things (IoT), particularly Industrial IoT. By linking devices such as sensors and trackers to information systems, these technologies connect people, products, and processes, generating real-time insights that support advanced monitoring, predictive maintenance, and data-driven operations.

IoT Adoption in Developing Countries and Kenya

Joiner et al. (2023) highlight IoT's growing role in addressing development challenges, projecting global IoT connections to more than double between 2021 and 2030, reaching over 37 billion.

In Sub-Saharan Africa and parts of Asia, cellular IoT connections are expected to exceed 156 million. Enterprise IoT, particularly in utilities, continues to outpace consumer IoT as the main growth driver in 2025, supporting services in climate resilience, agriculture, health, waste management, and transport (Joiner et al., 2023). Figure 4 shows the projected growth of IoT devices to 2030.

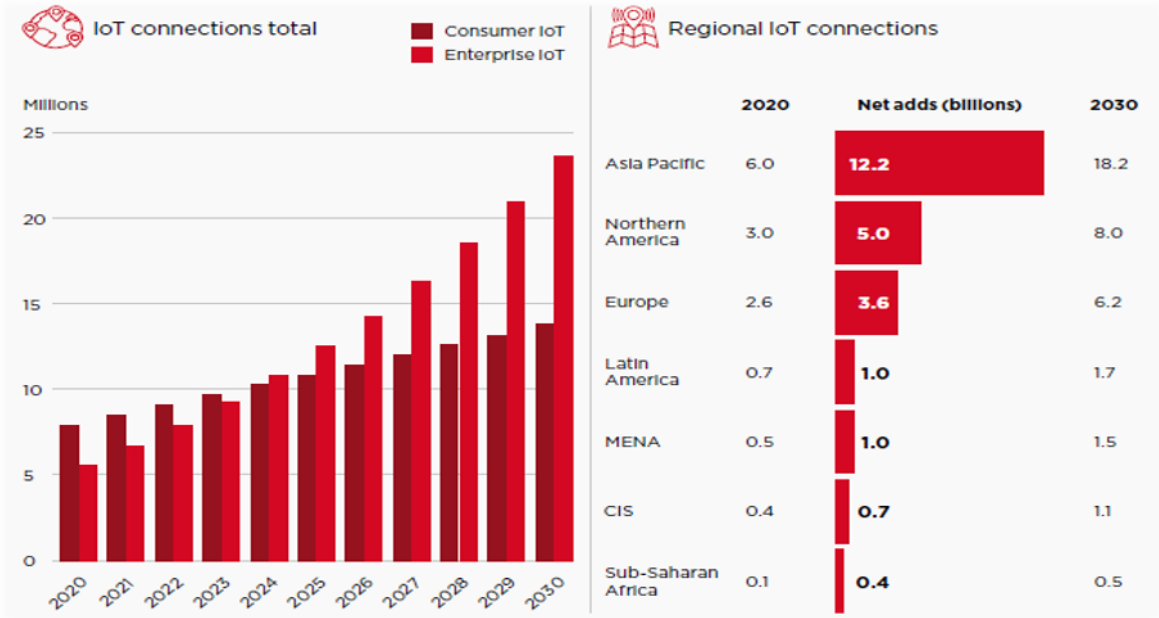

Figure 4.
Projected IoT Connections and Growth by Region.
Source: Joiner, J., Patsioura, C., Borole, S., & White, Z. (2023, March). *IoT for development: Use cases delivering impact*. GSMA. https://www.gsma.com/solutions-and-impact/connectivity-for-good/mobile-for-development/wp-content/uploads/2023/03/IoT-for-Development-Use-cases-delivering-impact.pdf

Despite infrastructural and connectivity limitations, countries like South Africa, Nigeria, Kenya, and Rwanda are prioritising IoT development. Nigeria is deploying Random Phase Multiple Access (RPMA)-based IoT networks, while other nations explore similar strategies to bridge digital divides (Bowen, 2021). Through IoT, Kenya is advancing smart farming, smart healthcare, security, and urban planning via initiatives such as the Galana Kulalu Irrigation Scheme; Konza Technopolis (the Silicon Savannah); Tatu City; Mombasa Port Digitization; Kenya Power Smart Grid; Kenya Wildlife Service IoT for Conservation; the Nairobi Intelligent Traffic System; and partnerships with global tech firms like Huawei.

Holland & Lenovo (2024) note that the COVID-19 pandemic accelerated Africa's shift toward the Fourth Industrial Revolution, increasing demand for smarter financial systems and telecom infrastructure. Yet challenges persist. Van Rensburg (2021) points to high device costs, unreliable power, limited internet access and gaps in skills and policy as key barriers. He calls for affordable, long-range IoT solutions, reduced reliance on proprietary systems, and locally adapted models, particularly for rural deployment.

Data collection in the IoT ecosystem

IoT facilitates real-time monitoring through millions of sensor-equipped devices that capture environmental parameters such as temperature, motion, noise, and pressure. These sensors form the first layer of data collection, converting

physical signals into digital data (Mouha, 2021).

Collected data is transmitted via protocols such as Wi-Fi, Bluetooth, Zigbee, or MQTT to processing platforms, ranging from edge devices and local servers to cloud and fog computing platforms, based on latency and complexity requirements (Ari et al., 2024). This second stage ensures secure and efficient data transfer, with variations depending on application domain (e.g., agriculture, healthcare, industrial systems, energy and security).

In the third stage, the data is processed to detect anomalies, trigger actions or undergo transformation or cleaning. Increasingly, artificial intelligence (AI) and machine learning are applied to enable real-time analytics and predictive capabilities (Ari et al., 2024). The final output is delivered in actionable formats; dashboards, alerts, or reports, supporting decision-making across fields like medicine, engineering, and marketing. IoT thus serves as a critical enabler of Big Data systems, driving interactive, data-informed processes and autonomous operations (Karbekova, Zak, & Milenkovic, 2025).

IoT and Digital Sovereignty

Digital sovereignty (the ability of a state, organisation, or individual to control their digital infrastructure, data, and technologies without foreign interference; Hummel et al., 2021) remains a contested and evolving concept (Steinbach, 2024). Divergent global interpretations have intensified geopolitical competition among major powers such as the United States, China, Japan and the European Union, each seeking to dominate critical data infrastructure and reduce technological dependence. This rivalry increasingly extends to the domains of IoT and AI.

Kenya, an emerging digital hub, faces challenges in maintaining digital sovereignty amid rapid IoT adoption. Connected technologies ranging from wearables, smart meters and surveillance systems generate vast quantities of sensitive data (Musyoka et al., 2024), much of which is transmitted across borders and processed on foreign-owned platforms. Consequently, concerns arise regarding data ownership, surveillance, regulatory autonomy, and economic exploitation (Venske, 2023).

Although the Data Protection Act provides a legal foundation for privacy and data governance, it does not fully address the unique demands of IoT, including real-time data flows, device interoperability, and cross-border data sharing (Chesosi, 2022). These gaps underscore the need for targeted reforms emphasizing data localization, system transparency, and accountability within Kenya's IoT ecosystem.

To strengthen digital sovereignty, Kenya must align its IoT policies with national legislation and societal values. Experts advocate for decentralised models, such as data cooperatives and self-sovereign identity systems, to enhance user control, privacy, and autonomy (Buhler et al., 2023). As AI-driven IoT systems expand, safeguarding national data will require not only innovative policy frameworks but also investment in local infrastructure and regulatory capacity (Feijoo et al., 2020). While IoT offers significant development opportunities, unregulated deployment poses risks to Kenya's digital autonomy. Preserving sovereignty will demand cohesive, forward-looking strategies that close regulatory gaps, fortify infrastructure, and prioritize governance models centred on national control and resilience (Tan et al., 2023).

Theoretical Perspectives on Digital Sovereignty and Postcolonial Technopolitics

This paper draws on the critical

frameworks of digital colonialism and postcolonial technopolitics to examine Kenya's complex relationship with foreign-owned digital infrastructure, such as cloud. Couldry and Mejias (2019) define digital colonialism as the reproduction of neo-colonial power dynamics through global data flows, where peripheral nations become raw data providers for dominant tech powers. Kenya's dependence on platforms governed by extraterritorial laws, such as the U.S. CLOUD Act, which allows U.S. authorities to have access, exemplifies this dynamic by limiting national control over digital infrastructure and data governance.

At the same time, alternative theoretical lenses highlight the dual nature of digital technologies. While infrastructure may reinforce dependency, it can also create space for local agency and innovation. However, Morozov (2013) critiques the ideology of "tech solutionism"—the belief that digital tools inherently solve social problems, warning that such narratives often obscure the structural power imbalances embedded in technological deployment (Wu, 2013). This critique is particularly relevant in Kenya's IoT landscape, where unchecked implementation risks deepening the existing digital divide.

Zuboff's (2019) concept of surveillance capitalism further enriches Wu's (2013) analysis. It illustrates how data extracted through IoT systems not only generates economic value for foreign corporations but also erodes user autonomy and democratic oversight (Hongladarom, 2020). This dynamic complicates Kenya's pursuit of digital sovereignty, as data commodification often undermines national policy objectives and individual rights.

Data Governance and Security in the IoT Ecosystems

Data governance refers to the policies, standards, and mechanisms that guide how data is collected, stored, shared, and protected throughout its lifecycle (Abraham, Schneider, & vom Brocke, 2019; Zorrilla & Yebenes, 2021). In Africa, these frameworks are still maturing as only 61% of countries have enacted data protection laws, compared to 74% in the Americas and 98% in Europe (UNCTAD, 2025). To bridge this gap, initiatives like the African Union's Data Policy Framework (African Union, 2024) and the Digital Transformation Strategy (2020–2030) aim to promote harmonised governance across the continent. However, implementation remains inconsistent across jurisdictions (CIPESA, 2022).

As IoT adoption accelerates across sectors including agriculture, healthcare and smart cities, the associated risks multiply. IoT devices generate vast quantities of sensitive, real-time data and are also act as an access point to broader systems. Without strong governance and robust security, these ecosystems become vulnerable to breaches. The Stuxnet attack, while not an IoT attack per se, illustrates the vulnerabilities of interconnected industrial control systems, vulnerabilities also evident in industrial IoT (Denning, 2012). The Mirai botnet, which hijacked thousands of IoT devices for global DDoS attacks, highlights the high stakes involved (Affinito et al., 2023).

Developed economies have introduced stringent regulatory, privacy, and cybersecurity frameworks to mitigate vulnerabilities. The European Union's GDPR for instance, sets global standards for consent, transparency, and accountability (Ienca & Malgieri, 2022). The EU Data Act further strengthens data governance by regulating access and sharing within the European Union. In the

U.S., the California Consumer Privacy Act (CCPA) and NIST cybersecurity guidelines emphasise risk mitigation and data minimisation (Folorunso et al., 2024; Jamesju, 2025; Dad & Nguyen, 2025). Countries like Germany and Japan have included IoT-specific security measures within their national cybersecurity strategies (Matsubara, 2016; Hessel & Rebmann, 2020).

Kenya's Framework: Progress and Gaps

Kenya has established a growing data protection legal foundation, including Article 31 of the Kenyan constitution, the Data Protection Act (2019), the Computer Misuse and Cybercrimes Act (2018), and the Kenya Information and Communication Act (1998). However, enforcement remains limited. According to KIPPRA (2024) and Lawi (2024), the Office of the Data Protection Commissioner (ODPC) is under-resourced and lacks sufficient authority to enforce full compliance. Additionally, data stewardship is fragmented across government agencies and institutions, and much of Kenya's personal data is processed offshore, raising concerns over data sovereignty (Njogu, 2023; Tunde, 2025).

Kenya's Cloud-First Policy (2024) is a promising step toward localising government data, but its enforcement and implications for private-sector data handling remain uncertain (Adams, 2024). To support a secure digital economy, Kenya must prioritise comprehensive, enforceable, and contextually relevant data governance policies that align with national security and sovereignty objectives.

Security Challenges & Regulatory Response

Kenya's IoT infrastructure, which is largely reliant on opaque, foreign-developed technologies, faces significant security vulnerabilities due to insufficient regulatory control. Although legal protections exist, their enforcement remains weak (Llp & Llp, 2025). While the ODPC has issued some regulatory guidance, primarily in the telecommunications sector, there are no unified cybersecurity standards specifically designed for IoT or for cross-border data flows. Moreover, compliance monitoring and auditing processes remain largely opaque.

The Communications Authority of Kenya (CA) has also introduced preliminary regulations on IoT device registration and cybersecurity, but these remain in the early stages of development. Key sectors, including utilities, transportation, and smart cities, continue to operate with limited safeguards (Chesosi, 2022). Urgent priorities therefore include establishing cohesive, enforceable IoT security standards, enhancing interagency coordination, and investing in domestic cybersecurity capacity to reduce dependence on foreign systems and strengthen national resilience.

Socio-Economic Implications of IoT and Data Governance

Globally, leading economies like the United States, China, and the European Union have strategically embraced IoT to boost productivity, modernise public services, and maintain global competitiveness. These countries pair rapid technological expansion with strong consumer protection and data governance frameworks to address ethical, economic, and social risks (Carriere-Swallow & Haksar, 2019). The strong regulations build trust and reputation.

In contrast, many African nations are still grappling with how to scale IoT adoption while ensuring equitable socio-economic

outcomes and responsible data use. Across the continent, IoT is being applied to address systemic issues in agriculture, healthcare, and urban development. However, inadequate digital infrastructure, limited data literacy, and weak regulatory systems hinder inclusive impact (Cohen, 2023). External technology providers often dominate these ecosystems, raising concerns about data exploitation, digital dependency, and sovereignty.

In Kenya, the Internet of Things (IoT) has demonstrated considerable potential across multiple sectors. In agriculture, it facilitates smart farming practices such as precision irrigation and real-time crop monitoring. The energy sector benefits from IoT through smart grids and detailed consumption tracking, while manufacturing leverages these technologies for predictive maintenance and enhanced operational efficiency. Urban planning is increasingly informed by smart city systems. Public service, including healthcare and security, utilize IoT to improve surveillance, service delivery, and remote monitoring (White et al., 2023). Despite these advances, persistent disparities in internet access, affordability, and digital literacy continue to marginalize rural and low-income populations (Van Rensburg, 2021). Furthermore, the absence of robust consent mechanisms and context-sensitive governance frameworks exacerbates the risks of surveillance, data misuse, and socio-economic inequality (Purnamaningsih et al., 2024).

To fully realise the socio-economic benefits of IoT, Kenya must strengthen and enforce data protection legislation, invest in accessible and resilient digital infrastructure, and foster inclusive, transparent, and accountable data governance models. Without these reforms, the promise of IoT may deepen, rather than bridge, existing socio-economic divides.

While the literature highlights IoT's transformative potential and underscores the urgent need for robust data governance, empirical research on the impact of these technologies on digital sovereignty in postcolonial African contexts, such as Kenya, remains limited. This study seeks to address that gap by critically examining the implications of IoT-enabled data flows for Kenya's national autonomy, with particular attention to regulatory frameworks, technological dependencies, and the geopolitical risks associated with opaque cross-border data transfers.

Through a contextual analysis of Kenya's digital ecosystem based on policy review, legal analysis, and infrastructure assessment, the discussion that follows identifies systemic vulnerabilities, evaluates existing governance mechanisms, and proposes strategic recommendations for strengthening Kenya's digital sovereignty.

Discussion

IoT, Data Flows, and Kenya's Digital Sovereignty

Manufacturing of IoT devices in Kenya

Kenya is rapidly positioning itself as a regional hub for IoT innovation, particularly in critical sectors such as energy, water, waste management, and transportation. Smart utility IoT connections across Sub-Saharan Africa are projected to increase nearly six-fold by 2030, with Kenya set to play a leading role in this transformation (Joiner et al., 2023). The country's Digital Economy Strategy aims to boost ICT's contribution to GDP from 2% to 10% by 2030 (Ministry of Information, Communications and the Digital Economy, 2023), focusing on device standardisation, local hardware

assembly, and efficient spectrum utilisation.

Although Kenya's IoT manufacturing ecosystem is expanding, it remains heavily reliant on foreign technology, capital, and supply chains. Notably, companies such as Numeral IoT, which produces smart meters and automation tools domestically, stand out as rare examples of end-to-end manufacturing. Other key players shaping Kenya's IoT landscape include Safaricom, the country's leading telecom provider, which delivers connectivity and solutions such as telematics, smart metering, and connected cooling systems for fleet and asset management, supported by its data centre infrastructure. Safetrac Limited specialises in IoT-based fleet, fuel, and cold chain monitoring, integrating blockchain to deliver real-time insights. Liquid Intelligent Technologies runs Kenya's first nationwide Sigfox Low Power Wide Area Network (LPWAN) network, enabling affordable, sector-specific IoT solutions in agriculture, healthcare, and urban infrastructure while also maintaining data centres. Synnefa develops AI-driven smart farming tools that facilitate remote monitoring of soil and crop conditions. Local integrators such as Geviton, Veno Autobotics, Novatech, and Adva IoT focus on design, assembly, and custom applications, reflecting a gradual shift from import dependence toward localised, value-added production.

Collectively, these organisations are nurturing a dynamic IoT sector by combining local assembly capabilities with an expanding array of innovative use cases. Nevertheless, the ecosystem still relies heavily on assembling imported components rather than undertaking full-scale manufacturing. Advancing digital self-reliance and industrial resilience will require significant investment in human capital, incubation programmes, government-backed financing and the gradual development of upstream capabilities, particularly in semiconductor design, testing, and fabrication, supported by an enabling policy and regulatory environment.

Who owns the cloud? Kenya's Infrastructural Development

In today's data-driven economy, data centres are the backbone of cloud computing, AI, financial systems, and public services. The Kenya *Data Centre Standard* describes data centres as centralised hubs for IT operations, housing power systems, storage, and applications (ICT Authority, 2019). The standard emphasises performance, resiliency, and scalability as critical design principles.

Figure 5 illustrates countries with the highest number of data centres in the world, dominated by G7 members. However, these figures do not reflect capacity or operational scale, both of which are more accurate indicators of digital power and influence.

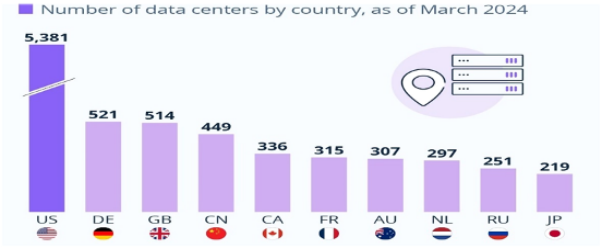

Figure 5.
Countries with the highest number of Data Centres in the World.

Source: Fleck, A. (2024, September 20). Which countries have the most data centers? *Statista Daily Data*. https://www.statista.com/chart/24149/data-centers-per-country/?srsltid=AfmBOooBDCbeigY15RB5yfdxzA7AOY9O-

TgBr2yLl04XGQIoiKHX4pKC

Despite Africa's data centre market growing at an annual rate of 12%, projected to reach US$10 billion by 2028, the continent accounts for less than 1% of global data storage capacity (Benamara, 2025). This disparity highlights a deep-rooted dependency on external digital infrastructure.

Within this broader context, Kenya's data centre market is expected to grow from USD 509.01 million in 2024 to USD 733.34 million by 2032, with a compound annual growth rate of 4.67%. Nairobi has emerged as a regional data hub, hosting around nine major facilities operated by providers such as iColo, IXAfrica, Safaricom, LINX Nairobi, Africa Data Centres, and the Government of Kenya (Phapale, Kadam & Patil, 2025). These Tier III-certified centres are critical for regional internet and cloud service operations.

Government-led initiatives, most prominently the Konza Technopolis, the national digital highway and the national cloud-first policy, further signals the country's ambition to become a digital powerhouse. Yet a deeper structural challenge persists: much of the software infrastructure, data storage, and analytics platforms on which Kenyan institutions depend remain under the control of foreign corporations. This situation constrains Kenya's digital autonomy. Couldry and Mejias (2019) describe this phenomenon as a form of digital colonialism, where data generated locally is either extracted, stored, and monetised abroad. This arrangement perpetuates structural inequality: while Kenya builds out its infrastructure, it remains dependent on global tech giants for core services and platforms. As Musyoka et al. (2024) warn, rapid digitalisation without sovereign control risks entrenching external influence and undermining long-term digital self-reliance.

IoT and Cloud Dependency: Implications for Kenya's Digital Sovereignty

Global shifts toward nationalism are reshaping how nations engage with cloud infrastructure. Kenya, like many developing nations, remains heavily reliant on foreign platforms like AWS, Azure, and Google Cloud, which operate mainly under an external legal framework such as the U.S. CLOUD Act. This extraterritorial reach limits Kenya's ability to control and govern its own data, even as it enforces its Data Protection Act. Recent geopolitical developments, such as the Iran-Israel-Lebanon attacks, Russia-Ukraine war, escalating U.S.–China trade sanctions, and the rise of power blocs like BRICS, have further exposed the risks of outsourcing digital infrastructure. These events prompt pressing concerns: What happens to a nation's critical data if relations with the host country deteriorate? While wealthier nations can mitigate such risks by building sovereign infrastructure, most developing states lack the financial, technical, and institutional capacity to do so, leaving them at the mercies of superpowers.

Kenya's deepening dependence on foreign cloud platforms and IoT devices therefore, means critical data in sectors like agriculture, healthcare, security and energy often leaves the country, bypassing local oversight and protection. This not only weakens Kenya's control over its digital infrastructure but also exposes the country to foreign surveillance, data exploitation, strategic manipulation and geopolitical vulnerabilities. Without full control of local cloud infrastructure, IoT governance frameworks and full-spectrum IoT production, Kenya risks entrenching a digital dependency cycle, serving primarily as a data generator for external actors.

Breaking this cycle demands concerted investment in local data centres, robust cross-border data flow regulations, and the cultivation of domestic IoT and AI capabilities. Globally, promising strategies are emerging. Countries like Brazil and India are experimenting with data portability frameworks and digital non-alignment policies to reduce reliance on single foreign providers (Binotto & Ponce, 2022; Belli et al., 2024). Similarly, regional initiatives such as the African Union's *Digital Sovereignty Agenda* and the African Continental Free Trade Area (*AfCFTA) Digital Trade Protocol African Union* offer collective platforms to assert greater control over data governance and digital trade across the continent (African Union, 2020). Aligning Kenya's efforts with these global and regional strategies will be crucial to building a resilient, sovereign digital future.

Data Governance Challenges and Strategic Opportunities

As Kenya deepens its reliance on foreign digital infrastructure, effective data governance becomes a critical pillar of digital sovereignty, citizen protection, and institutional accountability. The enactment of the Data Protection Act (2019), modelled on international standards like the EU's GDPR marked an important step forward. However, enforcement remains a key bottleneck. Key challenges lie in technical limitations, institutional capacity issues, and resource constraints. While the Office of the Data Protection Commissioner (ODPC) has made notable strides, its oversight remains uneven, particularly at regional levels. This inconsistency hampers full compliance and enforcement across the country.

Unlike the EU, where data governance is uniformly enforced, Kenya still lags in regulating cross-border data flows. This exposes the country to risks in an increasingly interconnected global data environment. Even countries without comprehensive federal laws such as the U.S., enforce data protection more robustly through sector-specific legislation like the California Consumer Privacy Act (CCPA). To fully harness the potential of its digital economy and advance the Sustainable Development Goals (SDGs), Kenya must prioritise enforcement mechanisms. This includes fast-tracking appointment of Data Protection Officers across sectors, conducting regular compliance audits, and investing in cybersecurity infrastructure and training.

Initiatives like the Kenya National Digital Master Plan 2022–2032, along with emerging sector-specific data governance strategies in agriculture, finance, health, and defence further demonstrate progress. However, data governance must be viewed not just as a regulatory obligation but as a strategic enabler of innovation, trust, and improved public service delivery.

Socio-Economic and Strategic Considerations in IoT

The rapid expansion of IoT in Kenya has generated transformative opportunities, improving public services, enhancing productivity, and stimulating innovation across sectors. However, without inclusive and equitable policy frameworks, this growth also risks deepening existing digital inequalities, particularly between urban and rural communities, where disparities in connectivity, device access, and digital literacy remain pronounced.

Strategically, Kenya's substantial reliance on foreign-owned digital infrastructure raises significant concerns regarding national security and data sovereignty. As IoT systems become increasingly integral to administrative processes and economic activities, the volume of sensitive, high-valued, actionable data being generated and potentially processed outside the

country has grown exponentially.

The composition of GDP by sector in Kenya in 2021.

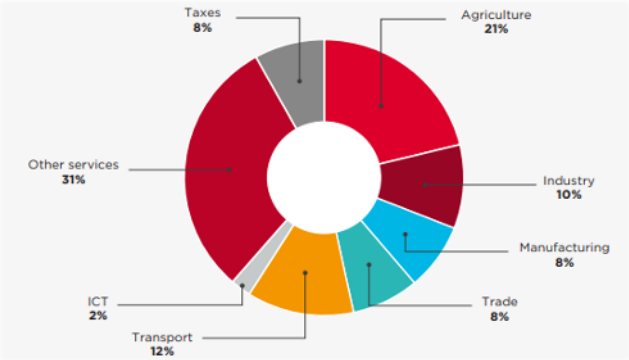

Figure 6
Sector Contribution to Kenya's GDP (2024).
Source: Harvey, M. H., Pate, D., Penteriani, G., Williams, M., Wamola, A., Mbugua, C., & Melly, L. (2024, October). *Driving digital transformation of the economy in Kenya: Opportunities, policy reforms and the role of mobile*. GSMA. https://www.gsma.com/about-us/regions/sub-saharan-africa/wp-content/uploads/2024/10/KENYA-DIGITAL-ECONOMY-REPORT-17TH-OCTOBER-V2.pdf

As illustrated in Figure 6, several sectors central to Kenya's GDP now depend heavily on IoT-enabled operations; agriculture, industry, manufacturing, transport and ICT. These sectors produce vast datasets that, if managed externally, could be leveraged in ways that influence national economic stability or political decision-making. This vulnerability was made evident during the 2017 presidential election petition, when critical electoral data resided on foreign cloud servers, placing essential evidence beyond the reach of Kenya's legal jurisdiction.

The risks associated with this form of digital dependence fall into three broad categories. First, foreign control of digital infrastructure may expose Kenya to national security threats, including surveillance, cyber interference, and economic coercion. Second, dependence on external technology providers can allow foreign regulatory environments, commercial incentives, or geopolitical interests to shape Kenya's digital trajectory. Third, the offshoring of data subjects' Kenyan information to foreign legal systems, thereby eroding data sovereignty and weakening domestic oversight.

Mitigating these challenges requires embedding digital development within Kenya's broader strategic agendas, including Vision 2030 and the Digital Industrial Policy. Initiatives such as Ajira Digital and Konza Technopolis are essential in this regard, as they aim to build digital literacy, local technical capacity, encourage home-grown innovation, and reduce structural reliance on foreign technology ecosystems.

Ultimately, Kenya's digital transformation must be guided by principles of inclusivity, security, and sovereignty. Achieving this balance demands coherent policy frameworks that facilitate technological advancement while strengthening national resilience, strategic autonomy, and equitable access to digital opportunities.

Ethics

Ethical considerations are central to Kenya's pursuit of digital sovereignty, particularly regarding privacy, informed consent, algorithmic fairness, and equitable access. As IoT and AI systems become increasingly pervasive, ensuring transparent data governance practices and safeguarding fundamental human rights is essential.

Global normative frameworks such as the Organisation for Economic Co-operation and Development (OECD)'s Principles on AI, UNESCO's Recommendation on the Ethics of AI, and the African Union's Data Policy Framework, offer valuable guidance for responsible technological deployment. However, operationalising these ethics in under-resourced regulatory environments remains a significant challenge. Constraints such as limited institutional capacity, low public awareness, and weak enforcement mechanisms often impede the effective implementation of ethical standards on the ground.

To move from principle to practice, Kenya must integrate ethical standards into law, education, and public procurement while building institutional capacity. Embedding ethics across the data lifecycle fosters trust, safeguards democratic values, and promotes inclusive, rights-based digital development.

Recommendations for Policy and Practice

Advancing Kenya's digital sovereignty and unlocking the full socio-economic value of IoT ecosystems will require a deliberately coordinated, multi-sectoral strategy aligned with flagship national initiatives such as the Digital Superhighway and the Kenya Digital Economy Acceleration Project. A fragmented or purely market-driven approach will be insufficient in the face of accelerating technological dependence and complex transnational data regimes.

A central priority should be sustained investment in domestic digital infrastructure, including the expansion of national data centres, coupled with the implementation of sector-specific data localisation requirements, where national security, financial stability, or citizen privacy may be at risk. Concurrently, regulatory frameworks governing cross-border data flows must be modernised to provide legal certainty, ensure interoperability with international norms, and articulate clear technical and ethical standards for both IoT and AI systems.

Strengthening Kenya's technological autonomy also necessitates deliberate cultivation of local production capabilities. Building capacity in IoT device assembly, sensor fabrication, and where feasible semiconductor design and prototyping should be supported through targeted tax incentives, research and development funding, and robust public–private partnerships. National IoT innovation challenges and hackathons can serve as important pipelines for talent discovery and rapid prototyping, reinforcing a culture of domestic innovation.

Equally important is the expansion of digital literacy and data rights education to foster a citizenry capable of meaningful, informed participation in digital ecosystems. Such initiatives must be complemented by strengthened institutional coordination across the ICT, education, security, and trade ministries to mitigate policy fragmentation and ensure coherence across regulatory, industrial, and educational interventions.

Finally, targeted support for SMEs and indigenous innovators through patient capital, incubation programmes, and preferential procurement will be critical for nurturing context-aware, locally grounded technological solutions. Taken together, these measures position Kenya not merely as an adopter of global IoT systems but as an emerging leader in secure, sovereign, and future-ready digital innovation.

Business Benefits

Advancing digital sovereignty offers clear advantages for Kenya's business ecosystem, notably in promoting

transparency and accountability. The development of local IoT manufacturing and data infrastructure will substantially reduce dependency on external providers while enhancing control over sensitive digital operations. This shift particularly benefits SMEs and start-ups by providing affordable, secure, and customized technological solutions. Similarly, locally hosted cloud services can lower latency, improve operational efficiency, and ensure greater regulatory compliance.

Moreover, fostering domestic digital capabilities stimulates homegrown innovation, generates skilled employment, strengthens value chains, and bolsters investor confidence. By aligning technological development with local needs and capacities, Kenyan businesses can scale sustainably and compete more effectively in the global digital economy, as exemplified by the transformative success of Numeral IoT and M-Pesa.

Conclusion

Kenya's journey toward digital sovereignty reflects both significant progress and persistent challenges. While portions of its infrastructure remain dependent on foreign technologies, initiatives such as the Konza Technopolis, the Digital Superhighway, local IoT manufacturing, and data governance measures under legal frameworks like the Data Protection Act (2019) and the Computer Misuse and Cybercrime Act (2018), demonstrate the country's growing capacity and ambition for greater data control.

Addressing systemic vulnerabilities and fostering supportive policy environments are essential to unlocking Kenya's full potential in the digital economy and safeguarding its digital future. By prioritizing local innovation, securing data sovereignty, and strengthening regulatory frameworks, Kenya can cultivate resilient, homegrown digital ecosystems that drive sustainable economic growth and protect national interests in an increasingly interconnected world. Such measures will also reduce dependence on global technology powers, in a manner reminiscent of China's strategic approach.

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Influence of Coaching Management Development Practices on Service Delivery in Kenyan Public Universities

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Abstract

This paper adapts the definition of Coaching as a one-to-one process of assisting employees to grow their career and to improve their performance through the provision of constant feedback, encouragement and raising awareness by scrutinizing the present and predicting the future. This study premises that coaching is also a developmental practice that employers embrace in organization that enables and empowers people and opens new opportunities for learning through which improved performance is attained. This study focused on coaching and how it influences service delivery in public Universities in Kenya. In the quest for organization to perform or deliver their service they need to inculcate coaching as a tool that will ensure that they have a sustained competitive advantage. This paper reveals how universities have embraced coaching as a management development. This study was conducted in public universities located in the south western Kenya.

Keywords: **Coaching, Human Resource, Service Delivery, Competence, Expertise.**

Background

The biggest challenge that organization face currently is how they inculcate coaching as a management development practice especially to the senior managers, organization are classified into three strata; the lower management, middle level management and senior management. The senior managers are charged with the responsibility of steering the organizational goal while the middle level managers interpret the policies into action plans as the lower-level managers the technical employees. Coaching as a management development practice has widely discussed meaning that is not a new phenomenon. The discussion has mainly been in counseling, clinical psychology and behaviour in sports, family therapy, industrial and organizational psychology, and within organizational management (McLean, Yang, Kuo, Tolbert & Larkin, 2005).

In order to provide a clear understanding of the concept of Coaching, researchers have traced the its' emergent in the management literature of the 1950's as it was used as master- apprentice approach to develop employees and cultivate a relationship that promotes performance (Evered & Selman, 1989). Based on this background in the 1970's researchers and writers attempted to translate athletic and sports coaching into managerial contexts although it a fact that much of the coaching literature in the context of management has been drawn from sports coaching. in order to obtain the required relevant information and knowledge that would assist management in organizations to be able to monitor, control and manage (Evered & Selman, 1989). The term coaching has been differentiated with counseling activities (Evered & Selman, 1989). Counseling generally addresses the employee's emotional state, the causes of personal crises and problems, and involves short term interventions designed to remedy problems that interfere with the employee's job performance (Mink, Owen & Mink, 1993).

Coaching efficacy in athletes has been considered to be a powerful variable in coaching effectiveness (Feltz, Chase, Moritz, & Sullivan, 1999). Coaching efficacy in this context refers to "the

extent to which coaches believe they have the capacity to affect the learning and performance of their athletes" (Feltz, Chase, Moritz & Sullivan, 1999). Feltz et al.'s concept of coaching efficacy is comprised of four dimensions: game strategy ("the confidence coaches have in their ability to coach during competition.."); motivation efficacy ("the confidence coaches have in their ability to affect the psychological skills and states of their athletes"); technique efficacy ("the belief coaches have in their instructional and diagnostic skills"); and, character building efficacy ("the confidence that coaches have in their ability to influence personal development and positive attitude toward sport in their athlete.

Feltz *et al.*, (1999) also contend that these coaching efficacy dimensions are influenced by the coaches' past experience, coaching preparation, and performance. They further suggest that such influences are sources of efficacy information. Their research studies have indicated that coaching efficacy is important in coaching effectiveness and athletic performance and subsequent studies have offered support for these concepts and extended the sources of coaching efficacy (Chase, Feltz, Hayashi, & Hepler, 2005). Within the context of work organizations, limited research has explored the beliefs associated with managerial coaches.

Ellinger and Bostrom's (2002) study has provided some preliminary insights with regard to managerial coaching beliefs. In their qualitative study of managerial coaches, five clusters of beliefs emerged that were categorized into three categories: Category 1 contained "beliefs about roles" and "beliefs about capabilities"; category 2 contained "beliefs about the learning process" and "beliefs about learning"; and, category 3 contained "beliefs about learners." In placing these belief categories in a belief map, managerial coaches within this study held several beliefs: those associated with their identity as coaches, their self-efficacy, their beliefs about the outcomes associated with learners, the learning process, and the learners themselves. While these beliefs have not been operationalized for testing, they do suggest that beliefs influence coaching behaviors of managers.

Coaching has traditionally been associated with improving problem work performance (Mumford, 1993) has acknowledged that any managerial activity contains the potential for learning. Mumford has identified several catalysts for managers' learning which include: a new assignment, a new challenge, a new project, a shock or crisis, problem solving within a group, different standards of performance, or an unsuccessful piece of work. These catalysts for managerial learning are similar to those identified by Dechant, Marsick and Kasl (2001) as catalysts for informal managerial learning. Findings exploring the catalysts or triggers specifically associated with coaching interventions similarly have offered support for Mumford (1993), although gaps and deficiencies of existing employees' skills was reported to be the predominant catalyst for coaching.

Coaching has not been described as an intervention to assist people in getting over their past but rather as an intervention designed to move forward with future endeavors (Williams & Davis, 2002) by facilitating understanding and learning (Diedrich, 2001) in a holistic approach (Diedrich, 1996). Coaches have also been referred to as change agents in the corporate culture.

Purpose and Focus of the Study

The purpose of this study was to find out whether Coaching is key in Influencing Service Delivery in Public Universities in Kenya as a managerial development practice that is put in place in developing the senior managers.

Empirical Literature

Ellinger's (2003) qualitative study also identified political and developmental issues that served as triggers for coaching interventions. Examples included high consequence issues catalyzing the need for managerial coaching along with assignments, projects, and employee transitions that stimulated the need for coaching in which managers actively looked for ways to develop their employees' skills and capabilities.

Managerial coaching includes use of the following skills; listening skills, analytical skills, interviewing skills, effective questioning techniques, observation, and typical coaching

behaviors often include giving and receiving performance feedback, communicating and setting clear expectations, and creating a supportive environment conducive to coaching (Zemke & Clark, 1996).

In terms of coaching skills, recent research by McLean, Yang, Kuo, Tolbert and Larkin (2005) has yielded a self-assessment of coaching skills based upon a four-dimension coaching model. This model, suggests that the "manager as coach" reflects four aspects of managerial behavior: the manager as coach should communicate openly with others, needs to take a team approach instead of an individual approach with tasks, tends to value people over tasks, and should accept the ambiguous nature of the working environment. Their findings suggest that managerial coaching is a multidimensional construct that supports their four-dimension coaching model.

In responding to this work, Peterson and Little (2005) have questioned whether the team approach is a primary component of effective coaching since coaching is often considered a one-on-one managerial intervention. Further they have noted that other factors associated with coaching skills have considered developing a partnership, effective listening skills and providing feedback as well as capabilities for facilitating development.

Managerial coaching behavior research has been conducted within the sales management context examining the specific behaviors that employees associate with managers who possess effective coaching skills for example, incorporating Schelling's eight behaviors associated with successful sales managers, Graham et. al. (1994) interviewed account representatives and obtained their ratings of their respective manager's coaching skills prior to the implementation of a manager coaching skills training program.

Brockbank, (2008) adds that coaching delivers results when a relationship is based on mutual respect and established between the coach and coachee. Coaching Makes use of deductive (drawing it out) techniques since the coach is required to be an expert on the topic and brief understanding of the

topic does help, but can sometimes be a problem. The individual is the one who primarily benefits from a coaching relationship and Measuring of the coaching session takes place in minutes since Coaching can take place at any time and Sessions are generally informal, but can be formal and a working relationship between coach and coachee helps.

Coaching involves the use more experienced employees coach the less experienced employees (Dixion, 2002). Coaching has numerous merits for the offers the conscientiousness development of employees, the coaching is often effective to newly recruited employees or promoted employees in the university when one is allocated a coach who most probably their immediate fore man or senior manager. Coaching does not signify the employees do not understand how to perform in the university. In the 21st century coaching is turning out to be the most sought-after employee development that enables the employee to perform better at their universities.

Coaching may be formal or informal in the universities and it invoked from the performance reviews, coaching include dealing with all day-to-day duties. Coaching is a normal process of management to enhance the performance of the managers, for instance coaching ensures that employees need to understand how they are supposed to perform and what is expected of them in order to perform task satisfactorily. Coaching gives a manager an opportunity to advance learning, encourage employees to tackle the challenges they have in performance (Contu & Kauffman, 2009)

Frisch (2001) defined internal coaching as "a one-on-one developmental intervention supported by the organization and provided by a colleague of those coached who is trusted to shape and deliver a program yielding individual professional growth". In this type of coaching scenario, absolute confidentiality would be cumbersome at best considering most work-related issues concerning performance would not only be discussed, but be judged by a colleague who may not be impartial, fair or above gossiping with other employees. Other definitions specify that executive coaching, to be defined as such, be provided by outsiders or individuals not

connected with the organization (Garman *et al.*, 2000).

Laske's (1999a) definition of coaching differs from the others in that it is limited to a method-specific model and uses distinct terminology that relates only to the model it describes. He has defined coaching as "the multidirectional ability to observe executive-organization interaction in two related mental spaces called the Professional House and the Company House, for the purpose of bringing about not only adaptive but transformative change". Some definitions describe coaching more in terms of a learning process in which clients increase their knowledge (Peterson & Little, 2005), facilitate learning (Diedrich, 2001), and increase opportunities with the tools that coaching provides rather than through the direct consultation from the coach as Kralj (2001) suggested.

Tobias (1996) emphasized the individualization of the process and noted that it is an ongoing process, unlike professional development workshops and seminars that serve as one-time consultations for employee issues. Williams and Davis (2002) agreed with the aspect that coaching is typically a long-term relationship. Some definitions are specific for coaching teams (Diedrich, 1996), while others call for an expansion of the definition to include individual, team and organizational interventions that are strategy-driven on a group level in order to stimulate individual and group change (Kralj, 2001).

Ritu *et al*. (2009) conducted a study on the performance effects of coaching using hierarchical linear modeling drawing on the conceptual foundations of feedback and behavior modeling. The study investigated the effects of managers' coaching intensity on the performance of those they supervise, at multiple levels of an organizational hierarchy. Data from 328 sales associates reporting to 114 middle managers, and 93 middle managers reporting to 32 executive managers were used to test the research hypotheses. The study found out that managers' coaching intensity influences the performance of their subordinates after controlling for job satisfaction, and this effect weakens at greater hierarchical levels.

Hicks, Carter and Sinclair (2013) studied on the impact of coaching using empirical longitudinal studies into coachee well-being, engagement and job satisfaction following a coaching programme at work. The research was an exploratory study into whether employees receiving coaching at work experience any impact on their perceptions of well-being, job satisfaction and engagement at work. Previous studies into well- being have tended to focus on top leaders coached by external coaches. Employees were targeted who had been involved in various coaching programmes designed to improve performance or support change. The study found out that coaching affected the performance of employee.

Taruru *et al*. (2015) examined the effects of coaching programmes on employee performance in business process outsourcing subsector of Nairobi city county, Kenya. The study aimed at determining the effects of coaching programs on employee performance and the reduction of staff attrition in the BPO industry in Nairobi, Kenya. Both primary and secondary data sources were adopted. The study found out that executive coaching and business coaching increases average employee performance

Pedro Núñez-Cacho *et al*. (2014) studied the effects of coaching in employees and organizational performance using a Spanish Case. The expansion of coaching in firms reflects its potential use as a tool to improve the development of human capital and of the firm itself. Nevertheless, research into the effects of coaching is lagging some way behind practice and there is a need to establish a theoretical framework capable of explaining how the coaching process precedes and its outcomes. The goal of the research was to analyze the effects of coaching in both, employee's development and organizational performance. Thus, a sample of 498 Spanish firms was used by the study. The study found out that coaching has an influence on both individual performance and organizational performance indicators. Coaching assists firms to improve their competitive position.

Muriithi (2016) assessed the effect of

coaching on employee performance in commercial banks with a case of standard chartered bank Kenya limited. The study sought to look into the relationship existing between coaching and employee performance among frontline employees and Line managers in Standard Chartered Bank. The study sought to understand specifically how coaching builds staff performance, and what areas need to be looked at so as to address any concerns the coaches may have on the process. The study established that frequent provision of feedback influenced employee performance at Standard Chartered Bank to a greater extent. The study further established that to a greater extent, structured coaching plan influenced employee performance.

Claudio Pousa and Ane Mathieu (2014) studied the influence of coaching on employee performance using Results from two international quantitative studies. Coaching has been identified as a key managerial behavior that organizations must promote to develop employees and achieve higher levels of performance. Despite this agreement and an increasing interest in coaching, there is still a paucity of studies exploring the impact of coaching on individual performance. The study presented an empirical investigation from two international field studies, one using B-to-B salespersons working in Latin America and the other one using B-to-C frontline employees from a service organization in Canada. The study found out that coaching increases individual performance beyond the potential impact of sales experience and tenure.

Alison and Carr (2016) assessed the effect of Executive and Employee Coaching using Research and Best Practices for Practitioners. It is increasingly common for organizational performance management strategies to include one-on-one coaching engagements. In one variation, called executive coaching, this engagement is between an executive-level employee and an external coaching agent. In another variation, called employee coaching, the engagement is between an employee and supervisor. The study found out that both types of coaching have the potential to substantially improve performance, and as such it is not surprising that both are seen favorably by human resource

professionals and employees alike. While employee and executive coaching are popular and widely used in practice, scholarly investigation into coaching is still in its infancy.

Rebecca *et al*. (2015) conducted a study on the effectiveness of workplace coaching using a meta-analysis of learning and performance outcomes from coaching. The study presented a meta-analysis synthesizing the existing research on the effectiveness of workplace coaching. The study examined moderation by a number of coaching practice factors. The study findings indicated a significant moderation of effect size for type of coach with effects being stronger for internal coaches compared to external coaches and use of multisource feedback (with the use of multisource feedback resulting in smaller positive effects.

McLean, Yang, Kuo, Tolbert and Larkin (2005) study yielded a self-assessment of coaching skills based upon a four-dimension coaching model. This model, suggests that the "manager as coach" reflects four aspects of managerial behavior: the manager as coach should communicate openly with others, needs to take a team approach instead of an individual approach with tasks, tends to value people over tasks, and should accept the ambiguous nature of the working environment. Their findings suggest that managerial coaching is a multidimensional construct that supports their four-dimension coaching model. In responding to this work

Peterson and Little (2005) have questioned whether the team approach is a primary component of effective coaching since coaching is often considered a one-on-one managerial intervention. Further they have noted that other factors associated with coaching skills that have appeared in the literature should be considered such as: developing a partnership, effective listening skills and providing feedback as well as capabilities for facilitating development.

Graham *et al*. (1994) interviewed account representatives and obtained their ratings of their respective manager's coaching skills prior to the implementation of a manager coaching skills training program. The findings supported the existing literature on

coaching concerning the importance of providing feedback, setting clear expectations, and creating a climate for coaching that involves a positive trusting relationship

Ellinger and Bostrom's (1999) research identified taxonomy of thirteen managerial coaching behaviors that were clustered into facilitating and empowering clusters. The empowering cluster consisted of the following behaviors: question framing to encourage employees to think through issues; being a resource – removing obstacles; transferring ownership to employees; holding back – not provide the answers. The facilitating cluster consisted of the following behaviors: providing feedback to employees; soliciting feedback from employees; working it out together – talking it through; creating and promoting a learning environment; setting and communicating expectations; stepping into other to shift perspectives; broadening employees' perspectives – getting them to see things differently; using analogies, scenarios, and examples; and, engaging others to facilitate learning.

Beattie's (2002) research on managerial coaching in the context of a social service organization revealed twenty-two discrete effective facilitative behaviors that were then classified and allocated into one of nine identified behavioral categories. Beattie's behavioral categories consisted of: thinking – reflective or prospective thinking; informing – sharing knowledge; empowering – delegation, trust; assessing – feedback and recognition, identifying developmental needs; advising – instruction, coaching, guidance, counseling; being professional – role model, standard setting, planning and preparation; caring – support, encouragement, approachable, reassurance, commitment/involvement, empathy; developing others; and challenging employees to stretch themselves. Considerable similarity between the managerial coaching behaviors of Ellinger, Ellinger and Bostrom and the Beattie studies have been found in subsequent analyses. Furthermore, recent comparative analyses of the results of these respective studies against the behavioral construct of Hamlin's 'Generic Model of

Managerial and Leadership Effectiveness

Levenson (2009) provides detailed information demonstrating the positive business impact of coaching in 12 case studies. Wasylyshyn *et al*. (2006) and Kombarakaran *et al*. (2008) both show high outcome ratings for in-company coaching programmes. Wasylyshyn *et al.* (2006) provides ratings for N=28 clients and N=17 'others' (direct colleagues of clients) in a pharmaceutical company.

Kombarakaran *et al*. (2008) provides ratings for N=104 clients and N=29 coaches. In both of these studies the majority of those surveyed report high value or 'sustainability of learning' from coaching. Schlosser et al. (2006) measured the outcome of executive coaching across a range of variables and industries and from the perspectives of manager/sponsor (N=14), client (N=56), and coach (N=70). Whilst a significant positive outcome was reported for all subjects, a significantly lower rating for the managers, in terms of return on investment, was reported. In a different approach, taken by Grant and Cavanagh (2007), the results of a self-report measure of coaching skill (scored by N=218 coaches) was correlated with N=38 clients' assessment regarding outcome. This correlation was significantly positive (r=0.58; p<0.001) thus providing a good indication that coaching skill can be inter-subjectively established.

Peterson (1993) studied N=370 leaders from various organizations at three points in time (pre-coaching, post-coaching and follow-up) with outcome defined by their own coaching objectives and five standards 'control' items, rated by at least themselves, their manager and their coach (multi-source ratings). The coaching programme was intensive and long-term, with typically 50+ hours of individual coaching with a professional coach over at least a year. Peterson found that clients, on average, achieved significant improvement on all measures of outcome related to coaching objectives (effect size d>1.5).

Olivero *et al*. (1997) studied managers who had taken part in a three-day educational training course followed by eight weeks of coaching. They found

that both the training and the coaching increased productivity considerably, with most of the increase attributable to the coaching (increase of 22.4 per cent with training alone and of 88.0 per cent with training and coaching, that is, almost fourfold; a difference which was significant at the $p<0.05$ level).

In another study by Thach (2002), $N=281$ managers participated in four one-hour sessions of coaching over five months with a 360° (multisource) feedback process before and after the coaching. They found an average increase in 'leadership effectiveness' both as rated by the coaches and their co-workers (average increase 60 per cent but no significance reported).

Bowles *et al.* (2007) looked at effectiveness in terms of increased productivity in army recruitment managers ($N=30$) and executives ($N=29$) who received coaching as compared to productivity changes in a non-random group of experienced recruitment managers over a similar, but not contemporaneous, time interval. The individuals who were coached showed greater productivity gains ($d=0.43$ with $p<0.05$ for the middle managers and $d=0.75$ with $p<0.01$ for the executives).

Perkins (2009) studied the effectiveness of executive coaching on improving leadership behaviours in meetings, as rated by the coach. Using quantitative and qualitative methods with a small sample ($N=21$), pre- and post-measurement of meeting behaviours were scored by the coach and author, with a clear improvement of behaviours reported (effect sizes $d>0.95$ for nine out of 11 behaviours measured, and $p<0.01$). There may, of course, have been researcher bias in these scores as coaches might understandably want their clients to do well.

Ellinger *et al.* (2003) have measured employee perceptions of the coaching skills of their supervisors in an industrial setting (on the shop floors of US warehouses). When these perceptions were correlated with their performance ratings as marked by their supervisors, a significant small effect was found (11 per cent of variance or $d\approx0.2$; $N=458$). Similarly, Gregory and Levy (2011) looked at employee or leadership coaching at front-line management level in Fortune-500 companies, and found

that supervisors' self-scored 'individual consideration for their employees' actually correlates with employees' ratings of the coaching relationship (50 per cent of variance or $d \approx 0.5$; $N=702$).

Smither *et al*. (2003), Sue-Chan and Latham (2004), and Evers et al. (2006) Sue-Chan and Latham (2004) compared the impact of internal and external coaches with a wide difference in reputation in terms of (perceived) expertise and credibility. This outcome study involved MBA students in two countries (total $N=53$) and compared the performance in terms of team playing and exam grades and found small but statistically significant differences at $p<0.05$, between faculty, peer and self-coaching with the first the most impactful. As in Perkins (2009) above, this study may suffer from researcher-bias as the external coaches/tutors did the scoring of performance.

Evers *et al*. (2006) measured self-efficacy beliefs and outcome expectancies, on each of three dimensions. Their study compared a pre-intervention and post-intervention measurement and also involved a (non-randomized) control group. The intervention was short with an average of only four coaching sessions. Although the sample was not very large (30 managers in both the experimental and the control group) they did find some objective evidence for a positive outcome of the coaching intervention. There was a significant increment for the coached group over the control group for one of the three dimensions in both self-efficacy beliefs ('setting one's own goals') and outcome expectancies ('acting in a balanced way') [$d \approx 0.5$ with $p<0.05$].

Smither *et al*. (2003) This study worked with a (non-randomized) control group and conclusions were based on more objective criteria than evaluations by the clients. Smither *et al*. (2003) included evaluations by independent researchers together with clients' superiors, colleagues and staff (multisource feedback). This research involved 1202 senior managers in one multinational organization with two consecutive years of 360o feedback. However, there were no more than 'two or three' coaching sessions per client. The researchers found that managers who worked with an executive coach were significantly

more likely than other managers to: (1) set specific goals (d=0.16; p<0.01); (2) solicit ideas for improvements from their superiors (d=0.36; p<0.01); and (3) obtain higher ratings from direct-reports and superiors in the second year (d=0.17; p<0.05).

Scoular and Linley (2006) looked at how both: (1) a 'goal-setting' intervention at the beginning of the conversation; and (2) personality (dis-)similarities between coach and client as measured by MBTI, impact on perceived effectiveness. The sample size was N=117 clients and N=14 coaches. No statistically significant difference resulted for outcome measurements at two and eight weeks after the session between 'goal-setting' and 'no goal-setting'; but when the coach and client differed on particular aspects of the personality instrument (the MBTI 'temperaments') the outcome scores were significantly higher.

Stewart *et al*. (2008) looked at how both client personality and client self-efficacy correlate with coaching outcome. They measured so-called 'big-five' personality factors (Digman, 1990) and general self-efficacy (Schwarzer *et al*., 1999) for 110 clients and correlated these with coaching outcome. They found moderate positive effects for conscientiousness, openness, emotional stability and general self-efficacy, but warned that other factors are likely to play a role as well.

Boyce *et al*. (2010) studied 74 coach client relationships in a US military academy where clients were cadets and coaches were senior military leaders who had had some training in executive coaching. The study analyzed the impact of relational aspects (rapport, trust and commitment) and matching criteria (demographic commonality, behavioural compatibility, and coach credibility), on coaching outcome. Their main findings were that matching had no significant impact on outcome, whilst relationship, as assessed by both client (explained proportion of variance around 50 per cent) and coach (explained proportion of variance around 25 per cent), affected outcomes significantly. With a sample of internal coaches working alongside a leadership development programme within a manufacturing company involving 30

coach-client pairs, Baron and Morin (2009 and 2012) were able to show that coaching clients' rating of the *working alliance* as a measure of the coaching relationship correlated with coaching outcomes (measured in terms of changes in client self-efficacy, explained proportion of variance around 25 per cent) whilst coaches' ratings of the working alliance did not correlate with outcomes significantly.

De Haan *et al*. (2013) examine how various executive coaching interventions make a difference to clients. Seventy-one coaching clients, from as many organizations, reported on the various interventions of their coaches and these ratings were compared with their evaluations. In that work, De Haan et al. found no distinction among specific coach interventions, leading to the conclusion that effectiveness is much less correlated with technique or intervention than by factors common to all coaching, such as the relationship, empathic understanding, positive expectations, etc.

De Haan *et al*. (2013) build on the previous study to research the relative impact and importance of various common factors for 156 new executive coaching clients and 34 experienced coaches. The purpose of this research was to look at various elements common to all coaching approaches (the 'common factors') and to measure which of these are likely to have the highest positive impact on clients. The study showed that client perceptions of the outcome of coaching were significantly related to their perceptions of the working alliance, client self-efficacy and perceptions of coaching interventions ('generalized techniques') of the coach. The client-coach relationship strongly mediated the impact of self-efficacy and the majority of techniques on coaching outcomes (except for perceived explicit focus on goals and helping the client to make discoveries), suggesting that the relationship is the key factor in coaching outcome.

Ianiro *et al*. (2012) analyzed the full interchange within 33 first coaching sessions with trainee psychologists as coaches and young professionals as clients, in terms of both the client's and

the coach's interpersonal behaviour, over two basic dimensions: affiliation and dominance. Findings suggest that both: (1) the coach's dominance behaviour; and (2) similarity of dominance and affiliation behaviour between coach and client predict positive client ratings of goal-attainment after five sessions; whilst (2) also predicts positive client ratings of the relationship quality after five sessions.

Conceptual Model and Hypothesis

The dependent variable in this study is service delivery. Service delivery is the execution of an action, Chapman, (2001). Service delivery is indicated by the Customer Satisfaction, Number of students supervised to completion Employee Satisfaction, Research Output, consultancy/advisory services, Publications, Adherence to set Teaching, number of students joining and leaving the university. Service delivery for all the constructs was calculated from the data obtained from the presidential delivery unit under performance contracting of public universities over five years. A service delivery index was obtained which was used as dependent variable. A conceptual framework is a structure of ideas presented in an inquiry (Cambell, 2013).

In conducting the study, the conceptual discussion was schematized in the model Figure 1.

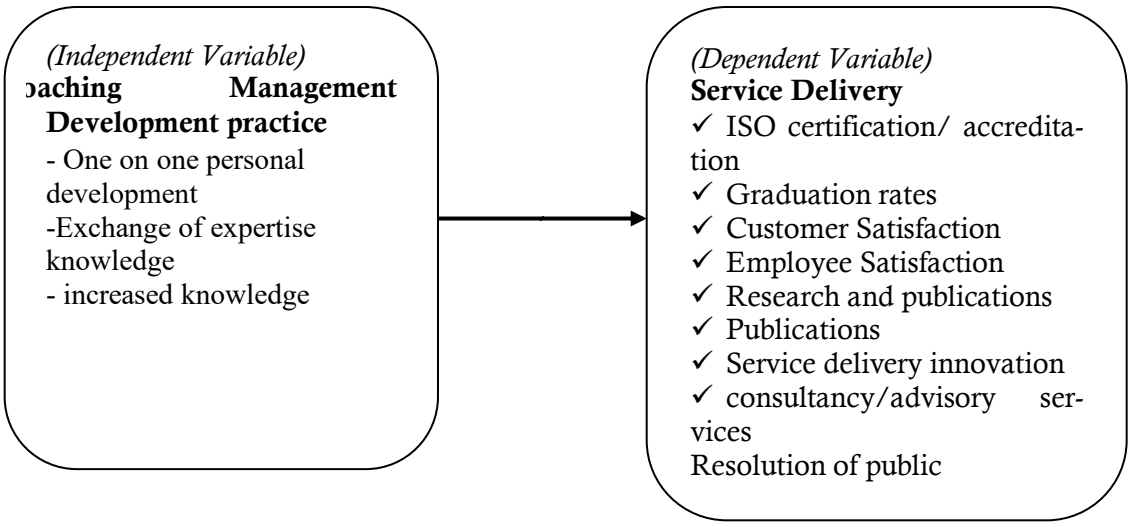

Figure 1: Conceptual Framework

The following research hypothesis was tested during the study:

Ho: Coaching management development Practices do not affect service delivery in Kenyan public universities

General Background of Research

The study adopted a positivism and interpretivism research philosophy. Positivism holds that there exists a reality further than the human mind; individual perceptions are separate from reality that forms the foundation of human knowledge.

The study adopted descriptive survey research design. The main consideration in this research design is to have the best framework to follow in collecting data necessary in addressing the research objectives and testing the stated research hypotheses.

The study targeted all the fourteen public universities located in the South Western Kenya. The Universities have been chosen since they are all operating under the Universities Act, 2012 and they have enough information on the topic.

The total numbers of management employees were 1134 in all public universities in Kenya of which 400 respondents were sampled. The study sample size was obtained using Yamane, Taro (1970) formula which simplified the procedure for sample size determination; the sample obtained by

the researcher was representative.

Yamane formula for sample determination was used (Yamane, Taro 1970) leading to a final sample size of approximately 400 respondents.

The study collected data from primary and secondary sources. Self-administered questionnaires and interview guides were used to collect Primary data while the university performance management records, journals and books were used in collecting the Secondary data.

Stepwise regression analyses were used for verification of moderating effect by adding them sequentially to the regression equation to determine how much each variable is adding to the Predictor Y and Analysis of Variance (ANOVA).

Research Findings

Best Practices in Coaching for Management Development

The objective of the study was to establish the influence of coaching management development practices on service delivery in the Kenyan public universities, the study objective informed hypothesis. The literature review and theoretical reasoning led to the belief that coaching management development practice was associated with service delivery outcomes. It was anticipated that coaching management development practices would have a strong, positive and significant relationship with service delivery outcome.

Coaching management development practice is adopted by the public universities in Kenya to enhance the management capabilities and abilities to perform better.

The respondents were asked to indicate to what extent they agreed to the various statements that defined best Practices in Coaching for Management Development. These responses were also captured in a five-point Likert scale (5=very large extent, 4=large extent, 3= moderate extent, 2=less extent and 1=not at all) and the research findings are in the table 1 below showing the resultant means and standard deviation for the variables. Findings for the best practices in coaching for management development are presented in Table 1.

Table 1: Best practices in Coaching for Management Development

Best practices in Coaching for Management	N	Min score	Max Score	Mean	Std. Dev.	Ranking
The university encourages its employees to advance their capabilities and abilities for them to be able to perform efficiently in their management tasks	209	1	5	3.263	.8277	
The university has put mechanisms in place in developing its employees using open-ended processes by analyzing the present situation, setting performance goals and implements a plan for obtaining the goal for its managers	209	1	5	3.028	.7132	
The highly personalized one-to-one personal development relationship has unlocked management potential to maximize their performance	209	1	5	3.019	.7153	Great Extent
The one-to-one personal development relationships often comprise of one-on-one needs assessment and setting of the main goals to achieve	209	1	5	2.803	.5324	
At the university, the one-to-one personal development involves controlled delegation with satisfactorily task completion.	209	1	5	2.794	.8719	
The one-to-one personal development relationships are highly emphasized for the newly employed persons within the university	209	1	5	2.788	.5140	
The university has created a highly personalized one-to-one personal development relationship based on mutual respect, possibilities and potential.	209	1	5	2.524	.5378	
The university has put mechanisms in place to	209	1	5	2.296	.9030	Moderate Extent

promote learning by encouraging managers to look at higher-level problems and how they would tackle them						
The one-to-one personal development relationships is becoming a very popular means of development in the university	209	1	5	2.291	.5521	
Older employees in the university are excluded from one-to-one personal development relationships	209	1	5	2.283	.8853	
There is a highly personalized one-to-one personal development relationship that involves facilitating learning rather than teaching in university management	209	1	5	2.278	.8731	
The university has more experienced employees who can lead one-to-one personal development relationships.	209	1	5	2.043	.3155	Small Extent
Grand Mean				**2.618**		

From Table 1: To a great extent (3.2≥Mean≥ 3.01, with significance, standard deviation≥0.71), the public universities in Kenya encourages its employees to advance their capabilities and abilities for them to be able to perform efficiently in their management tasks; they have put mechanisms in place in developing its employees using open-ended processes by analyzing the present situation, setting performance goals and implements a plan for obtaining the goal for its managers; and lastly their emphasize of highly personalized one-to-one personal development relationship has unlocked management potential to maximize their performance.

From Table 1: To a moderate extent (2.8≥Mean≥ 2.3, with significance, standard deviation≥0.3), the one-to-one personal development relationships in the public universities often comprise of one-on-one needs assessment and setting

of the main goals to achieve which involves controlled delegation with satisfactorily task completion; these relationships are highly emphasized for the newly employed persons within the university based on mutual respect, possibilities and potential; and lastly the university has put mechanisms in place to promote learning by encouraging managers to look at higher-level problems and how they would tackle them.

From Table 1: To a small extent (2.3≥Mean≥ 2.04 with significance, standard deviation≥0.3), the one-to-one personal development relationships is becoming a very popular means of development in the university; the older employees in the university are excluded from one-to-one personal development relationships; there is a highly personalized one-to-one personal development relationship that involves facilitating learning rather than teaching in university management; the university has more experienced employees who can lead one-to-one personal development relationships.

This study finding means that the public universities in Kenya have adopted Coaching for Management development to a moderate extent with an overall mean of 2.6180.

This study finding is in line with Brockbank, (2008) who adds that Coaching is seen as a highly personalized one to one personal development programme focusing on possibilities and potential, coaching involves facilitating learning rather than teaching and enables coaches to unlock their potential and maximize their performance. Coaching delivers results when a relationship is based on mutual respect and established between the coach and coachee.

The objective of this study was to establish the effect of coaching management development practice on service delivery in Kenyan public universities. This objective informed the null hypothesis that coaching management development practice has no effect on service delivery in Kenyan public universities. This hypothesis was tested by regressing coaching management development on service delivery in public universities guided by

the equation $Y= \beta_0+\beta_1X$.

The results presented in Table 6 show that the effect of Coaching management development practice on service delivery in Kenyan public universities was significant ($F = 19.892$, $p < 0.05$). From the table, 8.4% of the variation in service delivery in Kenyan public universities was explained by variation in coaching (adjusted R-square =.084, $p < 0.05$). β was also statistically significant ($\beta = 1.457$, $t= 4.470$, $p < 0.05$).

Table 6: Regression results for the effect of coaching management development practice on service delivery

Model Summary

Model	**R**	**R-Square**	**Adjusted R-Square**	**Std. Error of the Estimate**	**R-Square Change**	**F-Change**	***df*1**	***df*2**	**Sig. F Change**	**Durbin-Watson**
1	.297[a]	.088	.084	1.903	.088	19.982	1	207	.000	1.824

a. Predictors: (Constant), Coaching

b. Dependent Variable: Service Delivery

ANOVA Coefficients[a]								
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**	**Collinearity Statistics**	
		B	**Std. Error**	**Beta**			**Tolerance**	**VIF**
1	(Constant)	6.141	.865		7.101	.000		
	Coaching	1.457	.326	.297	4.470	.000	1.000	1.000
a. Dependent Variable: Service Delivery								

Overall, regression results presented in Table 6 indicate that coaching management development practice has a positive effect on service delivery in Kenyan public universities.

The hypothesis that coaching management development practice does not affect service delivery in Kenyan public universities was therefore not confirmed, the study found out as coaching management development practice increases also service delivery increases too.

Discussion

It was hypothesized that coaching management development practice does not affect service delivery Kenyan public universities and the findings in Table 6 above reject the hypothesis. Coaching management development practice in a single model as predicted are positively and significantly affect service delivery. This captures and unravels the methodological weaknesses noted by Awino (2013) that discussions of quantitative and balanced service delivery measures are noticeably excluded in most studies.

This empirical evidence follows conclusions from other studies which have found out that selection and implementation of coaching Management development practice in which management employees advance their abilities in order to perform efficiently in management tasks (Thurston, 2000) the implementation of management development practices facilitates performance of the management and lead to improvement of university metrics such as increase in

publication and research, community outreach and resolution of complaints.

In comparison to the results found by Franks (2001), employee empowerment is deemed critical to organizational efficiency, innovativeness and effectiveness since empowerment initiatives are geared towards enhancing management performance. This study contributes to the literature of management development and especially coaching by analysing the relationship of coaching management practice with service delivery than other studies on management development brings about employee's feelings of "being empowered" and this can be attributed to the increased participation in decision making, increased autonomy and access to information relevant to performance (Hamblin, 2010).

Conclusion

The primary objective of the study was to establish the influence of coaching management development practices on service delivery in Kenyan public universities. Coaching management development practice on service delivery in Kenyan public universities was significant (F = 19.892, p < 0.05). Findings indicate that 8.4% of the variation in service delivery in Kenyan public universities was explained by variation in coaching (adjusted R-square =.084, p < 0.05). β was also statistically significant (β = 1.457, t= 4.470, p < 0.05). Overall, regression results presented in Table 6 indicate that coaching management development practice has a positive effect on service delivery in Kenyan public universities. The study focused on service delivery outcome measures only which included: ISO certification/ accreditation, graduation rates, customer satisfaction, employee satisfaction, research and publications, service delivery, innovation, consultancy/advisory services and resolution of public complaints. The use of these wide range of measures in a balanced manner lend support of the findings. According to Becker and Huselid (1998) there was limited literature addressing issues of management development practices implementation in a balanced way although implementation of service delivery in public universities is now widespread.

Contributions to Knowledge

This study has contributed to knowledge in the fields of human resource development and service delivery in several ways. First, the study has

empirically extended our understanding of the way public universities in Kenya operate. Second, it has empirically established how coaching management development is one of the key constituents of human resource policy, a source of competitive advantage, and an instrument of organizational change (Clarke, 1999). However, despite its suggested crucial role, management development is still at the embryonic stage and is often described as *a-theoretical* (Mabey, 2002). The most significant contribution this study has made to knowledge is linkage of coaching management development practice and service delivery in public Universities service delivery. Previous literature had merely suggested that management development could have positive effect on management performance outcomes. These empirical findings are important and represent substantial contribution to literature and theory development for management development and service delivery in Kenyan public universities.

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Detecting Differential Item Functioning under Different Conditions using SIBTEST Statistic

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ABSTRACT

Differential Item Functioning (DIF) is a statistical method that determines if test measurements distinguish abilities by comparing two sub-population outcomes on an item. The SIBTEST statistic provides an effect size measure that can give the magnitude of DIF. The purpose of the study was to investigate through simulation the effects of Sample size, Ability distribution and Test length on the Effect Size of DIF and their influence on detection of DIF using SIBTEST method. A Factorial research design was used in the study. The population of the study consisted of 6000 examinee responses. A stratified random sampling technique was used with the stratifying criteria as the reference and focal groups. The sample size conditions were 60,200 and 2000 for each of the groups. WinGen3 statistical software was used to generate dichotomous item response data. The findings of the study showed that whereas Sample size and Ability distribution had significant effects on the ES of DIF items when SIBTEST was used, Test length had no statistically significant effect on the Effect Size of DIF items. However, the number of DIF detections using MH statistic increased with test length regardless of the nature of Ability Distribution. Findings are of great significance to teachers, educational policy makers, test developers and test users.

Key words: **Differential Item Functioning (DIF), SIBTEST, Effect size, Sample size, Ability distribution, Test length, WinGen3.**

Introduction

Differential Item Functioning (DIF) is defined as the different probability of giving the right answer to a test item by two individuals with the same Ability level, but from different groups (MaCarthy, Oshima & Raju, 2007). To determine the validity of tests, DIF analysis can be employed to investigate whether educational and psychological measurement of structures differs in terms of groups (Crane, Gibsons, Narasimhalu, Lai & Cella, 2007). The difference in item performance can be due to the content of the item or to how the question in the item is posed (Wiberg, 2009). DIF can be determined by comparing two subpopulations' outcome on an item and determining the presence of DIF. DIF also involves a decision of whether there is a large enough difference between subpopulations to eliminate or change the item of interest To detect DIF, test of statistical significance may be required. The accuracy of statistical significance tests may therefore be influenced by large sample sizes which may cause a false positive or a Type I error for an unbiased item (Wang & Su, 2004). Statistical significance tests use probability (*p)* values and chi square ($\chi 2$) tests that are not robust to varying Sample sizes that are not comparable across different methods. Statistical tests that use an Effect size measure are preferred in order to control for false positives and quantify the amount of DIF when detected (Thompson, 2002). This takes into account not only the magnitude of DIF, but also replicability and generalizability (Huberty, 2002).

DIF Detection Methods

There are various DIF detection methods which include parametric methods such as IRT methods and non-parametric methods such as Simultaneous Item Bias Test (SIBTEST) (Shealy & Stout, 1993), Mantel-Haenszel (MH) and Logistic Regression (LR). IRT methods require data that is consistent with the assumption of normality and also require a lot of theoretical knowledge. IRT is only robust in detecting DIF when the sample size is large.

Simultaneous Item Bias Test (SIBTEST) is yet another DIF detection method developed by Shealy and Stout (1993). It is a non-parametric method which may be good in detecting DIF items. However, its main disadvantage is that

it can only detect DIF for large sample sizes (Erdem, 2014). Before DIF is done, items are put in two groups; Reference Group and Focal Group. Matching is done with the actual scores estimated by means of the total scores on the items in the second group, and the performance of the groups which are analyzed for DIF is compared (Gierl, 2005). The expected scores of the applicants in the Reference and Focal groups are identified in Equations 1 and 2 where *k* is the score received from DIF items, $P_{Rk}(t)$ and $P_{Fk}(t)$ are ratios of *t* score and the applicants receiving the *k* scores on the items.

$$ES_R(t) = \sum_k kP_{Rk}(t) \quad \ldots \quad [1]$$

$$ES_F(t) = \sum_k kP_{Fk}(t) \quad \ldots \quad [2]$$

These two values are used by correcting for measurement errors in the SIBTEST. In this case the final output of the SIBTEST method, β_u is derived from Equation 3.

$$\beta_u = \sum_t \left([ES_R(t) - ES_F(t)] \left[\frac{N_R(t) - N_F(t)}{N} \right] \right) \ldots \quad [3]$$

$N_R(t)$ and $N_F(t)$ values in the formula indicate the number of applicants whose matching scores are *t* in the reference and focal groups. Because of the standard error of β_u index is known, a result of a hypothesis test can be obtained. β_u index indicates an Effect size. The classification developed by Roussos and Stout (1996) was used to interpret the amount of DIF as shown in Table 1 below. SIBTEST can be performed using a software called SIBTEST (Stout & Roussos, 1995).

Table 1: Classification Categories Recommended for the interpretation of β_u values

Type of DIF	Values	Amount of DIF
A	β_u <0.059	None or Negligible
B	0.059≤ β_u < 0.088	Moderate
C	$\beta_u \geq 0.088$	Large

SIBTEST can also test whether or not more than one item displays DIF synchronically. The β_u index also shows the amount of DIF for more than one item. It is possible to compare the β_u values for both groups of items. SIBTEST is a technique based on the fact that the skills necessary for responding to an item correctly are multidimensional. In this framework, when the primary skill necessary for responding to an item correctly is

taken as θ and the secondary skill taken as η differentiation of the distribution of different groups on η is considered to be the source of DIF. SIBTEST can be used for determining the characteristic of items displaying DIF, in testing the DIF hypothesis which can be constructed beforehand and in making healthier generalizations about the sources of DIF due to the fact that SIBTEST enables one to group items and perform DIF analysis on them. (Gierl, *et al*. 2003; Mendes-Barnett & Ercikan, 2006).

Ability Distribution, Test Length and Sample size DIF Conditions

Ability distribution is a condition that is given in terms of mean and standard deviation. Some distributions are assumed to be normal with mean 0 and standard deviation 1. Some DIF statistics such as Mantel-Haenszel and Logistic Regression are robust to various Ability distributions. Others such as IRT methods can only be used when the data have a normal ability distribution. The effect of Ability distribution on the Effect sizes of SIBTEST statistic can be of major concern to DIF researchers. Several studies have reported that a difference in mean ability of 1 standard deviation between certain reference and focal groups occurs frequently in real testing situations (French & Maller, 2007). Jodoin and Gierl (2002) simulated data for equal Ability distributions and unequal ability distributions under small Sample sizes to larger Sample sizes and set the unequal Ability distributions with a difference of .50 for the means of the reference and focal group with the same standard deviation. There were no differences in Type I error and power rates for the larger sample sizes. The findings of these studies indicate that the effect of Ability distribution on the effect size and the number of DIF detections has been inadequately studied.

The number of test items that is used for DIF detection can be of great concern to DIF researchers. No standard exists as to how many items should be used for DIF detection as this change from one study to another. Some DIF detection methods may require use of all items in a test, while others may require only those items suspected as DIF items (Guler & Penfield, 2009). Moreover, since total test score is used as the criterion variable for grouping examinees, a longer test length may result in

improved performance of the SIBTEST procedure. However, Rogers and Swaminathan (1993) showed that Test length had no significant influence on the power of the MH procedure for DIF detection, but only long tests were used (40- and 80-items). Uttaro and Millsap (1994) used both short (20 items) and moderate (40 items) test lengths, but DIF was presented only in the studied item. For the 20-item test, the MH procedure gave inflated Type I error rate when the groups differed in ability distributions. However, the inflation in the Type I error rate disappeared entirely in the 40-item test. Moreover, Test length generally had little effect on the detection rates in both the 20 and 40 item tests. The studies quoted earlier indicate that the influence of Test length on the power of the MH and LR statistics for DIF detection has rarely been studied using varied test lengths. They tested the influence of test length using statistical significance tests and found no effect. It was important to undertake a study that determines the effect of test length on the Effect sizes using SIBTEST statistic.

Purpose of the Study

The purpose of this study was to determine how different conditions, namely Ability Distribution, Sample size and Test Length, affect the detection of Differential Item Functioning using the SIBTEST statistic. The main objective was specifically to determine the effect of Ability distribution, Sample size and Test Length on the Effect size using SIBTEST Statistic.

Research Design

A factorial research design was used in this study. This design was used to simulate samples for different conditions resulting into a 3x3x2 factorial design giving 18 data sets.

The independent variables in the present study were Sample size, Ability distribution, and Test length. The dependent variables were the β_u, Effect size for SIBTEST.

Population

The population of the study consisted of 6000 examinee responses. It consisted of responses from the reference group and the focal group. Though the focal group represents the minority examinees, this study had an equal number of 3000 examinee

responses for the reference and 3000 for the focal group.

Sampling Technique

A stratified random sampling technique was used to select the sample from a pool of 6000 examinee responses. The stratifying criterion was based on the examinee responses designated as reference and focal. A balanced sample of 3000 was therefore drawn for the reference and the focal groups. Three sample sizes were therefore drawn randomly for the reference group and focal group as follows: 60, 200, and 2000 each. The Sample size conditions were described as small, moderate and large sample sizes.

Data collection Procedure

Statistical software such as WinGen3 (Han, 2007), was used to generate item response data. The main window consisted of examinee characteristics which included the number of examinees and the Ability distribution in terms of mean and standard deviation. The mean and standard deviation were used to model two Ability distribution conditions. The first condition was set with means of 0.0 for the focal and reference groups and standard deviations 1.0 for focal and reference groups. The second condition was also set with the focal group having a mean of 1.0 and a standard deviation of 2.0 and the reference group a mean of 1.0 and a standard deviation of 2.0. The tests had 20 items, 50 items and 100 items respectively (Davies, Eisenhardt & Bingham, 2017).

Data Analysis

Statistical analysis was done on the SIBTEST DIF method with the dependent variable as the β_u value, Effect size for SIBTEST. The independent variables were the Sample sizes, Test length and Ability distribution. Analysis was done on the raw data in order to obtain the Effect sizes for the SIBTEST method by using SPSS software. The number of detections of DIF items across 3 DIF Types; A, B and C were also determined.

The SPSS software was used to perform One Way Analysis of Variance (ANOVA) in order to determine the effect of Sample Size, Ability Distribution and Test Length on the Effect Size of DIF across three types of DIF; A, B and C for the SIBTEST method. The level of significance used was 0.05 with 2, 15

degrees of freedom for the main effects of Sample size and Test length and 1, 16 degrees of freedom for the main effects of Ability distribution conditions. The dependent variables were the mean Effect size values for the SIBTEST statistic. Post-hoc Bonferroni statistic was used to compare the difference among the means where the difference was statistically significant.

Results

The Effect size values obtained after analysis of data using SIBTEST statistic for 20 items, 50 items and 100 items; a Sample size of 60,200 and 2000; and Ability distribution in terms of Mean=0, Standard deviation=1 and Mean=1, Standard deviation=2 were summarized. Table 2 shows the mean Effect size β_u values for SIBTEST statistic under different conditions.

According to Table 2, the first column shows the number of items. The second column shows Ability distribution values in terms of mean and standard deviation. The third column shows the Sample size. The fourth, fifth and sixth columns show the mean Effect size values obtained for Type A, B and C DIF items.

Table 2: Effect size for DIF items under different conditions using SIBTEST statistic

No. of items	Ability distribution (Mean, SD*)	Sample size	Effect size		
			Type A	Type B	Type C
20	(0, 1)	60	.0443	.06260	.12469
20	(1, 2)	60	.0375	.07205	.09523
20	(0, 1)	200	.0326	.08250	.09460
20	(1, 2)	200	.0296	.08596	.17272
20	(0, 1)	2000	.0553	.07298	.08936
20	(1, 2)	2000	.0486	.06377	.13600
50	(0, 1)	60	.0264	.07248	.88564
50	(1, 2)	60	.0357	.06232	.13492
50	(0, 1)	200	.0466	.08953	.09986
50	(1, 2)	200	.0566	.07127	.09733
50	(0, 1)	2000	.0564	.06243	.13960
50	(1, 2)	2000	.0534	.08350	.16045
100	(0, 1)	60	.0555	.06281	.09235
100	(1, 2)	60	.4890	.07200	.01542
100	(0, 1)	200	.0475	.06259	.09713
100	(1, 2)	200	.0560	.06260	.08831
100	(0, 1)	2000	.0554	.08235	.09711
100	(1, 2)	2000	.0457	.07293	.09717

Key: Type A=Negligible DIF, Type B=Moderate DIF, Type C=Large DIF
*SD=Standard Deviation

In order to determine the effect of Sample Size on Effect size for each type of DIF items, One-way Analysis of Variance (ANOVA) was conducted with Effect Size as the dependent variable and Sample Size as the independent variable. Table 3 summarizes the ANOVA results for the effect of Sample size on the ES across the three types of DIF.

Table 3: ANOVA Summary for effect of Sample size on Effect size of DIF across 3 DIF types using SIBTEST statistic

Type of DIF		Sum of Squares	*df*	Mean Square	*F*	*Sig.*
A	Between Groups	.104	2	.0521	1.619	.225
	Within Groups	.482	15	.0321		
	Total	.586	17			
B	Between Groups	.060	2	.0300	5.357	.042
	Within Groups	.084	15	.0056		
	Total	.144	17			
C	Between Groups	.070	2	.035	.0212	.835
	Within Groups	2.780	15	0.185		
	Total	2.850	17			

A strong association therefore existed between Sample size and the Effect size only for the Type B DIF items and not the Type A and Type C. This association was quite sizable in a predictive sense for any population corresponding to the current study.

Table 3: Pairwise comparisons of Effect sizes across different Sample sizes for Type B DIF

Dependent Variable: Effect Size *Post-hoc test:* Bonferroni

(I) Sample size	(J) Sample size	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
60	200	.0558720	.0441727	.453	-.053118	.193862
	2000	-.0634358	.0441727	.543	-.182526	.062354
200	60	-.0728720	.0441727	.553	-.186362	.055118
	2000	-.1355079*	.0441727	.032	-.256498	-.00848
2000	60	.0653258	.0441727	.543	-.067354	.176626
	200	.1563079*	.0441727	.032	.009518	.253498

*The mean difference is significant at .05 level.

Significant differences were noted between sample size 200 and 2000. This indicated that sample size had a significant effect on the detection of DIF using the SIBTEST statistic.

In order to determine the effect of Test Length on Effect Size for each type of DIF items, One-way ANOVA was conducted with ES as the dependent variable and Test Length as the independent variable. Table 4 summarizes the ANOVA results for the effect of Test Length on the Effect size across 3 DIF Types using SIBTEST statistic. There was no significant effect of Test Length on the Effect Size using the SIBTEST statistic at a level of significance of .05.

Table 4: ANOVA Summary for effect of Test length on Effect size of DIF across 3 DIF types

Type of DIF		Sum of Squares	*df*	Mean Square	*F*	Sig.
A	Between Groups	.102	2	.051	1.4167	.235
	Within Groups	.425	15	.0283		
	Total	.527	17			
B	Between Groups	.008	2	.004	.4444	.583
	Within Groups	.135	15	.009		
	Total	.143	17			
C	Between Groups	.836	2	.418	2.3417	.763
	Within Groups	2.678	15	.1785		
	Total	3.514	17			

In order to determine the effect of Ability Distribution on Effect Size for each Type of DIF items, One-way Analysis of Variance was conducted with Effect Size as the dependent variable and Ability Distribution as the independent variable. Table 5 summarizes the ANOVA results for the effect of Ability Distribution on the ES of DIF across 3 DIF Types using SIBTEST statistic.

Table 5: ANOVA Summary for effect of Ability Distribution, on Effect size of DIF across 3 DIF types

Type of DIF		Sum of Squares	*df*	Mean Square	*F*	Sig.
A	Between Groups	.035	1	.035	1.061	.297
	Within Groups	.528	16	.033		
	Total	.563	17			
B	Between Groups	.004	1	.004	.4381	.902
	Within Groups	.146	16	.00913		
	Total	.150	17			
C	Between Groups	10.518	1	10.518	12.811	.002
	Within Groups	12.162	16	.7601		
	Total	22.680	17			

Statistically significant differences for the effect of Ability Distribution on ES were noted for Type C DIF only and not for type A and B. This indicated that Ability distribution had a significant effect on the effect size of type C DIF items only.

Discussion

The purpose of this study was to investigate the effect of Sample Size, Ability Distribution and Test Length on Effect Size of DIF, and the influence of the same variables on detection of DIF using SIBTEST statistic. Results indicate that Sample Size had a statistically significant effect on Effect Size for B Type items (Middle DIF items) and not for A or C Types. Post-hoc test indicated that significant differences in ES for B Type items existed between Sample Size=200 and Sample Size=2000 only.

Ability Distribution was found to have a statistically significant effect on Effect Size for Type C DIF items (i.e. Large DIF items) only. This suggests that for items with large DIF, the nature of Ability Distribution remains crucial when using the SIBTEST statistic.

Whereas Test Length had no statistically significant effect on Effect Size for all the three item Types, there was a general trend for Effect Size to increase with Test Length. This is consistent with the findings of Rogers and Swaminathan (1993) as well as Uttaro and Millsap (1994), who found that the greatest impact on Effect Size was for Type C items. This finding in the present study that SIBTEST works best for Type C items compared to either Type B or Type C items concurs with that of Zwick and Ercikan (1989).

Conclusion

The effects of Sample Size, **A**bility Distribution and Test Length on ES of DIF items using SIBTEST statistic was studied. Item responses were simulated for focal and reference groups, where the two groups had different Ability distributions. The findings were that Sample Size had a statistically significant effect on the Effect Size for Type B items and not Type A or C items, and that Ability Distribution also had a statistically significant effect on the Effect Size of Type C items and not for Type A or B items is a indicates the importance of making use of SIBTEST statistic in detecting DIF.

The finding that detection of DIF using SIBTEST statistic is independent of Test Length regardless of the nature of Ability Distribution and Sample Size considerations confirms that longer tests are normally not desirable than shorter ones with respect to DIF detection. Thus, the detection when SIBTEST statistic is used is better achieved for Type C items

than either Type A or B items.

Recommendations

The following are recommendations based on the findings of the study:

(i) Test developers should pay more attention to Sample Size when measuring Effect Size of DIF using SIBTEST statistic especially for items with moderate DIF.

(ii) Test developers should consider Ability Distribution when using SIBTEST statistic to detect DIF, especially for Items with Large DIF.

Suggestions for Further Research

The following are suggestions for further research:

(i) Research on SIBTEST statistic using polytomously scored items.

(ii) Research on the accuracy of SIBTEST statistic involving the independent variables used in the present study but with different levels.

(iii) Research exploring the accuracy of IRT methods of detecting DIF using the same independent variables.

(iv) Research comparing the accuracy of SIBTEST statistic and other DIF detection methods.

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Masuala Yanayofunzwa Kuhusu Sauti na Matamshi ya Kiswahili katika Shule za Upili za Kaunti ya Murang'a, Kenya

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IKISIRI

Mahitaji ya silabasi mpya ya Kiswahili (2006) kwa shule za upili hupendekeza ufunzaji wa mada za sauti na matamshi. Suala la matamshi ya lugha, linahusika na matawi ya fonetiki na fonolojia. Matawi ya fonetiki na fonolojia ya lugha yoyote ile hujenga msingi wa matawi mengine ya lugha husika. Hata hivyo, watahiniwa wamekuwa wakiripoti matokeo mabaya katika karatasi ya lugha 102/2 mwaka baada ya mwaka. Mojawapo ya vipengele vinavyotahiniwa katika karatasi hii ni mada za sauti na matamshi bora. Aidha, ilikisiwa kuwa mojawapo ya sababu za wanafunzi wengi kutojieleza vizuri kwa lugha sanifu ya Kiswahili ni kukosa msingi bora wa fonetiki na fonolojia. Hivyo basi kulikuwa na haja kubwa ya kutathmini kwa undani hali halisi ya ufunzaji wa matamshi katika shule za upili nchini Kenya. Malengo ya utafiti yalikuwa kutathmini yanayofunzwa katika shule za upili kuhusu sauti na matamshi ya Kiswahili. Utafiti huu uliongozwa na nadharia ya fonolojia zalishi iliyoasisiwa na Chomsky na Halle (1968). Nadharia hii imebainisha sauti za lugha ya Kiswahili kwa kuzingatia kipengele cha uwilisifa. Vile vile, nadharia ya utabia iliyoasisiwa na Skinner (1957) na nadharia ya uumbaji iliyochangiwa na Brunner (1996) zilitumika kushughulikia suala la ufundishaji wa matamshi ya Kiswahili. Utafiti wa maktabani na wa nyanjani ulizalisha data kuhusu mbinu na changamoto za ufunzaji sauti na matamshi katika shule za upili. Uteuzi wa sampuli ulikuwa wa kimaksudi ambapo shule kumi na nne; mbilimbili katika kila kaunti ndogo zilizoko katika kaunti ya Murang'a ziliteuliwa. Wanafunzi sita na walimu wawili wawilikwa kila shule waliteuliwa kuunda sampuli ya watafitiwa 112. Mbinu za hojaji, na mazoezi kwa wanafunzi zilitumiwa kukusanya data. Data ilichanganuliwa na kuwasilishwa kimaelezo, kwa njia ya majedwali na michoro duara. Uchanganuzi wa kitakwimu ulifanyika kwa kutumia mbinu ya tarakilishi ya uchanganuzi tarakimu sayansi za kijamii. Utafiti huu utawafaa wakuzaji mitaala kwani watabaini changamoto zinazokumba ufunzaji wa sauti na matamshi ya Kiswahili na kufanya marekebisho yanayohitajika. Aidha walimu na wanafunzi, wahadhiri pamoja na vyombo vya utangazaji vitafaidika kwa njia za kuandaa wanafunzi na walimu wa lugha kuhusu mbinu mwafaka za ufunzaji sauti na matamshi ya Kiswahili.

Maneno Muhimu Katika Utafiti*:* Sauti, Matamshi, Fonolojia, Fonetiki.

Usuli wa Mada

Lugha ya Kiswahili nchini Kenya imepewa hadhi ya juu ikilinganishwa na lugha nyingine. Kwa sasa Kiswahili kinatumiwakama lugha ya taifa, lugha rasmi, na tayari lugha hii ina wajibu mkubwa wa kimataifa. Aidha, Kiswahili kimekua kwa kiasi kikubwa kikitumika katika sayansi na teknolojia. Kwa kweli, lugha hii imepata umaarufu nchini Kenya. Hata hivyo, lugha hii ambayo wengi hujifunza kama lugha ya pili (L2) imekubwa na changamoto mbalimbali. Baadhi ya changamoto hizo huoanishwa na ufunzaji na ujifunzaji wake. Nchini Kenya lugha ya Kiswahili hufunzwa na kutahiniwa kama lugha ya lazima katika shule za msingi na shule za upili kote. Lugha hii inatumiwa kama chombo muhimu katika mawasiliano, biashara, dini, siasa miongoni mwa mengine hapa nchini. Sauti za lugha hufafanuliwa katika matawi ya fonetiki na fonolojia ambayo huhusiana (Massamba na wenzake, 2004:3). Kwa kawaida ujifunzaji lugha hutokea kwa viwango tofautitofauti ambavyo hujumuisha sauti, neno au maneno, sentensi, maana na vile lugha yenyewe inatumiwa. Yaani kiwango cha fonetiki nafonolojia(sauti), mofolojia(neno), sintaksia(sentensi), semantiki(maana) na pragmatiki (matumizi ya lugha). Matawi ya fonetiki na fonolojia ndiyo msingi wa matawi hayo mengine yote ambayo yanapatikana katika isimu.

Kiisimu, fonetiki ni matawi au tawi linaloshughulika na kuchunguza na kuchambua utaratibu wote unaohusiana na utoaji, utamkaji, usafirishaji, usikiaji na utambuzi wa sauti za lugha zote za binadamu kwa jumla (Massamba na wenzake, 2004). Taaluma hii inachunguza sauti zote ambazo zinaweza kutumika katika lugha zote bila kujali zinatumika katika lugha gani. Kindija (2012:5), anasema fonetiki ni lazima kwa mtu anayetarajia kujifunza isimu na ni vigumu mwanadamu kufafanua sarufi ya lugha fulani kama hawezi kusikia na kunukuu sauti na maneno yake. Kindija (2012), anadai walimu wa lugha lazima wawe na ujuzi wa fonetiki ili kusaidia wanafunzi wao. Ufunzaji na ujifunzaji wa mada zinazohusu sauti na matamshi bora ya Kiswahili katika shule za upili haujatiliwa maanani licha ya kupendekezwa na silabasi mpya ya Kiswahili ya sekondari ya K.I.C.D. ya 2006 pamoja na mwongozo wa baraza la mitihani (KNEC).

Suala la Utafiti

Katika shule za upili za kaunti ya Murang'a, Kenya, kumekuwepo na tatizo kubwa la wanafunzi kutoweza kuzungumza Kiswahili sanifu kwa ufasaha. Hii ni wazi kutokana na utafiti wa awali ambao umeonyesha kuwa wanafunzi wengi wanakumbwa na changamoto katika matumizi ya lugha hii, hasa katika maeneo ya sauti, fonetiki, na fonolojia. Tatizo hili linazua maswali kuhusu ufanisi wa mbinu za ufundishaji zinazotumika katika shule hizi, na pia kuhusu rasilimali zinazopatikana kwa walimu. Wanafunzi wengi wameonyesha kiwango kidogo cha uelewa wa misingi ya matamshi ya Kiswahili, hali inayosababisha vigumu katika mawasiliano yao ya kila siku. Aidha, kuna uwezekano kwamba mazingira ya kijamii na kifamilia yanaweza kuwa na mchango katika kukuza au kudumaza uwezo wa wanafunzi katika matumizi ya lugha hii. Kwa hivyo, ni muhimu kufanya tathmini ya kina kuhusu jinsi sauti na matamshi ya Kiswahili yanavyojifunzwa na kutumika katika shule za upili za kaunti ya Murang'a. Lengo kuu la utafiti huu ni kubaini dosari zinazoibuka katika ufunzaji wa sauti na matamshi, ili kutoa mapendekezo ya kuboresha uelewa wa wanafunzi na hatimaye kukuza kiwango cha lugha ya Kiswahili katika shule hizo.

Lengo Mahususi la Utafiti

Kutathmini masuala yanayofunzwa katika shule za upili kuhusu sauti na matamshi ya Kiswahili.

Swali la Utafiti

Ni masuala yapi yanayofunzwa katika shule za upili kuhusu matamshi ya Kiswahili?

Yaliyoandikwa Kuhusu Mada

Suala la sauti na matamshi linahusika katika matawi ya fonetiki na fonolojia kiisimu. Dhana ya fonetiki na fonolojia ya Kiswahili imeshughulikiwa na wanaisimu pamoja na watafiti tofauti tofauti. Kwa mfano, Massamba na wenzake (2004) wameshughulikia suala la fonetiki kwa upana. Wao wamesema fonetiki ni tawi la kiisimu linaloshughulika na kuchunguza na kuchambua utaratibu wote unaohusiana na kutoa, kutamka, kusafirisha, kusikia na kutambua sauti za lugha ya binadamu kwa jumla. Taaluma hii huchunguza sauti zote zinazoweza kutumika katika lugha yoyote ile bila kujali zinatumika katika

lugha gani au Kwa njia gani.

Aidha, Massamba na wenzake (2004:6) wanasema fonolojia ni tawi la isimu ambalo hushughulika na kuchunguza, kuchambua na kuainisha sauti pambanuzi zinazotumika katika mfumo mbalimbali wa sauti za lugha ya binadamu. Wazo hili linamaanisha kuwa fonolojia hushughulikia hasa zile sauti ambazo hutumika kutofautisha maana za maneno katika lugha mahususi. Fonolojia kama taaluma ya isimu hujishughulisha na vipengele mbalimbali kama vile matamshi, kiimbo, mkazo, lafudhi, mfuatano wa sauti kuunda silabi, mfuatano wa silabi kuunda mofimu na mfuatano wa mofimu kuunda maneno (Massamba *na wenzake* 2004:6) wanaendelea kusema kuwa fonolojia inauhusiano wa moja kwa moja na uundaji wa maneno.

Tafiti za awali, licha ya kuchangia ufahamu wa misingi ya fonolojia ya Kiswahili ambayo ni muhimu katika utafiti wetu, zilishughulikia fonolojia ya Kiswahili kwa ujumla bila kujikita katika ufunzaji wake shuleni, mbinu zinazotumiwa na changamoto wanazokumbana nazo wanaojifunza taaluma hii. Chieni (2001) anasema ufunzaji wa matamshi na maandishi ya Kiswahili yasisitizwe. Analalamika kuwa Kiswahili hakijapewa hadhi sawa na Kiingereza katika mfumo wa elimu. Analinganisha hadhi ya Kiswahili na Kingereza na kugundua kuwa Kiswahili kilipewa nafasi finyu katika shule za upili na vyuo vikuu. Utafiti huu ulishughulikia changamoto za ufunzaji wa lugha ya Kiswahili kwa ujumla tu bila kuzingatia mbinu za ufunzaji tofauti na ilivyo katika utafiti wetu.

Utafiti unaokaribiana na wetu ni ule wa Musau na Chacha (2001). Wao wamezungumzia mbinu za kufundisha matamshi ya Kiswahili. Wanakubaliana na watafiti wengine kwamba matatizo ya kimatamshi miongoni mwa wazungumzaji wa Kiswahili nchini Kenya yana asili tofauti tofauti lakini asili kuu ni athari za lugha ya kwanza. Wanasema kuwa mwalimu anayefundisha matamshi ya Kiswahili sanifu anapaswa kuwa na ufahamu wa fonolojia za L1 za wanafunzi wake. Hili litasaidia mwalimu kulinganisha sauti za lugha mama za wanafunzi pamoja na lugha ya Kiswahili na hivyo kuweza kubashiri matatizo ya matamshi yanayoweza kuwakumba wanafunzi wake. Ili kufahamu mfumo wa sauti za lugha ya mwanafunzi mwalimu atahitaji ufahamu wa masuala ya

vitamkwa vya lugha, vitamkwa vinavyotegemea mazingira, mpangilio wa vitamkwa vya lugha, viungo vinavyohusika na matamshi pamoja na namna ya kufundisha matamshi (Musau na Chacha, 2001:22).

Katika namna ya kufundisha matamshi Musau na Chacha wanasema kuwa mwalimu anaweza kutumia kinasa sauti kilicho na matamshi sanifu ya Kiswahili. Wanasema mwalimu anaweza kutumia jozi finyu za maneno ambazo zinatofautiana kwa sauti moja tu na kufanya zoezi la kutofautisha maneno yaliyoko katika jozi. Aidha, mwalimu anaweza kuwasomea wanafunzi wake sentensi mbili zinazotofautishwa kwa neno moja tu kwenye sauti anayotaka kufundisha. Mfano; Msasi atafika kesho na mzazi atafika kesho. Mwalimu anaweza tumia imla kufunza matamshi na vilevile anaweza waonyesha wanafunzi wake kutamka sauti fulani kwa kurejelea viungo vya utamkaji na jinsi ya kutamka.

Kwa vile lengo kuu la lugha nikutekeleza mawasiliana, ufundishaji wa matamshi unaambatana na stadi za kuzungumza. Watafiti hawa walipendekeza mbinu za maigizo, mazungumzo yanayotokana na tarakimu, matumizi ya picha na michoro, pamoja na mijadala kama mbinu mwafaka za kufunza mazungumzo ya Kiswahili. Musau na Chacha (2001) wanahitimisha kwa kusema kuwa ni jukumu la kila mwalimu kuwapa wanafunzi mazoezi ya kutosha. Hata hivyo utafiti huu haukulenga changamoto zinazowakumba wanaojifunza sauti na matamshi ya Kiswahili. Aidha haukujikita katika ufunzaji wa kiwango cha shule ya upili kama ilivyo utafiti wetu.

King'ei na Musau (2002) walitafiti kuhusu utata wa Kiswahili. Wao walisema kuwa, wazungumzaji wasiotumia matamshi sahihi ya Kiswahili hawaeleweki vizuri kila mara. Wanasema tatizo la kimatamshi miongoni mwa wazungumzaji wa Kiswahili nchini Kenya yana asili kuu ambayo ni athari za lugha ya kwanza. Njia moja inayotumiwa na walimu au wanaisimu kubashiri matatizo waliyo nayo wazungumzaji wa Kiswahili kama L2 ni kulinganisha sauti zinazopatikana katika lugha ya kwanza na zile za Kiswahili (King'ei na Musau, 2002:2).

Kulingana naKing'ei na Musau (2002) walieleza tatizo la kimatamshi kwa kulinganisha vitamkwa vya Kiswahili na zile za lugha za kwanza kama

Kinandi, Kijaluo, Kikamba, Kibukusu, Kimaasai na Kisomali. King'ei na Musau 2002:25, walitazama kuwa sauti nyingi za kukopwa kutoka Kiarabu huwapa matatizo makubwa wazungumzaji wengi. Hii ni kwa vile baadhi ya sauti hazipatikani katika lugha nyingi za Kenya kama vile Kikuyu, Kikamba miongoni mwa nyingine. Mifano ya sauti hizo ni/th/ /dh/ na /gh/. Walisema sauti nyingine zinazowatatiza wazungumzaji wengi ni /z/ /j/ /b/ /d/ /g/ /v/ na/r/.

Tofauti na utafiti wetu King'ei na Musau (2002), walishughulikia utata wa kimatamshi ya Kiswahili waziwazi na aina za makosa yenyewe pasi kujikita katika ufunzaji wa matamshi ya Kiswahili hasa kwa wanafunzi shuleni. Vile vile King'ei na Musau (2002), walishughulikia matatizo ya kimatamshi kwa kulinganisha vitamkwa vya Kiswahili na zile za lugha za kwanza kama Kinandi, Kijaluo, Kikamba, Kibukusu, Kimaasai na Kisomali tofauti na utafiti wetu uliohusisha walimu na wanafunzi wa lugha ya Kiswahili katika shule za upili kaunti ya Murang'a Kenya.

Misingi ya Kinadharia

Utafiti wetu uliongozwa na mihimili ya nadharia zalishi kielelezo cha S.P.E. (Sound Pattern of English) iliyoasisiwa na Chomsky na Halle (1968) ili kuchanganua data kuhusu sauti za Kiswahili. Aidha, nadharia ya utabia iliyoasisiwa na Skinner (1957) ilikuwa ya manufaa kwetu hasa katika uchanganuzi wa data inayohusu masuala ya ufundishaji fonetiki na fonolojia ya Kiswahili.

Nadharia Zalishi Kielelezo cha S.P.E

Nadharia hii ilianzishwa na Chomsky na Halle katika kitabu chao maarufu Sound Pattern of English (SPE) (1968). Mageuzi makubwa katika uchanganuzi wa vipengele vya kifonolojia yalitokea wakati wa uanzishwaji wa nadharia ya fonolojia zalishi ambayo ilielezwa kwa uwazi na ufasaha katika kiunzi ambacho kinajulikana leo kama kuinzi rasmi cha fonolojia zalishi (KRFZ). Kiunzi hikikilianzishwa na Noam Chomsky na Morris Halle walipoandika kitabu cha Sound Pattern of English (1968). Miaka ya 1940 na 1950 huko Ulaya Mashariki na Marekani wanafonolojia walishughulika zaidi na nadharia ya fonimu na jinsi ya kuitambua fonimu.

Kwa maoni ya Massamba (2011:108) "fonolojia zalishi ina kiunzi chake

katika uwakilishajiwa vipengele tofautitofauti vya kifonolojia kiulalao ambao unajulikana kama uwakilishi mozaama uwakilishi mkururo." Hivyo basi vipamba sauti huchukuliwa kama vijenzi vya vitamkwa. Nadharia hii huchanganua fonolojia vitamkwa na fonolojia arudhi katika lugha za binadamu. Kwa mfano, mkazo katika neno mtotounamilikiwa na unachukuliwa kuwa ni sifa pambanuzi ya irabu ya silabi ya pili kutoka mwisho.

Nadharia ya Utabia

Nadharia hii ina misingiyake kutoka kwa nadharia ya Saikolojia Utabia.Waasisi wa nadharia hii kama vile B.F. Skinner (1957), aliyedhamiria kufafanua vile tabia inajengwa. Skinner aliamini ya kwamba tabia inaweza kudumu kwa muda mrefu ikiwa tabia hiyo itaigwa, itarudiwa kila mara na kutuzwa, lakini tabia ambayo hairudiwi na na hata kutotuzwa hufifia. Wanautabia kama vile Skinner (1957) walidhani kuwa jambo analojifundisha mtu mwanzo linaathiri lile analojifundisha baadaye. Basi kwa vile utafiti wetu ulilenga kuchunguza suala la ufundishaji matamshi ya Kiswahili na changamoto zake, mihimili ya nadharia hii ilikuwa ya manufaa. Kwa mfano, kukariri na kurudiarudia matamshi mazuri, ufunzaji wa fonetiki na fonolojia kwa njia ya kusikiliza na kuzungumza kabla ya kuandika na matamshi kufunzwa mwanzo na vipengele vingine vya kisarufi kufunzwa baadaye ni mihimili itakayoongoza utafiti wetu.

Kwa vile nadharia hii ya utabia imezungumziwa upya na wanaisimu kama vile Brunner (1996) miongoni mwa wengine tulishirikisha mihimili ya dhana ya uumbaji inayodai kuwa kazi ya mwalimu ni kuelekeza wanafunzi na kuwapa mazingira huru na bora ya kuumba maarifa mapya kutokana na maarifa awali.

Mbinu za Utafiti

Utafiti huu ulijumuisha mbinu ya kiasi. Hojaji, na mazoezi kwa wanafunzi zilitumiwa kukusanya data. Data ilichanganuliwa na kuwasilishwa kimaelezo, kwa njia ya majedwali na michoro duara. Uchanganuzi wa kitakwimu ulifanyika kwa kutumia mbinu ya tarakilishi ya uchanganuzi tarakimu sayansi za kijamii.

Uchanganuzi wa Data, Tafsiri na Majadiliano

Mahitaji ya Silabasi ya Kiswahili

kuhusiana na Ufunzaji wa Matamshi ya Kiswahili katika Shule za Upili nchini Kenya

Baada ya kupitia silabasi ya Kiswahili (KIE, 2002) tulibaini kuwa, wanafunziwa kidato cha kwanza wanahitaji kufunzwa mada mbalimbali zinazohusiana na matamshi ya Kiswahili kama ilivyoorodheshwa katika Jedwali 1.

Jedwali 1: Mada za Matamshi ya Kiswahili Katika Kidato cha Kwanza

Stadi	**Yaliyomo**
Kusikiliza na kuzungumza	**Matamshi bora** i) shadda ii) kiimbo iii) irabu/vokali- /a/,/e/,/i/,o/,/u/ iv) konsonanti Shadda/b/,ch//d/,/dh/,/f/,/g/,/gh/,/h/,/j/,/k/,/l/,/m/,/n/,/ng'/,/ny/,/p/,/r/,/s/,/sh//,t/,/th/,/v/,/w/,/y/,/z/ v) Ala za sauti/kutamkia vi) Namna ya kutamka na aina za sauti. Mfano, ghuna, sighuna/ hafifu, vipasuo, vikwamizo na kadhalika. vii) Silabi viii) maneno ix) Vitate -mfano, baba, papa x)Vitanza ndimi
Sarufi na matumizi ya lugha	**sauti:** i) irabu/ vokali ii) konsonantianti iii) Mpangilio ilio wa sauti katika silabi na maneno
Kusoma	i) Sauti mwambatano ii) Sentensi iii) Kusoma vifungu vya maneno na aya kwa matamshi bora

Utafiti wetu kama ulivyowasilishwa katika Jedwali 2, umebainisha kuwa ufunzaji wa matamshi ya Kiswahili katika kidato cha kwanza umetiliwa maanani. Vipengele vya kifonolojia na hata vya kifonetiki vinafunzwa. Katika fonetiki, wanafunzi wanafunzwa namna ya kutamka sauti mbalimbali

na mahali sauti zinatamkiwa. Katika fonolojia wanafunzi wanabainisha sauti za Kiswahili yaani irabu na konsonanti na namna zinatamkwa pamoja na mahalizinatamkiwa. Aidha sifa arudhi kama vile silabi, mkazo na kiimbo vinaelezwa kinaganaga. Wanafunzi wanasoma sentensi na vifungu vya ufahamu kwa sauti na matamshi bora ya Kiswahili. Ilibainika kuwa, katika kidato cha kwanza msingi mzuri wa ufunzaji matamshi ya Kiswahili umewekwa na mada zote zinazofunzwa katika kidato hiki zinalenga mhimili wa nadharia zalishi kielelezo cha S.P.E. wa uwili sifa. Mfano; kuwa au kutokuwa na ughuna, kuwa au kutokuwa na unazali na kadhalika. Sauti /b/ ni +ghuna na /p/ ni –ghuna.

Ufunzaji wa sauti za Kiswahili katika kidato hiki umepambanuliwa kwa sifa pambanuzi zake na vigezo vya chembainayohusika, namna ya utamkaji na chombo cha sauti husika. Sifa pambanuzi za chombo zimebainika wazi katika mada hizi kama usonoranti, uvokali, ukonsonanti (konso), sifa za chombo ya mkondohewa, sifa za jinsi ya kutamka kama vile vizuizi, vipasuo, sifa chanzo; mfano sauti zenye sifa ya juu, chini, nyuma, sauti zenye sifa ya mkao wa mdomo (viringe na tandaze), kuwa au kutokuwa na utambaza, kuwa au kutokuwa na unazali, kuwa au kutokuwa na ughuna, kuwa au kutokuwa na usilabi na kadhalika.

Mahitaji ya Silabasi kuhusu Matamshi ya Kiswahili katika Kidato cha Pili

Kwa mujibu wa silabasi ya Kiswahili wanafunzi wa kidato cha pili wanahitaji kufunzwa mada mbalimbali zinazohusiana na matamshi ya Kiswahili kama ilivyoorodheshwa katika Jedwali 2.

Jedwali 2: Mada za Matamshi ya Kiswahili katika Kidato cha Pili

Stadi	**Yaliyomo**
Kusikiliza na kuzungumza	**Matamshi bora:** i. Silabi tatanishi-pa/ba, sa/sha, la/ra, cha/sha, za/sa, na kadhalika. ii. Sauti tatanishi /d/,/nd/,/g/ /ng/, /b/ /mb/ na kadhalika iii. Vitate- kua/kuwa iv. Vitanza ndimi
Kusoma	**Kusoma kwa sauti:** a. Kusoma sauti na maneno tatanishi b. Vitate mfano, kua/kuwa,pua/bua,vua/fua c. Maneno tatanishi yenye sauti mwambatano mfano kidani/ kindani, buni/ mbuni d. Sentensi zenye maana tatanishi e. Vitanza ndimi

Katika Jedwali 2, ilibainika kuwa silabasi ya Kiswahili imependekeza mada za sauti na matamshi ya Kiswahili kufunzwa chini ya stadi za kusikiliza na kuzungumza pamoja na kusoma kwa sauti. Utafiti wetu uligundua kuwa matamshi bora yalitiliwa uzito katika kidato cha pili. Utamkaji wa sauti tatanishi, silabi tatanishi, maneno tate na kusoma vitanza ndimi kwa sauti na kwa matamshi bora yamependekezwa na silabasi ya Kiswahili. Hata hivyo, ufafanuzi wa sifa za sauti mbalimbali za Kiswahili pamoja na sifa arudhi kama vile shadda, silabi na kiimbo hazijahusishwa katika ufunzaji matamshi kwa wanafunzi wa kidato cha pili.

Mahitaji ya Silabasi ya Kiswahili kuhusu Matamshi ya Kiswahili katika Kidato cha tatu

Kwa mujibu wa silabasi ya Kiswahili wanafunzi wa kidato cha tatu wanahitaji kufunzwa mada mbalimbali zinazohusiana na matamshi ya Kiswahili kama ilivyoorodheshwa katika Jedwali 3.

Jedwali 3: Mada za Matamshi ya Kiswahili katika Kidato cha Tatu

Stadi	**Yaliyomo**
Kusoma kwa sauti	i) Kusoma kazi walizotunga kwa sauti ii) Kusoma magazeti wakizingatia tahariri, habari za kimataifa na barua kwa mhariri, ripoti za michezo iii) Kusoma habari na ripoti za runinga na redio iv) kusoma sentensi na kurekebisha makosa

Mahitaji ya Silabasi ya Kiswahili kuhusu Matamshi ya Kiswahili katika Kidato cha Nne

Kwa mujibu wa silabasi ya Kiswahili wanafunzi wa kidato cha nne wanahitaji kufunzwa mada mbalimbali zinazohusiana na matamshi ya Kiswahili kama ilivyoorodheshwa katika Jedwali 4.

Jedwali 4: Mada za Matamshi ya Kiswahili katika Kidato cha Nne

Stadi	**Yaliyomo**
Kusoma kwa sauti	i) Kusoma kazi walizotunga kwa sauti ii) Kusoma vitabu teule iii) Kusoma ripoti za wahariri wa magazeti iv) kusoma matangazo

Kutokana na Jedwali 3 na Jedwali 4 tuligundua kuwa mada za matamshi ya Kiswahili kwa mujibu wa silabasi ya Kiswahili zimebainika katika stadi ya kusoma pekee. Baada ya kupitia silabasi ya Kiswahili K.I.E. (2002), utafiti wetu ulibaini kuwa ufunzaji wa matamshi ya Kiswahili katika vidato vya juu, yaani kidato cha tatu na cha nne, umepuuzwa na haujapewa uzito wa kutosha. Mwanafunzi anahitajika kusoma kwa sauti magazeti, matangazo mbalimbali pamoja na habari za kitaifa na za kimataifa. Msingi wa sifa za sauti za Kiswahili haujarejelewa katika vidato vya tatu na vya nne. Masuala ya silabi, shadda na kiimbo hayajazungumziwa katika vidato hivi vya tatu na nne mtawalia.

Hitimisho

Utafiti huu uligundua kwamba ufunzaji wa matamshi ya Kiswahili katika kidato cha kwanza na cha pili umetiliwa maanani. Katika kidato cha kwanza, vipengele vya kifonolojia na hata vya kifonetiki vinafunzwa. Katika fonetiki wanafunzi wanafunzwa namna ya kutamka sauti mbalimbali na mahali sauti zinatamkiwa. Katika fonolojia, wanafunzi wanabainisha sauti za Kiswahili yaani irabu na konsonanti na namna zinatamkwa pamoja na mahalizinatamkiwa. Aidha sifa arudhi Kama vile silabi, mkazo na kiimbo vinaelezwa kinaganaga. Utafiti huu ulibaini kuwa msingi mzuri wa ufunzaji matamshi ya Kiswahili umewekwa na mada zote zinazofunzwa katika kidato hiki cha kwanza zinalenga mhimili wa nadharia zalishi kielelezo cha S.P.E. wa uwili sifa.

Katika kidato cha pili ilibainika kuwa kwa mujibu wa silabasi ya Kiswahili, mada za sauti na matamshi ya kiswahili zilifunzwa chini ya stadi ya kusikiliza na kuzungumza pamojana kusoma kwa sauti. Utafiti wetu uligundua kuwa matamshi borayalitiliwa uzito katika kidato hiki. Utamkaji wa sauti tatanishi, silabi tatanishi, maneno tata na kusoma vitanza ndimi kwa sauti kulifunzwa. Hata hivyo, upambanuzi wa sifa za sauti mbalimbali za Kiswahili pamoja na sifa arudhi kama shadda, silabi na kiimbo hazikuendelezwa katika kidato cha pili.

Utafiti huu ulibaini kuwa katika vidato vya juu, yaani kidato cha tatu na cha nne. Mada za sauti na matamshi ya Kiswahili hazikutiliwa maanani sana kwa mujibu wa silabasi ya Kiswahili. Katika vidato hivi, ufunzajiwa matamshi ya Kiswahili umehusishwa katika stadi ya kusoma

pekee. Mwanafunzi anahitajika kusoma kwa sauti magazeti, matangazo mbalimbali pamoja na habari za kitaifa na za kimataifa. Msingi wa sifa za sauti za Kiswahili haurejelewi katika vidato vya tatu na vya nne. Masuala ya shadda, silabina kiimbo haujazungumziwa katika vidato hivi.

Mapendekezo ya Sera na Mazoezi

1. Kufanya marekebisho katika silabasi ya Kiswahili ili kuimarisha mafundisho ya matamshi katika vidato vya juu.
2. Kuhakikisha kuwa kuna mwendelezo wa ufundishaji wa matamshi kutoka vidato vya chini hadi vidato vya juu.
3. Kurekebisha mtaala wa vidato vya juu ili kujumuisha stadi za kusikiza na kuzungumza katika ufunzaji wa matamshi.
4. Kutunga mpangilio wa mada za matamshi ili ukuzie wanafunzi uelewa na umilisi kwa kila kidato.
5. Kutunga vitabu vya kiada ambavyo vinajumuisha mada za matamshi kwa undani na ufanisi zaidi.
6. Kuanzisha mfumo wa tathmini ya mara kwa mara kuhusu ufanisi wa ufundishaji wa matamshi katika shule za upili.

Mapendekezo ya Utafiti Zaidi

1. Utafiti wa kina juu ya mifano bora ya ufundishaji wa matamshi na sauti katika lugha ya Kiswahili, ili kubaini mbinu zinazofanikiwa katika kuboresha uelewa wa wanafunzi.
2. Utafiti kupunguza pengo katika mafunzo ya walimu kuhusu fonetiki na fonolojia ya Kiswahili kupitia utafiti wa mahitaji ya mafunzo ili kuboresha ujuzi na mbinu zao za kufundisha.
3. Utafiti kuchunguza jinsi teknolojia mpya ya kujifunzia inavyoathiri ufanisi wa ufunzaji wa sauti na matamshi ya Kiswahili, huku ukikumbatia matumizi ya vifaa vya kidijitali na rasilimali mtandaoni.

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Urban Design Frameworks and their Effectiveness in Mitigating Disaster Risks in Bungoma Municipality, Kenya

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Abstract

Urban planning involves regulating land use to develop viable environments and sustainable cities. It emphasizes establishing land-use policies and patterns for creating livable, sustainable communities. The gap between disaster mitigation and urban planning is well-documented worldwide. This study aimed to identify urban design frameworks and assess their effectiveness in reducing disaster risks in Bungoma Municipality, Kenya. The research utilized a mixed-methods sequential explanatory design to gather data from the municipality. Infrastructure assessments revealed inadequate drainage and poor-quality roads as significant problems. Evaluation of mitigation strategies showed that community tree-planting cut flood impacts, while multi-stakeholder coordination improved response times. The study concludes that, although structural improvements are in place, gaps in governance, technology adoption, and inclusive planning still exist. Key recommendations include strengthening policy enforcement, improving multi-stakeholder coordination, integrating early warning systems, and increasing community participation to address implementation gaps for sustainable urban resilience.

Key words; Urban Design framework, Disaster Mitigation, Urban planning, Sustainable urban resilience.

Introduction

Urban planning involves regulating land use to create viable environments and sustainable cities. It focuses on establishing land-use policies and patterns to develop livable, sustainable communities. The gap between disaster mitigation and urban planning is well-documented worldwide. Despite recognizing hazards and risks in the Convention on the Promotion of a Transparent Society in an age of High Information, Sendai Framework for Disaster Risk Reduction (20152030), and New Urban Agenda (2016) to include disaster risk reduction in urban planning, there are implementation gaps. Research by UNDRR (2022) shows that only 3 out of every 10 countries effectively integrate DRR into their urban development strategies. Additionally, the World Bank (2021) evaluation indicates that risk-sensitive planning is not institutionalized in most rapidly urbanizing cities where disasters cause recurring losses. This highlights a significant disconnect between policy goals and actual planning practices, especially in low- and middle-income countries with limited institutional capacity.

In Kenya, the presence of informal settlements has been a serious issue in rapidly growing cities such as Nairobi, Kisumu, and Mombasa, where these settlements are often located in flood-prone or unstable areas. Although the National Disaster Risk Management Policy (2018) and the Urban Areas and Cities Act (2011) emphasize the importance of risk reduction as part of urban development, this approach is hindered by a lack of coordination among financing organizations, insufficient funding, and limited access to data. A report by the Kenya Institute for Public Policy Research and Analysis (KIPPRA, 2022) notes that local authorities generally lack the technical capacity to incorporate risk assessments into spatial planning. Furthermore, urban planning is highly centralized and involves little community participation. This disconnect between urban planning and disaster mitigation has contributed to frequent urban flooding in Nairobi's informal settlements and infrastructural damage during extreme weather events, highlighting the need for integrated mechanisms.

Urban design has been shown to help reduce disasters, but little research and

action have been taken to support this (Rana et al., 2021). Most urban centers, especially in developing countries, face challenges such as limited resources, poor governance, and lack of information to make confident decisions (Gencer & UNISDR, 2017). Bungoma Municipality is exposed to disasters like floods and infrastructure collapse, which result from rapid and largely unplanned urban growth. Although policies exist to promote disaster risk reduction and sustainable urban development, their implementation at the municipal level is often weak and scattered. Urban planning tends to ignore resilience because it focuses on short-term functionality, leaving many communities unprepared for recurring shocks. This study addressed the gap by exploring urban design and disaster mitigation methods to improve community resilience in urban settings.

Purpose of the Study

The purpose of this study was to assess urban design frameworks and their effectiveness in reducing disaster risks in Bungoma Municipality, Kenya.

Literature Review

Several studies have highlighted the benefits of cross-functional structures. For example, Njoku et al. (2020) identify the advantages of big data analytics and the Internet of Things (IoT) that could enhance disaster preparedness and response. Likewise, the World Health Organization (2022) emphasizes that urban planning is crucial for creating healthy and resilient cities by considering environmental and health factors. The significance of governance and stakeholder collaboration has also been examined. The multi-stakeholder approach involves local governments, communities, and the private sector in integrating DRR into development planning (GAR, 2019). Strong governance structures can ensure disaster risks are incorporated into the urban planning system, leading to safer and more resilient communities (Kodag & Kodag, 2023).

In Germany, the effectiveness of considering social vulnerability in planning national disaster management activities could be tested through a case study (Grothmann & Michel, 2021). The paper has found that there is awareness that vulnerabilities need to be addressed, but operationalization is inconsistent.

The study reveals that inclusive and adaptive disaster management practices are necessary to enhance societal resilience (Brunken, 2024). In the literature review on resilience building in Germany, there are some knowledge gaps. A major shortcoming was the lack of empirical assessment of participatory models in resilience-building interventions. While participatory practices are encouraged overall, there has been no critical evaluation of their effects on promoting resilience knowledge, activities, and networks. Additionally, the division between the governmental and individual roles in resilience-building programs was insufficiently understood, as it tended to result in unilateral systems and discouraging impacts on non-state members.

Patnaik and Narayanan (2015) discussed the Cyclone Phailin that struck Odisha, India, bringing destructive winds and heavy rainfall. Urban planning was integrated with disaster risk reduction through a comprehensive disaster management approach developed by the state. Early warning systems were created in collaboration with local communities, enabling nearly a million people to evacuate. Community-designed cyclone shelters provided safe refuge and were strategically located to minimize travel time. This case study highlights the importance of considering community needs in urban planning to enhance resilience (Patnaik *et al.*, 2015). A combination of field surveys and community-based participatory research was used in this study.

Researchers interviewed local residents, government officials, and evacuation commanders to gather information on effective evacuation strategies and cyclone shelters. Spatial analysis of shelters, including their distribution and accessibility, was also conducted using Geographic Information Systems (GIS) (Patnaik et al., 2015). Although early warning systems played a crucial role, there was a lack of full utilization of innovative technologies like GIS and real-time data analytics in disaster management. This gap highlighted the potential for technology to enhance decision-making and resource allocation. While these evacuation and preparedness activities were highly effective in reducing casualties, less attention was given to the community's

long-term resilience. The research underscored the need for a stronger approach to help communities recover and prepare for future disasters.

Ward *et al.* (2017) discussed the integration of urban planning and the disaster management in Jakarta, Indonesia. In the research, it was noted that the government had drawn up a flood risk management plan in which it was planning to construct retention basins, renew the drainage infrastructure and flood monitoring system in the community (Koen & De Souza, 2025). It was discovered that the efficiency of those measures was enhanced by sufficient contribution of the local communities to planning and decision-making processes.

In a study conducted by Velasquez et al. (2018), researchers observed that Medellin, Colombia has reoriented the urban planning in order to accommodate disaster risks related to landslides and floods. Major elements of an integrated effort the city pursued include risk-sensitive land-use planning, the relocation of at-risk populations and building green infrastructure. According to a study by Velatquez *et al.* (2018), participatory planning was identified to play an important role in the development of community resilience as residents discovered themselves engaged in the process of identifying the risks and proposing their solutions. The participatory action research (PAR) methodology that was adopted in this case study focused on engaging the community members in the determination of risks, and development of solutions. The technologies of GIS and remote sensing were used to identify risk-susceptible regions and observe how green infrastructure operated. The paper also entailed a policy analysis to determine how disaster risk reduction was implemented in terms of urban plans (Velasquez *et al.*, 2018). Although the transformation of Medellin has been lauded and there are studies on the level of margins, there are few studies on the actual inclusion of marginalized communities when it comes to resilience-building efforts.

Theoretical Framework

Resilience Theory, advocated in works by Holling (1973), and subsequently elaborated by Walker and Salt (2012), concentrates on how the systems are able to absorb the disturbances, remaining intact in terms of their key

functions and structures. Ecological, social and disaster management are some other areas where the application of this theory has been or is extensively obtained. It focuses on the power of community to adapt, change, and recover disasters, which implies the role of flexibility and learning. The study conceptual framework operationalizes the resilience theory by means of the key dimensions including those which match resilience to urban disaster mitigation. The first is that the theory focuses on the adaptive capacity, and this will be reflected in the mediating variables of institutional capacity and community dynamics, which will represent the potential of a system to learn through past disasters and rearrange. Second, engineering resilience (return to stability) / ecological resilience (adaptation) was involved in the inputs of the framework: building design, and mitigation measures are the engineering measures; green infrastructure and policy harmonization are the ecological measures. Finally, the dependent variables of reduced vulnerability and enhanced adaptive capacity directly measure the theory's ultimate goal - a community's ability to both withstand shocks (engineering resilience) and evolve (ecological resilience). This integration ensures the framework assesses not just physical urban design elements, but the dynamic social and institutional processes that determine long-term resilience, particularly crucial for Bungoma's context of rapid urbanization and climate vulnerability.

Methodology

Research Design. This research utilized mixed-methods sequential explanatory design (Fetters, 2020). The methodology commenced with quantitative research followed by qualitative research which enables one to explore and bring out all aspects of the study at hand. The quantitative phase entailed distribution of the structured questionnaires to the households, and interviews to stakeholders, which included: Municipal Planning Department, County Planning Department, National Planning Department, County Disaster Committee Secretariat, County Finance and Special Programs, NGOs, CBOs and CSOs (including Lake Region Economic Bloc, Western Kenya DRR Forum, National Disaster Management Authority, National Disaster

Management and Unit, State Dept. for Urban Planning Interview Schedule.

Area of Study. The research site was Bungoma Municipality, situated in Bungoma County, Western Kenya. This urban centre is experiencing rapid growth, driven by population influx, economic activities and infrastructure development. Its strategic location near the Uganda border makes it a key trade and commerce hub, attracting people from various ethnic backgrounds and contributing to its socioeconomic vibrancy.

Study Population. The study population involved important urban planning and disaster management stakeholders in Bungoma Municipality and surroundings. In particular, the sample was selected among the Municipal Planning Department that consists of 24 employees; the County Planning Department consisting of 27 employees, and 8 employees representing various administrative approval rates and concerns of the National Planning Department. Additionally, the study involved members of the County Disaster Committee, the Secretariat, comprised of 38 members and the County Department of Finance and Special Programs, comprised of 47 personnel, who were crucial in coordinating disaster preparedness, response and recovery efforts. According to the Kenya National Bureau of Statistics (KNBS, 2019) census data, Bungoma Town (now upgraded to a municipality) had 18,597 individuals engaged in formal and informal business activities, representing 42.3% of the working-age population in the urban centre (KNBS, 2019).

Sampling. This study adopted a multi-stage sampling approach to ensure both representativeness and inclusion of strategic informants across sectors. For households, stratified random sampling was employed to capture diversity across the municipality's five administrative wards. Using Cochran's formula:

$n_0 = (Z^2 \times p \times q) / e^2$

Where:

- $Z = 1.96$ (for 95% confidence level)
- $p = 0.5$ (assumed proportion)

- $q = 1 - p = 0.5$
- $e = 0.05$ (margin of error)

$n_0 = (1.96^2 \times 0.5 \times 0.5) / (0.05^2) = (3.8416 \times 0.25) / 0.0025 = 0.9604 / 0.0025 = 384.16$

The resulting sample size for households was 384. These was distributed proportionally across the five wards based on population data from the Kenya National Bureau of Statistics (2019). Each ward's allocation was calculated as a proportion of the municipality's total household population to ensure equitable representation (Table 1).

Table 1: Sampling Design

Ward	**Total HHs**	**Sample Allocation (%)**	**Sample Size (*n*=384)**
Township	4,217	22.67	87
Khalaba	3,893	20.93	80
Sang'alo	3,452	18.56	71
Mukuyuni	3,203	17.23	66
Misikhu	3,832	20.61	80
Total	**18,597**	**100**	**384**

Data Collection Methods. This study used a comprehensive mixed-methods data collection strategy, combining both secondary and primary approaches. Secondary data collection involved analyzing national and county disaster management policies, urban planning documents and infrastructure blueprints using a standardized policy content analysis matrix adapted from the UNDRR monitoring framework, alongside GIS-based spatial analysis for risk mapping. Primary data collection applied four complementary methods which included household surveys, business entities, key policymakers, technical officers and institutional actors, and community groups.

Data Analysis. Quantitative data from surveys were processed using SPSS Statistics (v28). Qualitative data from

interviews and FGDs underwent thematic analysis in NVivo (v14) using a hybrid inductive-deductive coding approach, with member checking to validate interpretations. Methodological triangulation was integrated to findings through a convergence matrix comparing statistical results, qualitative themes and policy content. The study's findings were presented using a combination of tables (for quantitative data) and narrative descriptions (for qualitative data).

Results

Descriptive Statistics. The survey revealed that well-planned road networks were perceived by nearly half of respondents (45.8%) as the most effective urban design feature for reducing disaster risks, followed by well-designed drainage systems (27.7%) and green spaces and parks (15.6%). Only 10.9% cited safe evacuation routes as the most effective. Regarding land use and building regulations aimed at reducing disaster risks, a majority (57%) considered them somewhat effective, while 23.7% found them ineffective. Only 5.9% rated them as very effective and 13.4% remained neutral. In terms of primary urban infrastructure challenges related to disaster risk, 46.9% identified poor access to emergency services as the key issue, followed by road conditions (28.5%) and flooding issues (14.2%). Limited public spaces were noted by 10.3% of respondents. The research clinched that strong focus on roads and drainage prioritized mobility and flood mitigation, but low emphasis on evacuation routes and weak enforcement of regulations highlighted gaps in disaster response and planning.

Table 2: Urban design

	Frequency	%

Which urban design feature do you think is most effective in reducing disaster risks?	Green spaces and parks	56	15.6
	Well-planned road networks	164	45.8
	Well-designed drainage systems	99	27.7
	Safe evacuation routes	39	10.9
How do you feel about the rules for dividing land and buildings in your area to reduce the risk of disasters?	Very effective	21	5.9
	Somewhat effective	204	57.0
	Neutral	48	13.4
	Ineffective	85	23.7
What is the primary issue with urban infrastructure in this area concerning disaster risks?	Flooding issues	51	14.2
	Access to emergency services	168	46.9
	Road conditions	102	28.5
	Limited public spaces	37	10.3

Urban Design Practices for Community Resilience. Bungoma Municipality has adopted a set of urban design practices aimed at strengthening community resilience against disasters, combining physical infrastructure interventions with environmental management. Key elements include zoning and land use regulation, improved drainage systems, solid waste management improvements, urban greening and the promotion of non-motorized transport networks. These measures indicate a gradual alignment with Kenya's national urban resilience goals, yet their coverage remains uneven across neighbourhoods. While such practices address both structural and environmental vulnerabilities, the persistence of informal settlements and poor waste management highlights the need for stronger enforcement and integration of resilience considerations in all urban planning processes.

> *"Zoning and land use regulation; Improved drainage and storm-water management;*

Solid waste management improvements; Urban greening and Ecosystem protection; Development of Non-Motorized Transport (NMT) networks (i.e., design of Pedestrian walkways and cycle lanes separate from vehicular traffic)." (Source: Participant 1).

Enhancing urban resilience and disaster mitigation in Bungoma Municipality will require a more data-driven, coordinated and community-centred approach. This includes creating a comprehensive Urban Risk Atlas to guide zoning and emergency response, integrating DRR criteria into all building and land use approvals and establishing a multi-stakeholder resilience platform to institutionalize collaboration. Public awareness should be boosted through a dedicated risk communication strategy, while real-time disaster alerts can be delivered via digital and mobile platforms. Finally, embedding clear DRR indicators into municipal plans will ensure progress is tracked and sustained. As one participant stressed,

"Resilience is not built-in workshops alone - it must be lived in our streets, our homes and our daily planning decisions". (Source: Participant 2).

The effectiveness of Bungoma's current urban design measures is rated as moderate but improving, largely due to increased infrastructure investment, decentralization and growing public awareness of disaster risks. This trend suggests that recent reforms and funding programs (such as KUSP) are beginning to yield results. However, the progress remains fragile, particularly in high-risk areas, where encroachments on drainage reserves and poor maintenance undermine the impact of these initiatives. Ensuring consistent application of design standards across all urban zones will be crucial for long-term resilience.

"It is moderate but improving, influenced by recent decentralization, infrastructure investments and growing disaster risk awareness." (Source: Participant 3).

<u>*Urban Features that Enhance or Undermine Resilience*</u>. Several urban features stand out for their role in disaster risk mitigation—especially, KUSP-funded drainage systems that reduce flooding in the CBD and Kanduyi; tree-planting efforts that help control microclimate and improve water absorption; and better-planned markets that support emergency response. In contrast, resilience is weakened by unregulated settlements in wetlands, encroachment on riparian zones, poor waste disposal practices, and the lack of proper signage or disaster preparedness

infrastructure. This mixed landscape shows that although Bungoma has achieved notable resilience improvements, unplanned urban growth and weak enforcement of land use rules continue to diminish these gains.

> *"Urban features that enhance resilience… Drainage infrastructure (KUSP-funded) … Urban greening (tree planting initiatives) … Paved pedestrian walkways… Markets with better spatial layout… non-motorized transport lanes." (Source: Participant 4).*

> *"Urban Features that Undermine resilience: Encroachment on riparian and drainage reserves… Poor solid waste management in estates and informal areas… Informal settlements in wetlands… Inadequate signage or disaster response plans… Scattered and poorly maintained public toilets." (Source: Participant 5).*

<u>*Reactive and Proactive Disaster Management*</u>. The urban design frameworks in Bungoma Municipality largely operate in a reactive mode, responding to disasters only after they occur rather than preventing them. There is a notable lack of pre-emptive planning, which is evident in inadequate stormwater drainage and unregulated construction in flood-prone areas. Communities and authorities often find themselves unprepared when disasters strike, highlighting gaps in early warning systems and mitigation strategies. Civil society organizations (CSOs) emphasize the fact that they should have an inbuilt disaster mitigation strategy that include the community aspect of awareness and preparedness. In an event where proactive steps are not taken; the municipality is left susceptible to all manner of disasters that can be prevented. Such a reactionary tactic decreases the efficacy of disaster risk management activities as a whole. Advancing prospective urban planning would have a great impact in building community resilience.

> *"Disaster strikes, then people start responding... People facing stormwater disasters are not prepared at all." (Source: Participant 2).*

> *"We need a mitigation plan framework where communities are aware of disasters and how*

to respond." (Source: Participant 3).

Green Infrastructure for Disaster Mitigation. Use of green infrastructure like, parks, trees, grassed open spaces, riparian reserves have now become the key element of disaster mitigation framework in Bungoma Municipality. All these contribute to the control and management of storm water, minimise surface run off and prevention of urban flooding, enhancing the air quality as well as cooling the microclimates in urban areas. The present approach is comparable to resilience policies in Kenya, especially the Kenya Urban Support Programme (KUSP) and the National Climate Change Action Plan (NCCAP), which advocates nature-based approaches in coming up with urban risk-related solutions. At Bungoma, they are yet to take off but have the potential of improving the quality of the environment and equip the people of Bungoma to be better prepared.

> *"The integration of green infrastructure - such as parks, trees, grassed open spaces and riparian reserves - plays a growing and vital role in disaster mitigation strategies within Bungoma Municipality. Though still developing, its incorporation aligns with Kenya's broader urban resilience goals under programs like the (KUSP) and National Climate Change Action Plans (NCCAP)". (Source: Participant 1).*

The municipality is piloting nature-based solutions that incorporate green infrastructure, such as dual carriageways with walkways and green spaces, to mitigate urban heat and flooding. These projects in areas like Kandui and the central business district aim to blend concrete infrastructure with ecological features, reflecting a balance between development and sustainability. However, challenges arise as planned open spaces are often lost to private development proposals. Moreover, many roads have reserves narrower than the 9-meter standard, limiting the scope for integrated green designs. This loss of public and green spaces reduces the urban environment's capacity to absorb stormwater and regulate temperature. The committee stresses that while these initiatives show promise, enforcement mechanisms must be strengthened to protect public land and realize the full benefits of green infrastructure. Effective spatial planning combined with protective regulations is critical to maintaining ecological resilience.

> *"Road designs now include cycling lanes and green spaces…but some were destroyed during implementation. Bungoma lacks public open*

spaces...even proposed green spaces like Wanjenge face encroachment." (Source: Participant 6).

Informal Business Operations and Infrastructure Deficiencies. The urban design in Bungoma Municipality currently fails to accommodate the large informal business sector, forcing many vendors to operate on roads, sidewalks and drainage areas. This misuse of public spaces not only disrupts orderly commerce but also increases vulnerability to flooding due to poor drainage systems. Additionally, inadequate lighting further constrains business activities, especially during evening hours, reducing economic opportunities. The design shortcomings create a cycle where infrastructure development leads to forced demolitions of informal businesses, causing significant economic losses and instability for these operators. Overall, the framework does not effectively support informal economic activities nor mitigate the risks they face during adverse weather events.

"Informal businesses use road signs and roads for operations... drainage is very poor... floods displace businesses during rains." (Source: Participant 5).

"Lighting systems are inadequate for evening commerce... road networks lack space for business activities." (Source: Participant 8).

Road Design and Safety Hazards. The road layouts in Bungoma, particularly in areas like Kandui, show critical design flaws that compromise safety and functionality. Although the presence of dual carriageways suggests adequate road capacity, these lanes are frequently occupied by parked vehicles and informal vendors, effectively reducing available lanes and causing congestion. Pedestrians are forced to walk dangerously close to moving traffic, leading to frequent accidents. This misuse stems from both design limitations and lack of enforcement, revealing a gap between intended urban design and actual use. The urban framework does not sufficiently protect vulnerable road users or ensure smooth traffic flow.

"The outer lane is used for parking, leaving one lane... accidents occur daily as pedestrians walk near vehicle lanes." (Source: Participant 3).

Green Infrastructure and Encroachment.

Green infrastructure efforts, such as tree-planting under the Financing Locally Led Climate Action (FLLoCA) project, are underway to improve environmental resilience by enhancing water retention and reducing flood risks. However, these initiatives face challenges from unchecked urban expansion where new buildings encroach on green spaces and block planned roads. Such unregulated development undermines the positive impact of green infrastructure and compromises the overall disaster mitigation capacity of the urban environment. Thus, while green infrastructure is recognized as a valuable asset, enforcement and integration into urban design remain inadequate.

> *"Planting trees helps control flooding... but buildings encroach on planned roads like Simba Road." (Source: Participant 9).*

Green infrastructure such as parks, trees and open spaces plays an important role in mitigating urban flooding and enhancing environmental quality. However, in Bungoma, green spaces are shrinking due to unplanned urban expansion and weak enforcement of environmental regulations. Riverbanks, which should act as natural flood buffers, are being encroached upon and polluted, affecting water quality and community health. Although projects like the FLLoCA initiative promote tree planting and environmental restoration, their impact is limited by ongoing illegal developments and poor land-use planning. The lack of public green spaces also diminishes opportunities for community recreation and social cohesion, which are important for resilience. Strengthening policies to protect and expand green infrastructure could significantly improve disaster mitigation outcomes.

> *"People build right up to riverbanks... River Sio-Malaba is polluted, affecting drinking water." (Participant 7).*

> *"Public parks and parking lots are non-existent; all land is privatized." (Participant 5).*

Green infrastructure is recognized as a vital element for mitigating flooding and improving air quality in Bungoma's urban landscape. The director highlights its role in enhancing water infiltration and oxygen production, which are crucial for environmental and public health benefits. However, despite its acknowledged importance, implementation remains inconsistent, largely due to competing demands for land and insufficient enforcement of regulations. Construction activities increase impervious surfaces, leading to surface runoff and exacerbating flood risks. The disconnect between planning ideals and on-the-ground realities undermines the potential of green infrastructure to function as natural flood buffers. Addressing these implementation gaps through stronger policies and land-use enforcement would safeguard urban ecosystems. This would also improve the municipality's overall resilience to climate-related hazards.

> *"Green infrastructure plays a part in... improving infiltration...and air purification. Construction produces surface area...water will leak, creating flooding issues." (Source: Participant 10).*

Participatory Planning Approach. Bungoma's urban planning process places significant emphasis on multi-sectoral spatial planning developed through community engagement. This inclusive approach particularly supports climate-resilient projects funded by programs like the Kenya Urban Support Program (KUSP). Engaging stakeholders early ensures that projects are aligned with local priorities and increases community ownership, which facilitates smoother implementation. However, despite these strengths, gaps remain in translating participatory planning into full project delivery, mainly due to limited technical capacity and constrained funding. The committee notes that donor-funded projects tend to maintain higher resilience standards, but this consistency does not extend uniformly across all developments. This indicates a need for enhanced local capacity and resource mobilization to bridge the gap between planning ideals and practical outcomes. Sustained engagement with communities can also improve responsiveness to emerging urban challenges.

> *"We involve public participation...all stakeholders are involved so when we implement, the community owns the projects. KUSP funding requires climate-resilient designs...markets and roads must meet sustainability standards." (Source: Participant 11).*

Discussion

The study found that advanced infrastructure such as big data analytics and IoT could improve disaster preparedness and response, while well-planned road networks and drainage systems were prioritized for risk reduction. Although both approaches emphasize proactive planning, the local strategy remained heavily focused on physical infrastructure with minimal integration of advanced technologies. The low emphasis on safe evacuation routes highlighted a significant gap in comprehensive emergency planning. This finding partially aligns with Njoku *et al*. (2020), who

emphasized the importance of advanced technologies, but contrasts with Patnaik *et al.*'s (2015) integrated, community-focused model in Odisha, which incorporates such measures more fully. Thus, while the study aligns with literature on structural hazard reduction, it diverges on preparedness practices, suggesting a need to broaden frameworks to include technology-enabled and socially inclusive disaster response systems.

The research reported that a multi-stakeholder-based governance was deemed necessary to integrate considerations of disaster risks in the process of urban planning, which is consistent with the perspective offered by GAR (2019). Nevertheless, the working practices were relatively sparse, and there were large loopholes between the intentions of policy and action. This result was aligned with the situation identified by Brunken (2024), who stated that participatory approaches often lack empirical assessment, and this fact poses risks in terms of sustainability. Although the level of community awareness had improved, the efforts were vulnerable to poor institutionalization. Such steps as zoning, drainage system and non-motorised transport network showed evidence of the progress but lack of powerful collaboration structures threatened to cut such steps in parts (Sharifi, 2021). In general, the paper has identified the resilience within plural design efforts but pointed out a very important gap in having tested and systematic systems of government necessary to preserve and enforce their performance.

It was made obvious that including community-driven planning with infrastructure improvement in the form presented by Patnaik et al. (2015) substantially boosted the resilience to disasters as was the case with the drainage systems, tree planting and better market placements funded by the KUSP. These actions reinforced flood control, microclimate control and emergency accessibility, and speak to a strategic emphasis on the fabric and facilities of the setting. Nonetheless, in contrast to Odisha model characterized by incorporated early warning tools, such efforts did not have identifiable technological or preparedness aspects (Were et al., 2023). Gap reduced the overall effectiveness of previously useful infrastructure. What was positive was the evidence of physical improvements on the surface, but the weakness was that it lacked integral communication and

evacuation preparedness and, as such, it decreased the ability to turn structural advances into an integrated preparedness.

It has been discovered that the well-developed governance structures were necessary to protect resilience investments in particular by regulating land use and avoiding hazardous settlements, which was also noted in GAR (2019). Nonetheless, the fact that illegal occupations of wetlands and riparian areas remained unabated despite having far-reaching implications on weak law enforcement practices was a direct hit to the gains associated with enhanced infrastructure. This was demonstrated in the context of vulnerability awareness not always having a follow through operational action in reference to the findings of Grothmann and Michel (2021). Moreover, the shopping grid with limited preparatory systems and signs implied that the city was not very proactive in its view toward disaster management. The strengthening of the physical infrastructures was a good sign of strategic development but lack of institutionalized controls and mechanism of preparedness showed a fatal structural constraint. There will be thus the need to combine the good governance discipline to the current physical design initiatives in order to achieve long-lasting resilience.

The disaster risk governance systems present in the study area indicated rising opportunities as well as the challenges that have not abated. GAR (2019) has noted that multi-stakeholder governance was recognized as the added essential component helping to consider disaster risks when drafting planning actions and the idea was partially captured at the local level through the promotion of local community awareness steps. The advantage in this case was that there were vocal actors of the civil society who had wished to see more inclusive frameworks, which were in accordance with global suggestions. Nevertheless, as seen by Grothmann and Michel (2021), the mere awareness was not considered enough to translate into operational implementation, which can be deemed as a drawback in the lack of institutionalized pre-disaster measures treatises. This disparity undermined the incorporation of proactive planning within the administration systems. This means that unless operationalized structures were put in place to undertake these advocacy considerations, the issues of disaster risk would only be ideal as opposed to

practical.

It was established by the study that when presented with various road related assets, well-planned road networks and efficient drainage systems were deemed the most effective in curbing disaster risks and green spaces had a minor yet considerable role to play. This was consistent with what Ward *et al*. (2017) realized in Jakarta, i.e., the integrated transport and drainage systems yielded better results in managing disasters. Unlike Patnaik *et al*. (2015), community-informed evacuation planning was not at the forefront of resilience in the present study since there was less prioritization on evacuation paths. Such deviation implied either a lack of awareness or the insufficient supply of such infrastructure. The resiliency of road and drainage systems in hazard mitigation is identified to indicate the resiliency in the preparedness, but lack of sufficient attention to evacuation measures meant that a significant weakness in preparedness was also highlighted that may undermine rapid disaster response.

Proper access to emergency services and issues of roads were also pointed out by the respondents as the significant infrastructure issues faced together with the lack of public spaces. The focus on accessibility or the solution to this problem resonates with Velasquez *et al*. (2018), in which integral planning in Medellin not only served to enhance the mobility within a city, but also disaster preparedness by having cluster-based services. The examples, nevertheless, differed among all others as the supply and loss of open spaces in the current research were in contrast based on the absence of governance and land management in Njoku *et al*. (2020). Whereas the current green infrastructure programs had potentials to resolve flooding and heat stress, their vulnerability to erosion by the pressure of development was a major constraint. The enhancement of protective regulations and the equal provision of access to needed services still was vital in order to gain the engineering and ecological resilience.

Weaknesses in the system were further seen in the form of insufficient light and the eviction of informal businesses in order to improve the infrastructure. As Patnaik *et al*. (2015) showed in Odisha, community input in urban planning enhanced disaster preparedness by establishing cyclone shelters in destined spots and in the aspect of inclusive evacuation plans. The comparison between current results pointed to the fact that the participatory

mechanisms were non-existent or did not work to protect the economic livelihoods under the unfavourable incidents. Although Njoku *et al*. (2020) focused on the opportunities of using technologies, including GIS and IoT, to improve risk-sensitive planning, that tool seemed to be underused in this context, and, therefore, cannot contribute to informal business integration. This consistency with literature relevant to smaller cities (Hossain *et al*., 2017) epitomized a larger shortcoming- resource limitation that inhibits designing policy into design interventions in the form of physical safety at the micro-scale and economic resiliency at the macro-scale.

The findings also indicated that there was gross violation of pedestrian safety thus people had to walk near running traffic causing regular accidents. This partially aligned with Velasquez *et al*. (2018) who demonstrated that safe and risk-based planning might enhance safety of vulnerable users in the situations where communities participate in hazard detection and solution. But, as opposed to the literature, which focused on structural redesign and participatory planning, the study implied that tight enforcement and improved space management had the potential of being equally efficient. The weakness was the fact that the urban structure failed to respond to actual trends of use, whereas its strength was the potential to increase safety via selective governing and policy interventions (World Health Organization, 2022).

The results further revealed that the contraction of green areas in the society minimized ecological values as well as the well-being of the community given that recreational activities and bonding were limited. This was in line with Ward *et al*. (2017), who mentioned that by incorporating the communities into the green infrastructure planning, the authors observed that they were able to increase environmental and social resilience. Construction works in Bungoma led to an expansion of the number of surfaces that do not absorb water which resulted in a greater risk of flooding and the water quality of rivers like the Sio-Malaba was negatively affected. Although in-progress ventures demonstrated the potential to solve several hazards, the success of the venture was diminished by lack of coordination between planning and enforcement agencies therein indicated gaps found in Grothmann and Michel (2021) concerning lack of uniformity in

operationalization of resilience therefore disturbing a similar hazard in the concern of widespread awareness of the importance of implementation.

The results also implied that initiatives funded by donors were more likely to sustain higher resilience thresholds than the ones funded by the community, but this partially resonated with Ward *et al*. (2017) who discovered that community involvement succeeded in promoting project effectiveness provided the adequate number of resources and governance was used. In Bungoma, close involvement in stakeholders fostered good uptake of project, but variances between developments in quality showed the lack of regular use of resilience measures. Although this implied good backbones in comprehensive planning, there was insufficient local finances and technical competencies employed to inhibit long-term sustainability. Filling these gaps might help bridge the disconnection of the ideals of participatory planning and the results of climate-resistant, concrete, changes (World Health Organization, 2022).

Conclusion

The current analysis of the current state of urban design systems in Bungoma shows that it has a diverse combination of advances and failure to attain disaster resilience. The strategic investment evident in reduction of hazards is also captured in development of physical infrastructure like road networks, drainage, green spaces etc. Nevertheless, such advantages are jeopardised by lax implementation, reactive instead of proactive planning and insufficient application of high technologies or early warning systems. There is community participation although it is usually partial due to lack of technical support and coherent operationalisation hence an uneven gain especially on marginalised groups. Informal enterprise, lack of safety to pedestrians and declining green areas demonstrates issues of inclusivity and government. On balance, the frameworks are favoring structural interventions at the expense of forecasting, socially inclusive and institutionally controlled resilience measures.

Recommendations

To improve urban resilience in Bungoma, it is recommended that:

i. The frameworks should aim to expand to include forward-looking, technology-driven, and socially inclusive measures. This involves integrating early warning systems,

GIS mapping, and IoT applications into planning, along with a clear evacuation plan.

ii. Governance capacity should be strengthened by enforcing land-use regulations, establishing multi-stakeholder platforms, and institutionalizing participation that includes marginalized and informal economic agents.

iii. Green spaces should be protected, expanded, and used to control urban sprawl.

iv. Public awareness campaigns should be linked to preparedness procedures to convert knowledge into action. Long-term success depends on consistent funding and capacity building, especially for locally led projects, to ensure equitable resilience outcomes.

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Enhancing Road Construction Project Success through Stakeholder Participation in Monitoring and Evaluation: Insights from Kenya Rural Roads Authority roads Projects in Gatanga Constituency, Murang'a County, Kenya

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Abstract:
The objective of the research was to assess how stakeholder participation in monitoring and evaluation (M&E) influence the success of road construction projects by the Kenya Rural Roads Authority (KeRRA) in Murang'a County, Kenya. The study examined the extent of stakeholder participation in the design of the M&E framework, participation in data collection, and their involvement in using the M&E findings for decision-making in KeRRA road projects within the Gatanga constituency. The study was guided by three key research questions. This study adopted a descriptive research design. The target population comprised approximately 300 stakeholders, including project managers, government officials from KeRRA, contractors, and community representatives. A sample size of 150 respondents was selected using stratified random sampling. Primary data was collected using questionnaires with both closed and open-ended questions, incorporating a Likert scale (1-5) to measure respondents' perceptions. The study ensured voluntary participation, confidentiality, and informed consent to maintain ethical integrity, with necessary approvals from relevant institutional review boards. Data analysis involved both descriptive and inferential statistics. Descriptive analysis included frequencies, means, and standard deviations, while inferential techniques such as Spearman's correlation assessed the strength of relationships between stakeholder participation and M&E effectiveness. The study findings confirm that stakeholder involvement in the design of the monitoring and evaluation (M&E) framework plays a significant role in the success of road construction projects. The results highlighted the critical role of stakeholder participation in data collection for M&E. Projects that involve diverse stakeholder groups in data collection experience high levels of transparency and accuracy in project monitoring. The statistical results confirm that stakeholder participation in utilizing M&E findings significantly contributed to project success, though slightly less than the other variables.

Keywords: Monitoring & Evaluation, Stakeholder Involvement, Data Collection, Results Utilization, Road Construction Projects

1. Introduction

Monitoring and Evaluation (M&E) is a systematic process used to assess project progress, ensure efficiency, and measure the impact of interventions. In road construction, M&E plays a critical role in ensuring projects are completed on time, within budget, and to the required quality standards (Osiemo, Wagude, & Ogombe, 2019). A well-implemented M&E framework provides stakeholders with tools to track project milestones, identify risks, and take corrective action when necessary (Kusek & Rist, 2004). According to the World Bank (2021), M&E enhances transparency, promotes

evidence-based decision-making, and ensures infrastructure investments deliver long-term socio-economic benefits. Without effective M&E, road projects risk delays, budget overruns, substandard construction, and eventual failure (Chepkemoi & Otieno, 2020). Additionally, the absence of stakeholder participation in M&E weakens project ownership, leading to low community engagement and reduced sustainability (Maina, 2020).

The lack of robust M&E mechanisms in road construction projects has been linked to resource mismanagement, accountability failures, and inefficiencies in service delivery (Gaventa & Blauert, 2014). Research in both developed and developing countries highlights the significant role of M&E in improving project performance. Cheung (2010) found that in Asia, road projects with strong M&E frameworks were more likely to be completed within budget and time constraints. Similarly, Stern et al. (2021) observed that process improvements in European road construction projects significantly reduced costs and completion times. However, in many African nations, including Kenya, M&E weaknesses have led to delayed projects, cost escalations, and compromised construction quality (Munyao & Ngugi, 2023). The Kenya Roads Act (2007) mandates KeRRA to conduct M&E for rural road projects, but challenges such as inadequate stakeholder engagement, weak data collection mechanisms, and limited budgetary allocations have hindered effective implementation (Omondi & Kinoti, 2020). Strengthening M&E in road construction is essential to enhancing accountability, improving project efficiency, and ensuring infrastructure longevity (Naidoo, 2011).

Globally, stakeholder involvement in Monitoring and Evaluation (M&E) of infrastructure projects is widely recognized as a key driver of efficiency, transparency, and sustainability. In developed countries, robust M&E frameworks ensure inclusive decision-making, minimize project risks, and enhance infrastructure longevity. For instance, in Germany and the Netherlands, road projects emphasize multi-stakeholder engagement, integrating government agencies, private contractors, independent evaluators, and local communities to provide oversight and accountability (Stern *et al.*, 2021). The United States Federal Highway Administration (FHWA) mandates public participation in highway projects, ensuring stakeholder input is factored into project evaluation to align with societal needs. In Asian countries such as China and Japan, technological advancements have further strengthened participatory M&E frameworks, incorporating real-time data monitoring, automated reporting systems, and structured community engagement platforms (Cheung, 2010). These countries demonstrate that stakeholder participation enhances infrastructure project success, reducing inefficiencies and promoting socially and environmentally sustainable development.

Despite these successes, developing countries struggle with institutional weaknesses, poor coordination, and funding limitations that hinder effective stakeholder engagement in M&E. Many governments acknowledge the need for inclusive monitoring frameworks, but implementation remains inconsistent due to political interference, weak

regulatory enforcement, and lack of technical expertise. In some cases, while stakeholders are consulted in M&E, their input is rarely utilized in decision-making, undermining the effectiveness of project oversight. As a result, many infrastructure projects in developing nations continue to suffer from cost overruns, delays, and poor-quality outcomes. These challenges highlight the importance of designing context-specific participatory M&E models that can be effectively implemented in different governance environments to enhance road construction project performance.

In Africa, M&E implementation in road construction projects remains inconsistent, with many projects facing budget overruns, prolonged delays, and substandard workmanship due to weak stakeholder engagement. Countries like South Africa have made strides in institutionalizing participatory M&E by involving local communities, civil society organizations, and independent oversight bodies to improve project monitoring (Naidoo, 2011). In contrast, in Nigeria, the Federal Roads Maintenance Agency (FERMA) has struggled with inefficiencies in implementing structured stakeholder engagement, often leading to poor accountability and project mismanagement (Karma & Warnakulasuriya, 2016). Studies indicate that African road projects frequently lack effective feedback loops, meaning that even when community members or local organizations provide input, their concerns are not adequately addressed in decision-making. This results in projects that fail to meet local development needs, environmental standards, and quality expectations, limiting the long-term impact of infrastructure investments.

In East Africa, particularly Uganda and Tanzania, M&E practices have been introduced into road construction projects, but stakeholder participation remains limited. Many projects rely on external consultants for evaluation, with little involvement from affected communities and road users (Gaventa & Blauert, 2014). Additionally, weak enforcement of procurement regulations and governance policies has led to contract mismanagement, project delays, and financial inefficiencies. Studies highlight that when stakeholders, particularly local communities and end-users, are actively engaged in project monitoring and feedback mechanisms, infrastructure projects tend to have better sustainability and long-term benefits. However, across Africa, the absence of structured M&E mechanisms and the exclusion of key stakeholders, particularly community members, in project evaluation processes continue to affect the successful implementation of road construction projects.

In Kenya, M&E frameworks for road construction projects are well-documented in legal frameworks such as the Kenya Roads Act (2007) and the Public Procurement and Asset Disposal Act (2015), which assign key agencies like the Kenya Rural Roads Authority (KeRRA), Kenya National Highways Authority (KeNHA), and Kenya Urban Roads Authority (KURA) the responsibility for monitoring and evaluating road infrastructure projects. Despite these legal provisions, stakeholder involvement in the M&E process remains weak, contributing to budget overruns, substandard road quality, and project delays. Studies by Munyao and Ngugi (2023) indicate that

a lack of community participation in project oversight often leads to inadequate quality control and contractor accountability. In Kilifi County, for example, Omondi and Kinoti (2020) found that road projects where local stakeholders were involved in M&E had better completion rates and improved service delivery compared to those where participation was minimal. However, challenges such as limited access to evaluation reports, lack of community engagement forums, and failure to incorporate stakeholder feedback in decision-making persist in many KeRRA projects.

1.1 Statement of the Problem

Monitoring and Evaluation (M&E) play a fundamental role in project planning, implementation, and overall success by providing a structured framework for tracking progress, ensuring accountability, and making informed decisions. An effective M&E system should involve stakeholders at all stages, from the design of evaluation frameworks to data collection, analysis, and utilization of results. This participatory approach enhances transparency, fosters inclusivity, and ensures that the concerns and insights of all relevant parties are integrated into decision-making. The Kenya Roads Act (2002) mandates the Kenya Rural Roads Authority (KeRRA) to implement M&E practices in rural road construction projects. Ideally, proper stakeholder engagement in M&E would ensure that these projects are completed on time, within budget, and to acceptable quality standards, ultimately leading to improved mobility and service delivery. Despite this legal framework, KeRRA projects frequently suffer from inefficiencies attributed to weak M&E structures, insufficient oversight, and limited stakeholder participation. Without proper involvement, critical aspects such as project sustainability, effectiveness, and impact assessment remain inadequately addressed, leading to suboptimal outcomes.

In Murang'a County, specifically in Gatanga Constituency, road projects implemented by KeRRA have faced criticism for poor contractor accountability, delayed timelines, and inadequate stakeholder engagement (Kenao, 2020). While the agency is tasked with ensuring efficient M&E, stakeholder participation remains largely superficial, with community members, local leaders, and road users often excluded from meaningful involvement in project evaluation. Weak feedback mechanisms and lack of structured communication channels between KeRRA and stakeholders contribute to misalignment between project goals and community needs.

In practice, numerous road construction projects across Kenya experience cost overruns, prolonged delays, and substandard quality due to deficiencies in M&E processes. Research indicates that stakeholder involvement in M&E significantly contributes to project success, yet this remains a challenge in many KeRRA-managed rural road projects. For instance, studies in Kilifi County reveal that enhanced stakeholder participation improves project execution and reduces inefficiencies (Omondi & Kinoti, 2020). However, many KeRRA projects in Murang'a County continue to experience setbacks due to weak contractor oversight, lack of accountability, and ineffective resource allocation. Statistical evidence further underscores the severity of the issue—Chepkemoi and Otieno (2020) report

that approximately 68% of road projects across Africa constructed by local firms suffer from cost and time overruns, while Maina (2020) found that of 30 completed road projects in Kenya, only 16 met the expected success criteria. These challenges highlight a broader issue where M&E remains a passive, underutilized tool rather than a dynamic, participatory process. The lack of stakeholder engagement in data collection, performance tracking, and evaluation feedback mechanisms significantly reduces the effectiveness of road infrastructure projects, resulting in repeated inefficiencies, budgetary mismanagement, and poor service delivery to road users.

While existing research provides insights into stakeholder engagement in M&E, many studies focus on urban projects, donor-funded initiatives, or large-scale infrastructure programs, leaving a gap in understanding how M&E functions within rural road projects under KeRRA. For instance, research conducted by Miriti and Karithi (2020) in Dagoretti, Sule (2021) in Kisumu Sub-East Roads, and K'Akumu and Gateri (2023) in Nairobi's mainstream projects primarily examine urban-based projects with distinct funding mechanisms and administrative structures. As a result, these studies fail to capture the unique challenges faced by rural road projects, where local stakeholder involvement is often more fragmented and underdeveloped. This study seeks to bridge this gap by specifically evaluating the extent, nature, and impact of stakeholder participation in M&E of KeRRA road projects in Gatanga Constituency, Murang'a County. In examining the levels of engagement in M&E framework design, data collection, and utilization of evaluation results, the study aims to provide practical recommendations for improving participatory M&E practices, strengthening accountability, and ultimately enhancing the efficiency and sustainability of rural road construction projects in Kenya. The general objective of this research was to evaluate the extent of stakeholder involvement in M&E of road construction projects by the Kenya Rural Roads Authority (KERRA) in Murang'a County, Kenya.

1.2 Research Questions

This research was guided by the following specific questions:

i. How does stakeholder involvement in designing the monitoring and evaluation (M&E) framework influence the success of KeRRA road projects in Gatanga Constituency?

ii. What is the impact of stakeholder participation in data collection on the transparency, accuracy, and oversight of KeRRA road projects in Gatanga Constituency?

iii. How does stakeholder engagement in the utilization of M&E results contribute to decision-making, project adjustments, and the overall success of KeRRA road projects in Gatanga Constituency?

1.3 Theoretical Review

The study of Monitoring and Evaluation (M&E) in road construction projects is anchored in several theoretical frameworks that explain the significance of stakeholder engagement, project performance, and accountability. One such theory is the Stakeholder Theory, developed by Freeman (1984), which emphasizes the role of diverse stakeholders (government agencies, contractors, local communities, and development partners) in shaping project success. This theory posits that stakeholders have varying interests, and their involvement in decision-making, particularly in M&E, enhances transparency, ownership, and overall project sustainability (Donaldson & Preston, 1995). In the context of KeRRA road projects, stakeholder participation in designing, implementing, and utilizing M&E results ensures more inclusive decision-making and reduces resistance to project interventions (Omondi & Kinoti, 2020). When stakeholders feel excluded, project inefficiencies arise, leading to cost overruns, delays, and disputes (Munyao & Ngugi, 2023).

Another relevant framework is the Theory of Change (ToC), which provides a structured approach for understanding how project inputs, activities, and outputs contribute to desired long-term outcomes (Weiss, 1995). ToC underscores the importance of M&E in tracking performance indicators, identifying challenges, and adjusting strategies to enhance project success (Vogel, 2012). In road construction, M&E frameworks guided by ToC ensure that the initial planning, resource allocation, and implementation align with the project's overall goal i.e., providing quality and durable roads within the allocated time and budget (Maina, 2020). Without a well-structured M&E framework, road construction projects risk deviating from their objectives, leading to inefficiencies and eventual project failure (Stern *et al.*, 2021). KeRRA projects, therefore, require robust M&E mechanisms that incorporate stakeholder feedback and data-driven decision-making to improve infrastructure outcomes.

Additionally, the Program Theory and Logical Framework Approach (LFA) further support the role of M&E in infrastructure projects. LFA, developed in the 1970s by the United States Agency for International Development (USAID), provides a structured way of defining project objectives, indicators, and monitoring mechanisms (Kusek & Rist, 2004). The theory asserts that projects must be designed with clear cause-effect relationships, measurable indicators, and stakeholder participation in evaluation processes (Naidoo, 2011). When applied to road construction, the LFA ensures proper alignment of project goals, risk mitigation strategies, and quality assurance (Chepkemoi & Otieno, 2020). However, in Kenya, weak enforcement of M&E policies and limited stakeholder involvement have contributed to inefficiencies in road infrastructure projects (Gaventa & Blauert, 2014). Strengthening the application of these theoretical frameworks in KeRRA projects is critical to improving M&E effectiveness, enhancing accountability, and ensuring infrastructure sustainability.

2.0 Literature Review

A study conducted by Kananura (2017) examined the role of participatory monitoring and evaluation approaches in maternal and newborn health programs in Eastern Uganda. The study

targeted various stakeholders, including health workers, community members, and local leaders, and employed a qualitative methodology using interviews and focus group discussions. The research adopted a cross-sectional design, and data analysis was conducted through thematic content analysis. The findings indicated that involving stakeholders in the design of M&E frameworks led to better decision-making and a sense of ownership over program outcomes. Stakeholders who contributed to the framework's development were more committed to implementing changes based on M&E findings, which improved service delivery and program sustainability.

Similarly, a study by Galgallo and Ngugi (2023) assessed stakeholder involvement in government water supply projects in Garissa County, Kenya. The study targeted project managers and employed a descriptive research design using questionnaires to collect data. A cross-sectional approach was used, and data was analyzed using descriptive and inferential statistics. The findings showed that stakeholder involvement at the initiation and planning stages significantly improved project outcomes. When stakeholders were engaged early in the process, they were more likely to support project execution, reducing delays and resistance to implementation. Another study by Ochieng (2018) focused on the effect of stakeholder participation on the performance of road projects in Kenya. Using a survey research methodology with structured questionnaires, the study employed a descriptive design and applied regression analysis for data interpretation. The findings indicated that stakeholders who were actively involved in M&E design contributed valuable insights that enhanced the effectiveness of road project implementation. The study concluded that early engagement in designing M&E frameworks ensured that monitoring tools were relevant, practical, and aligned with project objectives.

In a study on participatory M&E approaches in Eastern Uganda, Kananura (2017) focused on maternal and newborn healthcare, targeting health program stakeholders, including health workers and community representatives. The study applied a qualitative methodology using focus group discussions and interviews, with a cross-sectional design. Thematic content analysis was used for data interpretation. Findings revealed that stakeholder participation in data collection improved the accuracy of information and increased the credibility of M&E reports. When stakeholders were directly involved in data collection, they were more invested in the outcomes, ensuring that the data gathered was relevant and reliable.

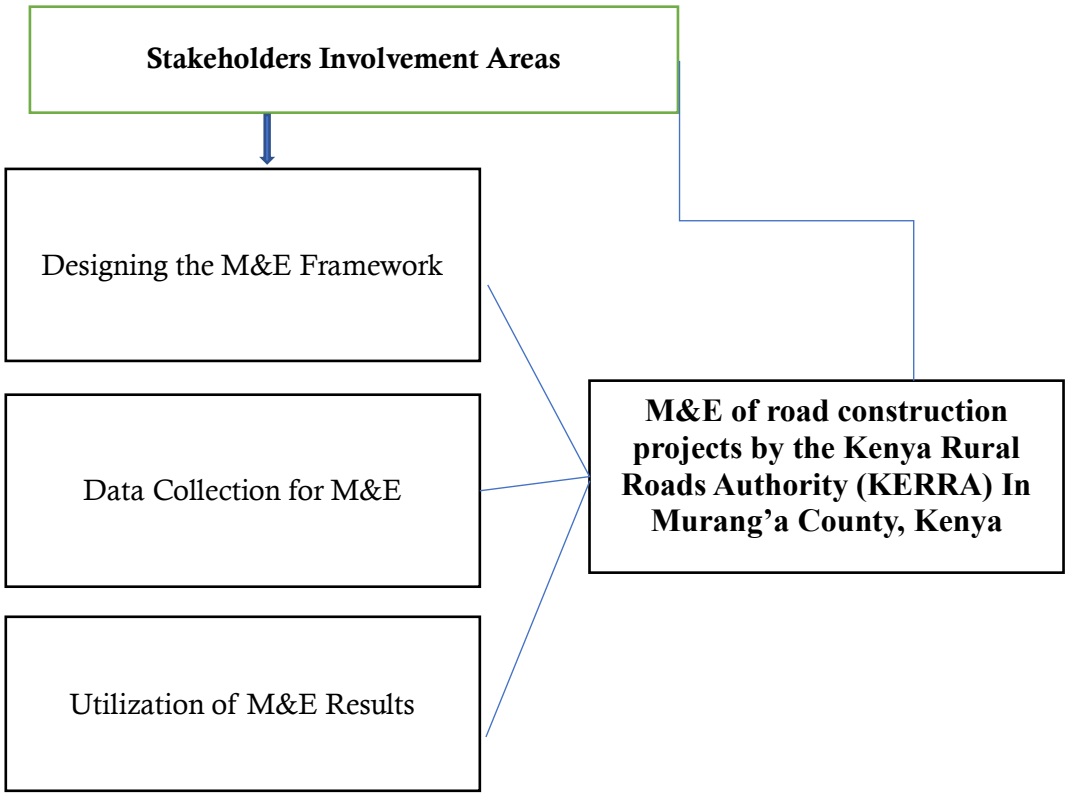
Namayi (2020) conducted a study on healthcare providers' knowledge in Vihiga County, Kenya, and its implications for maternal and newborn care. The study focused on healthcare professionals and used a cross-sectional research design with surveys for data collection. Descriptive statistics were applied to analyze the data. The study found that engaging healthcare workers in M&E data collection enhanced their understanding of patient needs and strengthened healthcare service delivery. The findings suggested that when stakeholders actively participate in gathering data, they are more likely to use the findings to inform decision-making and improve program

implementation. Additionally, a study by Maskrey (2016) in the United Kingdom examined stakeholder involvement in flood risk management. The research targeted local stakeholders and used participatory modeling workshops as a methodology within a case study design. The qualitative analysis of workshop discussions revealed that involving stakeholders in data collection allowed for the development of more context-specific and acceptable flood management strategies. The study highlighted that stakeholder engagement in data collection ensures that the information gathered is not only accurate but also aligned with the needs and priorities of the affected communities.

Kananura (2017) also examined how stakeholders utilized M&E findings in maternal and newborn health programs in Eastern Uganda. The study applied qualitative methods, using interviews and focus group discussions with health program stakeholders. The cross-sectional study utilized thematic content analysis to interpret the findings. The study concluded that when stakeholders were actively involved in interpreting and utilizing M&E results, they were more likely to implement necessary program adjustments. This led to better maternal and newborn health outcomes, as stakeholders were committed to using the insights gained from M&E to refine their service delivery strategies.

A study by Mulwa (2019) examined stakeholder involvement in M&E utilization in community-based projects in Machakos County, Kenya. The study targeted project managers and community representatives, applying a descriptive survey research design and using questionnaires for data collection. Data was analyzed using inferential statistics. The findings indicated that stakeholders who participated in discussions about M&E results were more likely to take ownership of project outcomes. The study emphasized that stakeholder engagement in utilizing M&E results enhances accountability and fosters a culture of continuous improvement. Similarly, a study by Adebayo (2021) investigated how stakeholder engagement influenced the use of M&E results in education projects in Nigeria. The study targeted education sector policymakers and school administrators and employed a mixed-methods approach, combining surveys and interviews within a longitudinal research design. Data was analyzed using both qualitative thematic analysis and quantitative regression techniques. The findings revealed that when stakeholders actively participated in reviewing and applying M&E results, educational programs were more adaptive and effective in meeting learning objectives. The study concluded that meaningful stakeholder involvement in M&E result utilization strengthens project sustainability and increases the likelihood of achieving long-term success.

2.1 Conceptual Framework



3.0 Research Methodology

This study adopted a descriptive research design to examine the impact of stakeholder participation in monitoring and evaluation (M&E) on the effectiveness of road construction projects in Kenya. The target population comprised approximately 300 stakeholders, including project managers, government officials from KeRRA, contractors, and community representatives. Using stratified random sampling, a sample size of 150 respondents was selected to ensure diverse stakeholder representation. Primary data was collected using structured questionnaires with both closed and open-ended questions, incorporating a Likert scale (1-5) to measure respondents' perceptions. Secondary data was obtained from policy documents, published reports, and past studies on M&E in infrastructure projects. To maintain ethical integrity, the study ensured voluntary participation, confidentiality, and informed consent, with necessary approvals from relevant institutional review boards. Data analysis involved both descriptive and inferential statistics. Descriptive analysis included frequencies, means, and standard deviations, while inferential techniques such as Spearman's correlation assessed the strength of relationships between stakeholder participation and M&E effectiveness. A multiple regression model was applied to determine the predictive influence of stakeholder involvement, with the equation: $Y=\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\varepsilon$. Y represents M&E effectiveness and X_1, X_2, X_3 denoted stakeholder participation in designing M&E frameworks, data collection, and utilization of results, respectively. The Analysis of Variance

(ANOVA) tested model significance, and the coefficient of determination (R^2) assessed the extent to which independent variables explained variations in M&E effectiveness. These statistical tools provided insights into how stakeholder involvement enhances decision-making and project sustainability.

4.0 Findings

The results in Table 1 are for stakeholder involvement in designing the M&E framework. They indicate that a significant proportion of stakeholders recognize the importance of their involvement in designing the M&E framework. 70% (40% Agree, 30% Strongly Agree) believe early stakeholder engagement enhances project success, emphasizing that projects with well-structured stakeholder input in M&E are more likely to meet objectives.

Additionally, 77% (45% Agree, 32% Strongly Agree) affirm that stakeholder participation improves the relevance of M&E tools, showing a strong preference for inclusive frameworks. On the other hand, the 40% who strongly agree and 38% who agree that lack of participation leads to inefficiencies indicate that when stakeholders are not engaged from the onset, projects may suffer setbacks.

Table 1: Stakeholder Involvement in Designing the M&E Framework

Statement	**SD (%)**	**D (%)**	**N (%)**	**A (%)**	**SA (%)**
Early involvement of stakeholders in M&E framework design improves project success.	5	10	15	40	30
Stakeholders provide valuable input that enhances the relevance of M&E tools.	3	8	12	45	32
Lack of stakeholder participation in designing M&E leads to project inefficiencies.	4	9	18	38	31
Engaging stakeholders in M&E framework design increases ownership of project outcomes.	2	7	14	50	27
Stakeholder-driven M&E frameworks are more adaptable to project changes.	6	11	17	42	24

Similarly, 77% (50% Agree, 27% Strongly Agree) agree that stakeholder involvement increases project ownership, leading to smoother implementation. The findings further highlight that 66% (42% Agree, 24% Strongly Agree) believe M&E frameworks designed by stakeholders adapt better to project changes, demonstrating that participation enhances flexibility and responsiveness. These findings align with previous research, which emphasizes that

stakeholder-driven frameworks lead to improved decision-making, accountability, and sustainability in M&E practices. The data suggests that organizations like KeRRA should actively engage stakeholders in designing M&E processes to optimize project effectiveness.

Table *2* shows the findings for stakeholder participation in data collection for M&E. The findings indicate that 71% (42% Agree, 29% Strongly Agree) of respondents believe stakeholder involvement enhances data accuracy and credibility, reinforcing the idea that participatory data collection improves the reliability of M&E.

Table 3: Stakeholder Participation in Data Collection for M&E

Statement	SD (%)	D (%)	N (%)	A (%)	SA (%)
Stakeholder participation in data collection improves data accuracy and credibility.	4	9	16	42	29
Training stakeholders in data collection enhances the quality of M&E reports.	3	8	14	47	28
Projects with active stakeholder involvement in data collection are more sustainable.	5	12	18	38	27
Excluding stakeholders from data collection reduces M&E effectiveness.	6	10	20	35	29
Involvement in data collection enhances stakeholder commitment to project success.	4	7	13	50	26

Additionally, 75% (47% Agree, 28% Strongly Agree) agree that training stakeholders in data collection enhances report quality, demonstrating the need for capacity-building initiatives. A notable 65% (38% Agree, 27% Strongly Agree) believe projects with active stakeholder participation are more sustainable. Conversely, 64% (35% Agree, 29% Strongly Agree) argue that excluding stakeholders weakens M&E effectiveness, highlighting the risks of centralized data collection. Furthermore, 76% (50% Agree, 26% Strongly Agree) affirm that involvement in data collection fosters commitment to project success. The results suggest that data accuracy, sustainability, and project effectiveness depend on an inclusive data collection process. The findings further reinforce the idea that participatory M&E builds trust and transparency, as stakeholders are more likely to support projects when they are directly involved in gathering and

validating information.

Table *4* contains findings on stakeholder participation in the utilization of M&E. Th information illustrates that 78% (48% Agree, 30% Strongly Agree) of stakeholders believe their participation in M&E result utilization enhances decision-making, indicating that involving stakeholders in interpreting results leads to informed project adjustments.

Table 5: Stakeholder Participation in the Utilization of M&E Results

Statement	SD (%)	D (%)	N (%)	A (%)	SA (%)
Stakeholder participation in using M&E results leads to better decision-making.	3	7	12	48	30
Regular review of M&E results by stakeholders improves project adjustments.	4	8	15	44	29
Stakeholders' involvement in M&E utilization enhances accountability.	5	9	17	40	29
Ignoring stakeholder input in M&E result interpretation affects project success.	6	11	19	38	26
Active use of M&E results by stakeholders leads to project sustainability.	3	6	14	49	28

Similarly, 73% (44% Agree, 29% Strongly Agree) believe that regular stakeholder review of M&E results leads to improved project modifications. The data further shows that 69% (40% Agree, 29% Strongly Agree) of respondent's view stakeholder participation as enhancing accountability. Additionally, 64% (38% Agree, 26% Strongly Agree) note that disregarding stakeholder input in M&E result interpretation negatively impacts project success. Lastly, 77% (49% Agree, 28% Strongly Agree) agree that active use of M&E results by stakeholders enhances sustainability. The findings suggest that M&E results are more impactful when stakeholders actively participate in their interpretation and application. This supports previous research emphasizing that participatory evaluation fosters ownership, improves project implementation, and leads to better outcomes.

4.2 Influence of Participation in M&E on Success of Road Construction Project

Table 4 contains the findings for the influence of stakeholder participation in M&E processes on road construction project success The inferential statistics provide strong evidence that stakeholder participation in M&E processes significantly influences road

construction project success. The model summary shows a high explanatory power (R^2 = 62.7%). The regression analysis confirms that all three independent variables significantly contribute to project success. Spearman's correlation further validates these relationships, with M&E design showing the strongest association. Finally, the ANOVA results indicate that the overall model is statistically significant, reinforcing the importance of stakeholder engagement in M&E.

Table 6: Model Summary

Model	*R*	*R*-Square	Adjusted *R* Square	Std. Error of the Estimate
1	0.792	0.627	0.615	3.214

The model summary indicates a strong relationship between stakeholder participation in M&E and project success, as shown by $R = 0.792$. The *R*-Square value of 0.627 suggests that 62.7% of the variation in project success is explained by the independent variables, meaning stakeholder participation in M&E plays a crucial role in determining project outcomes. The Adjusted *R*-Square (0.615) corrects for any overestimation due to sample size and still shows a strong model fit. The Standard Error of the Estimate (3.214) represents the average deviation of observed values from the predicted values, indicating a relatively good fit.

Table 7: Relationship between Participation in M&E and Project Success

Variable	Unstandardized Coefficients (B)	Std. Error	Standardized Coefficients (Beta)	*t*	(*p*-value)
(Constant)	1.256	0.712	-	1.764	0.079
Stakeholder Involvement in M&E Design	0.482	0.093	0.501	5.182	0.000
Stakeholder Participation in Data Collection	0.391	0.087	0.412	4.495	0.001
Stakeholder Utilization of M&E Results	0.278	0.072	0.301	3.861	0.002

*Dependent variable is Project Success.

The linear regression analysis reveals that all three independent variables significantly influence project success.

Stakeholder involvement in M&E design (β = 0.501, p = 0.000) has the strongest effect, showing that involving stakeholders in designing the M&E framework enhances project outcomes. Participation in data collection (β = 0.412, p = 0.001) also has a substantial impact, highlighting the importance of accurate and inclusive data gathering. Utilization of M&E results (β = 0.301, p = 0.002), though slightly lower, still plays a critical role in ensuring project success. Since all p-values are below 0.05, the relationships are statistically significant, confirming that stakeholder engagement in M&E is crucial for road construction projects.

Table 8: Spearman's Correlation Analysis

Variables	M&E Design	Data Collection	Utilization of M&E Results	Project Success
M&E Design	1.000	0.692**	0.587**	0.721**
Data Collection	0.692**	1.000	0.645**	0.703**
Utilization of M&E Results	0.587**	0.645**	1.000	0.679**
Project Success	0.721**	0.703**	0.679**	1.000

Spearman's correlation analysis shows strong positive relationships between all variables. M&E design and project success (0.721) have the strongest correlation, confirming that effective planning in M&E significantly enhances project outcomes. Data collection and project success (0.703) also show a strong correlation, reinforcing the idea that well-managed data collection improves decision-making. The correlation between utilization of M&E results and project success (0.679), though slightly lower, remains significant, indicating that applying M&E findings positively impacts project success. Since all correlations are significant at $p < 0.01$, the relationships are statistically meaningful.

Table 9: Analysis of Variance

Model	Sum of Squares	*df*	Mean Square	*F*	Sig. (*p*-value)
Regression	258.721	3	86.240	21.307	0.000
Residual	154.382	76	2.031	-	-
Total	413.103	79	-	-	-

The ANOVA results confirm the overall significance of the model (F=21.307; p=0.000). Since $p < 0.05$, stakeholder involvement in M&E has a meaningful effect on project success. The large sum of squares for the regression (258.721) compared to the residual (154.382) suggests that the independent variables explain a substantial proportion of the variability in project outcomes. This supports the conclusion that engaging

stakeholders in M&E processes enhances road construction project performance.

5.0 Discussion

The findings from this study align with previous research on stakeholder involvement in Monitoring and Evaluation (M&E) within road construction projects. The strong agreement regarding stakeholder participation in designing M&E frameworks, data collection, and result utilization indicates a broad consensus on the importance of inclusivity in M&E processes. These findings are consistent with prior studies that emphasize participatory M&E as a critical factor in project success.

The study found that stakeholder involvement in M&E design enhances project relevance, aligning with research by Mwangi (2017) in Kenya, who established that projects with stakeholder-driven M&E frameworks achieved higher efficiency and adaptability. His study, conducted in the road construction sector using a descriptive survey design, found that projects with inclusive frameworks had fewer delays due to better stakeholder engagement. The study supports our findings that stakeholder input leads to improved decision-making and ownership.

Similarly, a study by Ofori (2018) in Ghana on public infrastructure projects found that stakeholder-led M&E design contributed to fewer project revisions than projects without stakeholder input. This aligns with our results, which indicate that stakeholder-designed M&E frameworks are more adaptable. However, unlike our study, Ofori (2018) found that some stakeholders lacked technical expertise in M&E, limiting their contribution, an issue that our study did not explicitly explore.

Conversely, research by Njoroge (2019) in Tanzania reported that stakeholder involvement did not always guarantee better M&E effectiveness, as political influences sometimes skewed participation. This slightly contradicts our findings, where stakeholder participation was overwhelmingly seen as beneficial, suggesting that the effectiveness of participation may depend on governance structures and transparency mechanisms.

The results indicate that stakeholder participation in data collection enhances project success and accuracy, consistent with a study by Kimani (2020) in Kenya, which found that community-driven M&E data collection improved project sustainability. His study, using a mixed-method approach, revealed that stakeholders were more committed to projects when they actively contributed to M&E processes. This strongly supports our findings that involvement in data collection enhances ownership and credibility.

Similarly, a study by Mensah (2016) in South Africa found that when stakeholders were trained in data collection, the accuracy of reporting increased. His study, using a case study design, highlights the importance of capacity building, which our findings also emphasize, as stakeholder training improves data collection outcomes. This confirms that data quality improves when stakeholders are adequately equipped with skills.

However, a study by Adebayo (2019) in Nigeria found that stakeholder-led data collection sometimes led to biases in reporting, particularly when financial incentives were involved. Unlike our study, which found overwhelmingly positive perceptions of stakeholder participation, Adebayo (2019) warns that unless transparency measures are enforced, data quality might be compromised. This suggests that while stakeholder involvement is beneficial, ethical considerations in data collection must be addressed.

The study established that stakeholder participation in using M&E results enhances decision-making, which is in agreement with findings from Okello (2018) in Uganda. His study on road projects found that projects where stakeholders engaged in result interpretation had a higher chance of sustainability. This supports our conclusion that active stakeholder participation improves long-term project success. Similarly, research by Mugisha (2021) in Rwanda found that stakeholder engagement in M&E result utilization led to improved accountability and transparency. His study, based on a quantitative survey of 120 infrastructure projects, found that projects with participatory evaluation frameworks experienced fewer financial mismanagement issues. This aligns with our findings, where stakeholder engagement in M&E results enhanced accountability.

However, Kibet (2022) in Kenya found that while stakeholder participation in M&E result utilization improved decision-making, bureaucratic challenges often delayed the implementation of findings. This contrasts with our findings, which suggest that stakeholder engagement is mostly positive. The discrepancy may arise from differences in project management structures, where delays might occur due to government processes rather than stakeholder inefficiency.

Overall, the study's findings strongly align with existing literature that emphasizes the importance of stakeholder participation in M&E processes. The agreement in our study demonstrates broad support for participatory M&E. While some studies highlight potential limitations, such as bias in data collection or bureaucratic delays in utilizing M&E results, the consensus remains that inclusive M&E frameworks improve project effectiveness, sustainability, and accountability. Future research should focus on mitigating the challenges associated with participatory M&E, such as addressing biases and ensuring structured stakeholder involvement to maximize project success.

6.0 Conclusion

The findings from the research established that stakeholder participation in M&E design enhances the chances of success for road construction projects. Evaluating project success is directly associated with high efficiency, reasonable cost control, and timely project completion. Road construction projects where stakeholders have a hands-on say in defining criteria, indicators, and other elements of evaluation and objectives will have a high probability of performing well. Part of the positive relationship with project success is clear evidence that whether it involves regression analysis, stakeholder involvement in M&E design had the best prediction of accountability and ownership and was an effective end product of the project. Moreover, the significance of stakeholder involvement in data collection for M&E is highlighted in the study. So much transparency and accuracy are availed for monitoring a project where the now varied groups of stakeholders, particularly contractors and community stakeholder stakeholders, collection process. These findings indicate the concrete nature of such relationships between stakeholder engagement in data collection and project success, whereby it is projected that data collection involving those different stakeholders creates stricter oversight of projects. Should projects maintain stakeholder participation in the reporting and verification processes, that process can provide an essential safeguarding mechanism that reduces mistakes and conflicts and promotes better-

informed decisions. The study outlines the importance of M&E findings in decision-making. Due to M&E, some data become available for use; however, the relevance of such data rests in how readily they get applied to adaptations in projects, policy, or strategic planning. Statistical results show that stakeholder participation in using M&E results plays a critical role and significantly contributes to project success, albeit slightly less than the others. Utilizing these evaluation findings to make an actual improvement means M&E will improve lessons and plans learned from past projects to enhance some belief-based sustainability and project efficiency in road construction at a later date.

Overall, over 60% of project success was primarily influenced by stakeholder engagement in MM & from the models of regression and ANOVA. This underlines the numerous previous studies that thoroughly emphasized the role of stakeholder engagement in infrastructure development. There is no doubt that road construction projects are expected to experience inefficiency, cost overruns, and lack of quality without an organized participative M&E mechanism. Therefore, the success of road construction projects in Kenya mainly depends upon embedding strong M&E frameworks within the spirit of the active involvement of stakeholders.

6.1 Recommendations

The following recommendations are based on the findings of the study:

1. To enhance the effectiveness of monitoring and evaluation (M&E) in road construction projects, it is crucial for the Kenya Rural Roads Authority (KeRRA) to institutionalize stakeholder engagement in the design phase of M&E frameworks. This can be achieved by establishing formal consultation forums where key stakeholders, including local communities, government agencies, contractors, and project beneficiaries, actively contribute to defining project indicators, evaluation criteria, and monitoring strategies. By ensuring early involvement, project implementers can increase transparency, accountability, and stakeholder ownership, leading to improved project outcomes.
2. Stakeholder participation in data collection should be strengthened through capacity-building initiatives. KeRRA and other relevant agencies should invest in training stakeholders on effective data-gathering techniques, ethical considerations, and reporting standards. Enhancing the technical capacity of stakeholders will ensure that data collected is accurate, reliable, and comprehensive. Additionally, leveraging digital tools such as mobile data collection apps and Geographic Information Systems (GIS) can improve efficiency and accessibility in monitoring project progress, allowing real-time reporting and evidence-based decision-making.
3. To ensure that M&E findings translate into meaningful project improvements, there should be structured mechanisms for utilizing evaluation results in decision-making. KeRRA should develop clear policies that mandate the integration of M&E insights into project planning, budget allocation, and implementation adjustments. Regular stakeholder meetings should be held to discuss findings, address challenges, and implement

corrective actions based on the data collected. By institutionalizing feedback loops, road construction projects can become more adaptive and responsive to emerging issues, enhancing overall project success.

4. The government should allocate adequate resources for M&E activities, recognizing them as essential components of project management rather than peripheral functions. Increased funding should be directed toward hiring skilled M&E professionals, acquiring advanced monitoring technologies, and conducting independent evaluations to validate project outcomes. Policymakers should also review existing M&E regulations to ensure they align with international best practices and address gaps that hinder effective stakeholder participation. Strengthening regulatory frameworks will promote adherence to M&E guidelines and improve accountability in road construction projects.
5. Collaboration between KeRRA, academic institutions, and research organizations should be encouraged to enhance knowledge-sharing and innovation in M&E practices. Universities and technical institutions can provide expertise in developing robust evaluation methodologies and training programs tailored to road infrastructure projects. By fostering partnerships with research institutions, KeRRA can integrate scientific approaches into M&E, ensuring that monitoring frameworks are evidence-based and continuously improved to meet industry standards.

6.2 Implications to Policy

The findings of this study provide four important policy implications for the management of road construction projects in Kenya.

1. The government, through the Ministry of Roads and Transport, should formulate a policy framework that institutionalizes stakeholder participation in the Monitoring and Evaluation (M&E) of road projects. A legally binding framework would ensure that all KeRRA projects incorporate stakeholders in designing M&E frameworks, data collection, and the utilization of findings. This would improve accountability, efficiency, and sustainability in project implementation.
2. Policies should be introduced to enhance transparency and the use of technology in M&E. The government should mandate the adoption of digital data collection tools such as Geographic Information Systems (GIS), real-time dashboards, and mobile-based reporting applications to ensure accurate tracking of project progress. Additionally, policies should require public accessibility of M&E reports to foster accountability and evidence-based decision-making.
3. There is need for budgetary provisions for M&E activities. The government should recognize M&E as an integral part of infrastructure development and ensure that each road construction project has a dedicated budget for M&E processes. A policy enforcing financial allocation to M&E would enable effective stakeholder engagement, capacity building, and

independent assessments that enhance project quality.

4. A policy should be enacted to establish an independent regulatory body for evaluating the implementation of M&E frameworks in road construction projects. This body would oversee the compliance of road agencies such as KeRRA with M&E guidelines, ensuring that stakeholder feedback is actively integrated into decision-making processes and project modifications.

6.3 Implications to Practice

From a practical perspective, this study underscores the necessity of integrating structured stakeholder engagement in all phases of M&E. Project managers should establish stakeholder consultative forums where community members, local leaders, and government representatives can contribute to M&E framework design. This would ensure that projects align with the actual needs of beneficiaries and reduce resistance from communities affected by road construction.

Moreover, project implementers should adopt innovative and technology-driven data collection methods. The use of digital monitoring systems, drone surveillance for project tracking, and mobile-based data reporting applications would improve efficiency in M&E processes. Training programs should also be conducted to enhance stakeholders' capacity in using modern M&E tools for data collection and analysis.

Another key implication is the need to strengthen feedback mechanisms. Road construction projects should institutionalize clear communication channels for disseminating M&E findings to stakeholders. This could be achieved through public forums, project websites, or social media platforms that provide real-time updates on project progress. By ensuring that feedback loops are functional, project teams can make informed adjustments that align with stakeholder expectations.

Finally, there is a need for capacity-building initiatives targeting M&E personnel and stakeholders. KeRRA and other road agencies should invest in regular training sessions to enhance the technical skills of M&E teams. Additionally, partnerships with academic institutions and research organizations should be encouraged to promote knowledge-sharing and the adoption of best practices in M&E. By fostering a culture of continuous learning and improvement, road projects can achieve greater efficiency, cost-effectiveness, and long-term sustainability.

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Adoption of Modern Agricultural Technologies in Crop Production and Animal Husbandry by Women in Luanda and Emuhaya Sub-Counties, Kenya

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Abstract

The potential role of modern agricultural technologies (MATs) has been taken up globally in pursuit of alleviating threats challenging food security. However, in Sub-Saharan Africa, yield levels and adoption of MATs remain low globally. Women farmers produce more than 50% of the food grown worldwide, provide 65% of labour in food production in Africa yet their adoption of MATs is low. This study investigates the extent at which women have adopted MATs to establish the operations that are important to them. 384 women were selected using stratified random sampling. Qualitative and quantitative data was obtained from key informants, questionnaires, interviews, focus group discussions, agricultural reports and statistical abstracts. Data analysis was done using frequencies and percentages. This study established that 98.4% of the women had adopted various MATs. 36.7% of the women were full adopters while the rest 64.3% comprised partial and non-adopters. Concerted efforts should be put in place to empower women with resources to acquire MATs suitable to their needs.

Key words: Agriculture, Food Security, Modern Agricultural Technologies, Women

Background

Over the last century, agriculture has transformed from the ancient practices to advanced technologies which have significantly increased production of food. The Green Revolution which intensely boosted yields of cereals through application of fertilizers and improved seeds transformed agriculture in Europe and South East Asia (Muzari *et al.* 2012 & Ogada *et al*. 2014). Though there is an increasing trend of cereal yields in most Sub-Saharan Africa countries, these levels remain low compared to other regions of the world (Chauvin, *et al*., 2012). Besides, the fast-growing population characterized by a decline in land holding sizes together with continuous expansion of cultivated land are untenable due to inadequate arable land and land use competition (FAO). Adoption of MATS therefore play an important role in global food security. According to FAO, world agriculture is able to meet global demands for food as a result of substantial agricultural productivity growth that continually relies on technologies that increase productivity. In sub-Saharan Africa (SSA) more than 70% of the labour force in Africa makes a living from agriculture. Nonetheless, women's labour is increasingly becoming significant in agricultural production. They constitute 44% labour force globally (FAO, 1994). According to FAO, (2010), women in SSA provide 65% of labour for food production. Despite their dominance in agriculture, women continue to adopt MATs and management systems at low rates (Doss et al, 2001).

Kenya has been ranked as one of the countries with the largest number of people living in extreme poverty (Adonijah, 2018). The 14.7 million people consume less than sh. 197per day. This drags behind the drive to achieve the United Nations Sustainable Development Goals (SDGs). Besides some achievements in adoption of fertilizer and improved maize varieties, adoption levels are still low and varying across regions (Ogada, 2013). In Kenya, adoption of improved farm technologies such as fertilizer, hybrid seed and concentrate feeds remain low among farmers (Republic of Kenya 2007). Kenyan farmers used fertilizers at 35kg/ha far below the world average at 94kg/ha (Republic of Kenya, 2012). In Emuhaya and Luanda sub-counties, low

adoption of MATs is one of the contributing factors for the low agricultural productivity. According to (Republic of Kenya, 2008) the continuous tilling of the land without application of new agricultural practices in Emuhaya and Luanda sub-counties led to drastic decline in food production. For instance, the average maize production is 4 bags per acre compared to its potential of 15 bags per acre (Republic of Kenya, 2013).

Statement of the Problem

Adoption of MATs is important in enhancing agricultural productivity and food security. Women are the majority key players in provision of labour. However, adoption of MATs is low in Kenya and the impact of MATs is yet to be felt among women farmers in spite the fact that they have been generated through research and disseminated through the media and government extension services to highlight on their availability and benefits in crop farming and animal husbandry. This has lowered agricultural productivity and pose a threat to food security since almost all food stuffs are imported. Hence Emuhaya and Luanda sub-counties are a perfect example of why the Kenyan government will not achieve the Big Four Agenda especially the pillar for food security. Application of MATs will therefore help increase production to meet their food demands and earn income to alleviate poverty.

Women make decisions in adoption and are known to devote more time and labour in agricultural activities. Besides, they have detailed, complex knowledge of the growing practices in agriculture of which they are in charge. Hence understanding MATs adopted by women in both crop farming and animal husbandry is important. Many studies highlight activities carried out by women but have not documented MATs adopted. Other studies have looked at adoption of MATs in crop farming and animal husbandry separately, hence it's difficult to comprehend the crop and livestock activities which integrate more intensively to strike a balance and also ensure sustainability. This study therefore examines MATs adopted in crop farming and animal husbandry.

Methodology

Emuhaya and Luanda sub-counties are in Vihiga County. They are situated on longitude 34°35' E and latitude 0° 4' N. They cover a total area of 173.2 sq kms.

The main market town is Luanda, located on Kisumu-Busia highway about 3km from Maseno (Republic of Kenya, 2009). They receive reliable rainfall that ranges from 1500mm to 2000mm and is bimodal in distribution. The temperature varies between 14º and 32º degrees (Republic of Kenya, 2008). This area has a population of 185,069 (Kenya National Population Census (KNPC), (2009) and an average population density of 1,067 persons per sq.km. The population growth is 3% per annum. About 57.6% of the population live in absolute poverty line which is set at Kshs 2,648 and Kshs1,238 per month for urban and rural areas respectively (GOK, 2004). The "Abanyole" are peasant farmers and 90% of them depend on agriculture for their livelihood. Emuhaya and Luanda sub-counties have 164 sq. km arable land. The average farm size is about 0.5 hectares which is basically used for subsistence farming with a high bias in maize farming. The main food crops grown are maize, beans, bananas, and to a lesser extent sweet potatoes, cassava, sorghum, millet, groundnuts, soya beans, local vegetables and tea. Most households own local zebu cattle (average 1-2 per household) and a few households keep grade cattle. A few farmers practice fish farming, bee keeping and commercial poultry keeping. The target population was women aged 15 and above because they play a significant role in socio economic development. The statistics drawn from the projection at the Sub-Counties statistics office (2008) indicate that the population of women from the age of 15 years and above is 61,420. The adequate sample size of 384 was obtained using the (Fisher *et al.,* 1983) formula, out of which 256 and 128 women were sampled proportionately for crop farming and animal husbandry practices respectively. Purposive sampling was used to select the informants who included sub chiefs, extension officers and focus groups. A pre-tested structured questionnaire was used to obtain important information about the MATs adopted by women. Interviews were carried out to obtain information from key informants who included 4 agricultural extension officers and 8 assistant chiefs serving in the district. Focus group discussions (FDGs) were undertaken with women to give opinion on adoption of MATs. Secondary data

was sourced from text books, paper presentations, statistical abstracts, the government and districts agricultural reports, district development plans, newspapers and journals from the internet. The quantitative data was used to analyze frequency counts and percentages to establish MATs adopted by women.

Findings and Discussion

Socio-economic and demographic information

The socio-economic and demographic information examined in this study were age, education level, marital status, source of livelihood, involvement in decision making, size of the farm and ownership of land.

Age. The study established that 34.6% of the women were between 45-59 years of age followed by 33.6% between 30-44 years, third 23.4% of age bracket 60 years and above, while 8.3% were between 15-29 years.

Education. The majority, 51.8% had acquired at least primary education, 28.6% secondary education and 13.8% tertiary education while a few 5.7% had not acquired formal education. A majority of the women possess literacy and numeracy skills that are important in interpretation of MATs. Quisumbing (1993) found that an increase in the number of women completing primary school led to an increase in early adoption of new technology. A few women who have attained higher education seek off farm permanent employment. They can significantly impact on adoption of MATs because income earned will enable them to invest in farm inputs (Malenya *et al.*, 2003). They are therefore capable of adopting better management practices.

Marital status. According to the marital status 69.5% were married, 23.7% widowed, 5.7% single and 1.0% was divorced. Married women are expected to pick up most MATs because of easy access to resources. This is because men control productive resources such as land, labour and capital which are important in adoption of new technologies (Akudugu *et al.*, 2012).

Decision-making. Results show that 95.5% of the married women were involved in making decisions on adoption of innovations while 4.5% were not. A majority of the married women are involved in making decisions on adoption of MATs. This is

important in adoption because they play a dominant role in implementation of MATs.

Main source of livelihood. Most women 71.1% depend on food crop farming as the main source of livelihood, 14.1% on off farm casual employment, 12.8% on livestock farming and a few; 1.3 % and 0.8% depends on off farm permanent employment and other sources like petty trade respectively. This means that women will strive to adopt relevant MATs in crop farming to improve production and for fear of losing their livelihood strategy.

Size of land. Results show that 69% of the women farm on land size between 0-1ha followed by 21.1% who had land size between 1-2ha. A few women 6.5% and 3.4% occupied land size between 2-3ha and more than 3ha respectively. This implies that most women operate on small sizes of land linked to the continuous cultivation of crops because of increasing land fragmentation (Republic of Kenya, 2009). This limits the ability of the women to effectively manage the land in terms of adoption of innovations like mechanised farming which are economical on large expanses of land so as to meet the demand for food production (Eze *et al.*, 2011).

Land ownership. This study found that 99.7% of the lands used by women were privately owned and only 0.3% is leased. Security of tenure empowers them to adopt MATs with ease associated with greater land improvements. This confirms with (Ogada *et al.*, 2014), who reported that application of fertilizer and improved maize varieties were highest on farms with title deeds than their counterparts with insecure land tenure.

Awareness of MATs among Women. All the respondents 100% were aware of MATs recommended for farm practice. This means that MATs are available and being implemented.

Period of Adoption. The results indicate that the majority 47.1% women had implemented MATs between 5-10 years, 32% who had practiced MATs for less than 5 years and 20.8% above 10 years. A majority of the women have adopted MATs for the period less than 5years. They lag behind the other women in adoption of MATs. Rogers (2003), classifies them as laggards. For those whose period of adoption of MATs is between 6-10 years (Rogers, 2003) identifies them as early adopters. These are potential adopters who relies on

innovators for advice and information about the innovation. Bandiera and Rasul (2006) looked at social networks and technology adoption in Northern Mozambique and found that the probability of adoption is higher amongst farmers who reported discussing agriculture with others. A few women had applied MATs for 10 years and above. These are the pace setters of adoption in their communities. According to Rogers (2003) they play a very important role in diffusion process. According to (Ani *et al.*, 2004) the experience of farmers largely affects their management and decision making. However, there is the other group of women who have not adopted MATs at all. They seem to be focused on traditional methods of farming either because of the low status in the society, financially low, oldest among the adopters and in contact with only a few members in the social setting (Rogers, 2003)

Modern Agricultural Technologies Adopted in Crop Farming

The results in Table 1 show that 98.8% respondents practiced intercropping, 94.9% used fertilizer, 68.8% used certified seeds, 40.2% practiced plant spacing and population, and 25.4% applied other agro-chemicals like herbicides and pesticides. Furthermore, 5.1% practiced agro forestry, 2% irrigation, 1.2% tissue culture bananas and 0.4% for mechanized farming and green house farming respectively. Also, 22% of the women adopted other technologies like crop rotation, push and pull, Integrated Soil Fertility Management (ISFM), horticulture and soil liming.

Table 1: Modern Agricultural Technologies Adopted in Crop Farming.

No.	List of technologies in crop farming	Adopted *f*(%)	Not adopted *f*(%)
1	Intercropping	253 (98.8)	3 (1.2)
2	Fertilizer	243 (94.9)	13 (5.1)
3	Certified seeds	176 (68.8)	80 (31.3)
4	Plant spacing	103 (40.2)	153 (59.8)
5	Other agrochemicals (pesticides & herbicides)	65 (25.4)	191 (77.6)
6	Agro-forestry	13 (5.1)	243 (94.9)
7	Irrigation	5 (2)	251 (98)
8	Tissue culture bananas	3 (1.2)	253 (98.8)
9	Mechanized farming	1 (0.4)	255 (99.6)
10	Green house	1 (0.4)	255 (99.6)
11	Others (crop rotation, push and pull, horticulture, soil liming and ISFM)	58 (22.7)	198 (77.3)

(Multiple responses)

Majority of the women practiced intercropping. This is an indication of crop diversification which could be a risk minimization strategy due to population pressure that continues to diminish holdings due to land fragmentation (Jayne and Muyanga, 2012). This result is higher than (Oladele *et al.*, 2008) who established that cereal legume intercropping adoption rate was 88.3%. Fertilizer had been adopted highly at 94.8%because of the urge to boost production. It is found in different packages depending on their need and ability to afford. Besides, subsidized fertilizer is usually provided by the County and National governments. Either, the One Acre Fund (OAF) organization provides farmers with farm inputs such as certified seeds and fertilizer for planting on credit. This study result differs from (Bala *et al.*, 2006) who found that adoption rate for fertilizer meant for cereals for the beneficiary group was 45.33% and 12% for non-beneficiary group. A majority of the women adopted certified seeds for planting. Seeds were found in farm input outlets available and others were acquired from the OAF organization on credit. However, because of scarce resources to obtain certified seeds, some women use uncertified seeds. This is in agreement with (Ojiem *et al.*, 1996) who

noted that given the rapidly increasing prices of hybrid seed and fertilizer, farmers seem to be justified in selecting their own local seed for. Agronomic practices like proper plant spacing recorded low percentage in adoption. This means plant spacing and population was not systematic as designed and this did not improve crop productivity. A study by Bala *et al.*, (2006) established that plant spacing adoption rate was 20% among the beneficiary group and 4% among the non-beneficiary group. Use of other agro chemicals like pesticides and herbicides is also minimal. Agrochemicals require resources and knowledge to interpret the procedures of use and precautions to be taken when implementing. This result of this study is slightly higher than (Ani *et al.*, 2004) in southern Nigeria who established that adoption rate of agrochemicals was at 23%. The rate of adoption of irrigation, tissue culture bananas, greenhouse farming and agro-forestry was low. Low adoption of irrigation means that they rely on rainfall for farming yet Emuhaya and Luanda sub counties are well endowed with permanent rivers which make irrigation viable (Republic of Kenya, 2009). The tissue culture banana stems were not available when needed for planting. FGDs revealed that acquisition of inputs required to support is not easy. Green house farming is not popular. It requires skills, knowledge and capital to implement. This result is lower than (Ani *et al.*, 2004) who established that 1.6% respondents adopted mechanization. Farm mechanization was minimal implying that the small sized farms were not viable for mechanization. Agro forestry is not widely practiced by women yet it is less demanding on labour and capital. They may be constrained by inadequate farming space, inadequate seedlings and insufficient knowledge on integrating it within their farming systems. This result is different from (Mujivane, 1999) who established that 40% of the women in dairy farming adopted agro forestry.

The other technologies which include soil liming, ISFM, horticulture and push and pull have not been significantly adopted. Lack of proper sensitization and adequate funds to facilitate acquisition of resources slowed down implementation of these technologies.

Levels of Adoption in Crop Farming

Levels of adoption identified from adoption of MATs in crop farming were categorised as full adopters and partial adopters. Those who adopted all the three technologies were referred to as full adopters while those who adopted less than three technologies found in this category or any other MAT that does not fall within the complete package were referred to as partial adopters. The results in Table 2 show that 36.7% of the women were full adopters who applied fertilizers, used certified seeds and observed plant spacing. The partial adopters include 28.4% of the women who applied fertilisers and certified seeds while 23.4 used fertilizer only. Also 3.9% adopted fertilizers and plant spacing while 1.2% used certified seeds and plant spacing. The other partial adopters, 5.9% adopted other MATs like agro forestry, greenhouse farming mechanised farming and agro-chemicals.

Table 2: Adoption Levels of MATs Adopted by Women in Crop Farming

No.	Technology	Frequency	Percentage
1	Fertiliser	60	23.4
2	Fertiliser and certified seeds	74	28.9
3	Fertiliser, certified seeds and plant spacing	94	36.7
4	Fertiliser and plant spacing	10	3.9
5	Certified seeds and plant spacing	3	1.2
6	Other MATs (*Agro chemicals, Agro-forestry, irrigation, green house, mechanised farming, etc*)	15	5.9
	Total	**256**	**100**

The majority of the women were full adopters. They can be able to access and afford resources required for implementation. They are likely to get

high yields. According to (Ogada, 2013) full adoption promised high yields. Partial adopters of fertiliser and certified seeds value the inputs but ignore the best practices of planting such as proper plant spacing. What matters to this group was acquisition of the inputs for use. The best practices are probably taken for granted. This may also have been brought about as a result of lack of sufficient information to help interpret proper implementation of MATs. The category of partial adopters who adopted fertiliser only prefers to use local seed varieties. They may have lacked resources to acquire certified seeds. Also, the local seed varieties fulfil their perceived grain quality (Hess, 1999). This also applies to the category of women who used fertilizer and observed plant spacing. They are keen on the use of fertilizer so as to improve on the soil nutrients for better yields. The Emuhaya strategic Report (2009) indicate that continuous tilling of the land has led to soil exhaustion and decline in land productivity. The other partial adopters like women who planted certified seeds and observed plant spacing may have experienced resource constraints and hence not able to source for fertilizer for planting.

Modern Agricultural Technologies Adopted in Animal Husbandry

Findings on technologies adopted in animal husbandry are presented in Table 3. A majority 90.6% adopted veterinary technologies like; spraying, de-worming, vaccination, antibiotics and multivitamins. Also, 88.3% fed their livestock on improved grasses, 79.7% practiced zero grazing, 65.6% adopted supplementary feeds. Others, 56.3% kept improved breeds, 38.3% practiced artificial insemination, 21.7% adopted proper housing unit, 2.3% deep litter system in chicken and 7.8% adopted other technologies like calf feeding and clean milk production.

Table 3: Modern Agricultural Technologies Adopted in Animal Husbandry

No.	Technologies in animal husbandry	Adopted *f*(%)	Not adopted *f*(%)
1	Veterinary technologies, (vaccination, spraying, de-worming, antibiotics, multivitamins)	116 (90.6)	12 (9.4)
2	Improved grasses	113 (88.3)	15 (11.7)
3	Zero grazing	102 (79.68)	26 (20.4)
4	Supplementary feeds	84 (65.6)	44 (34.4)
5	Improved breeds	72 (56.3)	56 (43.7)
6	Artificial Insemination (AI)	49 (38.3)	79 (61.7)
7	Proper housing unit	27(21.1)	101 (78.9)
8	Deep litter system	3 (2.3)	125 (97.7)
9	Others (clean milk production)	10 (7.8)	118 (92.2)

High adoption of veterinary technologies like animal spraying, de-worming, vaccines, and administration of antibiotics, multivitamins and treatment of diseases implies that women highly valued them as an effective precautionary and therapeutic program against the external and internal parasites. This result differs from (Nell & Schwalbach, 2002) whose study on sheep and goat farmers found that full adopters of external parasites, internal parasites, and antibiotics were 67%, 12%, and 16%. None of these farmers adopted vaccination. This means that farmers were keen on external parasite control. Improved grasses like napier, desmodium, calindria and luciana were highly adopted since they constitute the main feed of the animals. Bala *et al.* (2006) found that 58% of the beneficiary group and 52% of the non-beneficiary group had adopted improved grasses. Zero grazing system was also popular among women. This innovation is manageable on small farms. This result is different from (Mujivane, 1999) who established that 98% of the women in the area of study had adopted zero grazing system. Low adoption of AI signifies poor accessibility or availability of the innovation. This could be due to time and resource constraints of the individual woman farmer. The use of AI can be much more labour intensive than using a bull to breed cows (Howley, 2012). Bala *et al*. (2006) found that 90%

of the beneficiary group and 60% of the non-beneficiary group adopted AI. Deep litter system in poultry farming has been adopted by very few women implying that this technology is not affordable by many due to financial constraints.

A summary of adoption levels of MATs adopted in animal husbandry was prepared based on the first five MATs that were highly adopted as presented in Table 4. These were; veterinary technologies, improved grasses, zero grazing, supplementary feeds and fodder preparation and improved breeds. In this study, women who had adopted all the 5 technologies would be termed as full adopters while the ones that had adopted less than the mentioned five would be termed partial adopters. Those who did not adopt any MATs in animal husbandry would be referred to as non-adopters.

Table 4: Adoption Levels of MATs Adopted by Women in Veterinary Farming

No.	Technology	Frequency	Percentage
1	Veterinary technologies and improved grasses	8	6.3
2	Veterinary technologies, improved grasses and zero grazing	21	28.9
3	Veterinary technologies, improved grasses and supplementary feeds	5	3.9
4	Veterinary technologies, improved grasses zero grazing, supplementary feeds and improved feeds	47	36.7
5	Other MATs (*AI, modern housing unit, etc.*)	35	27.3
6	Not adopted	6	4.7
	Total	**128**	**100**

The results indicate that 36.7% were full adopters. The partial adopters consist of various categories which recorded 27.3%, 21.1%, 6.3% and 3.9%. Non adopters consist 4.7%. These results show that full adopters were many in this category. They adopted a full package of veterinary technologies, improved grasses, zero grazing, supplementary feeds and fodder preparation and improved grasses. They had acquired quality breeds and were trying to implement best practices for better yields. The partial adopters who

only picked a few technologies may have experienced resource constraints that barred them from adopting a full package. However, the full adopters together with many partial adopters' value veterinary technologies and improved grasses. Their priority is to ensure that their livestock are treated and prevented from diseases (Nell & Schwalbach, 2002). The common improved grasses thus napier is valued as the main feed of cattle. Napier grass is easily available and manageable. The non-adopters may have encountered serious constraints that bar them from adopting MATs in animal husbandry.

Main Sources of Information on MATs

The main sources of information on MATs are presented in Table 5. It was established that the main source of information for 33.9% of the women was from fellow farmers, 23.2% from agricultural field days, 12.5% from extension officers and 12.5% from other sources like NGOs.

Table 5: A Comparison between Main Sources of Information in Crop Farming and Animal Husbandry

No.	Source of Information	Crop Farming Frequency (%)	Animal Husbandry Frequency (%)
1	Radio	15 (5.9)	11(8.6)
2	Television	11 (4.3)	3 (2.3)
3	Printed material	21 (8.2)	8 (6.3)
4	Agricultural field day	39 (8.2)	51 (39.8)
5	Visit from extension	27 (10.5)	20 (12.5)
6	From another farmer	106 (41.4)	24 (18.8)
7	Others (NGOs etc.)	37 (14.5)	11 (8.6)
	Total	**256 (100)**	**128 (100)**

A paltry 7.6% of the women acquired information from printed materials, 6.8% from radio and 3.6% from television. A relatively large proportion of women learned from one another to effect change in production. This means that that there is a high possibility of innovation adoption and diffusion among women farmers (Rogers, 2003). This result differs from (Okunlola *et al.,* 2011) in Nigeria who established that the majority respondents 42% of his

study acquired information from fellow farmers. Results from a study carried out by (Odini, 2014) show that 62% of the women acquired information by asking people and friends, 58% by listening and talking and 53% through discussing with those people who have the information. Low turnout of women for agricultural field days means that they were not informed about the events or are unable to attend because of time and distance, (Lubwama, 1999).

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Extension services were not very frequent yet many women were involved in adoption of MATs. Non significance of extension information may be attributed to the poor frequency visits and this may not have a positive effect on agricultural production. In most African countries there is a widely recognised difficulty of male extension agents having any type of contact with individual female small holders due to entrenched norms and cultural difficulties in engaging face to face communication (Swanson & Rajarahti, 2010). The other sources like radio and television were not very important sources of information to women farmers. It seems many of them lack the time and passion to acquire information about MATs on radio and TV because of the numerous responsibilities to carry out at home. This is in agreement with (Lubwama, 1999) that programmes on appropriate technologies normally aired through mass media (radio, newspaper, television) do not often reach women since such programmes are aired at times when women are very busy. This result differs from (Fadiji & Atala, 2009)

who found that the majority respondents 92.8% had access to radio. Few women had access to printed material like newspapers, pamphlets and books. This means the reading culture among women is poor. According to Odini (2014), majority of women did not access external assistance or formal information systems and centres such as libraries. Besides, the Vihiga County Information and Documentation Centre (DIDC), which should play an important role in collection and storage of information is not well stocked and is rarely open. Printed material may only be applicable to women with substantial levels of education for them to be interpreted well.

Further analysis shows that farmer to farmer source of information was prominent among women in crop farming while agricultural field days were important in animal husbandry. Farmer to farmer is the most popular means through which women gain knowledge about MATs in crop farming. This illustrates that there is difficulty in accessing information through the other sources of information. It seems their information seeking habits were influenced by the activity and problem at hand. Farmer to farmer mode of obtaining information about MATs reaches many women, however it may not be very effective in terms of quality information if most of the discussions are not done with the technical experts. Hence it may not be reliable and women may find it difficult to stick on to the right agricultural practices which could enable them to be food secure. According to (Kathage *et al.,* 2013*)* farmer-to-farmer transfer of information is less accurate.

Agricultural field day is the most important media through which information on MATs reach women. Field days give women an opportunity to meet with the experts and practicing farmers who enlighten them on modern techniques in farming. However, again the role of the extension services meant to provide expert services is less felt. There is minimal contact between women and extension services. There is need to unlock the barriers that exist between extension services and women farmers.

Type of Training Attended in Crop Farming

Results indicate that 27.7% of the

women had trained on fertilizer use and preparation of FYM, 27.7 % on seed selection, plant spacing and population, 14.8% on pesticide preparation, disease and weed control, 7.8% on intercropping, and 4.7% on crop rotation. The other areas trained included 3.5% on banana planting and spacing, 1.2% on greenhouse farming and horticulture, 0.8% on agro-forestry and tree nursery management. 27.3% of the women trained in harvesting and storage, ISFM, soil sampling and liming, climate change and land preparation.

Table 6: A Comparison of Adoption of MATs in Crop Farming and Areas trained

No.	Technology/Adoption level (*f*)	Relevant area of training (*f*)
1.	Fertilisers (243)	Fertiliser use & FYM preparation (67)
2.	Intercropping (253)	Intercropping (18)
3.	Certified seeds (176)	Plant spacing & seed selection (69)
4.	Plants spacing & population (103)	Plant spacing & seed selection (69)
5.	Agro-chemicals (65)	Pesticides preparation & weed control (43)
6.	Agro-forestry (13)	Agro-forestry (10)
7.	Other (Soil conservation, crop rotation, horticulture) (58)	Soil conservation (82)

There was a low turnout of women training in various MATs in crop farming. It was noted that 27.7% and 7.8% of women trained on fertilizer use and preparation and intercropping. Besides the low turnout, there was high adoption of fertilizer and intercropping as reported by this study. This means that the few women who train on various MATs become an important

link in the diffusion process (Rogers, 2003). They pass on new ideas to their peers when they interact. Bandiera & Rasul, (2006) looked at social networks and technology adoption in Northern Mozambique and found that the probability of adoption is higher amongst farmers who discussed agriculture with others.

Low turnout in seed selection, planting and spacing is worrying because some other MATs like certified seeds and fertilizer depend on them for proper implementation. This could affect crop production and threaten food security. Tree nursery management, horticulture, greenhouse farming, soil sampling and disease control recorded few women who turned out for the training. This is reflected in the low adoption of these technologies as reported in this study.

A summary of comparisons of adoption rates of various technologies adopted in crop farming against the areas that they were trained in reveal that few women participated in the training. However, many women adopted relevant MATs in the areas that they were trained. High adoption rates were noted in fertilizers, intercropping, certified seeds, plant spacing and population, agro-chemicals and agro-forestry. However, low attendance rates were noted in terms of training. It is clear that training sessions are not attractive to many women. These are issues that need to be addressed.

Type of Training Attended in Animal Husbandry

Results for the type of training attended in animal husbandry are presented in Table 7. They indicate that the majority of women (53.1%) had been trained on veterinary technologies, 35.9% on animal feeding pasture management and silage preparation, 18% on establishment of a housing unit, 12.5% on record keeping and 7.8% on cross-breeding and AI.

Table 7: Comparison of Adoption of MATs in Animal Husbandry and Areas Trained

	Technology adopted (*f*)	**Relevant area trained (*f*)**
1	Veterinary (116)	Veterinary (68)
2	Improved grass (113)	Dairy farming (68)
3	Zero grazing (102)	Dairy farming (68)
4	Supplementary feeds (84)	Silage preparation (14)
6	Artificial insemination (49)	AI & cross-breeding (10)
7	Proper housing unit (7)	Housing unit (23)
8	Deep litter (3)	Poultry keeping (2)

The other areas in which women were trained trained include 4.7% in preparation of farm yard manure, 1.6% poultry-keeping, 1.6% bee-keeping, 0.8% dairy farming, and 0.8 % agribusiness in agriculture.

The trends displayed in training of women in animal husbandry show that many women trained in veterinary technologies. This promoted adoption of innovations in veterinary technologies as established in this study. Low turnout of women who trained in poultry keeping could have been the cause for low adoption of innovations applied in poultry keeping.

A summary of comparisons of adoption rates of various technologies adopted in animal husbandry against the areas that they were trained in reveal that few women participated in the training. However, many women adopted relevant MATs in the areas that they were trained. This could imply that women preferred to attend training in some areas because of the need at hand. Many women who adopted veterinary technologies, improved grasses, zero grazing, supplementary feeds and fodder and deep litter did not take part in training. There are some MATs which may not be complicated in adoption. In such circumstances, they assume that they understand them and therefore may not find it necessary to attend such training. However, training is very important for farmers since it updates them with skills to handle challenges that come with adoption. According to (Dehinenet *et al.,* 2014), the availability of livestock training increases the level of dairy technology adoption through creating awareness on the advantages of the technology and then improving the farm management skill. There is need to focus on training to establish why training is not popular among women.

Overall Training on MATs in Crop Farming and Animal Husbandry

Overall, results indicate that 72.1% of the respondents had undergone training while 27.9% had not had any training. This implies that majority of the women had been exposed to various technologies in agriculture. Training and exposure to successful stories of agricultural technologies can help to break the long-time culture and traditional phenomenon (Oladele *et al.*, 2008).

Even for those with low levels of education, training imparted them with knowledge which enabled them to understand about innovations. Some may have missed the training because of poor channels of communication.

Either, the training centres were far and those who were willing to participate in such programmes were constrained financially (Lubwama, 1999).

Conclusion

High adoption rates of some MATs in crop and animal husbandry imply that they are easily accessible and affordable. This has been made possible by role played by the private organizations like the OAF and subsidies from both the national and county governments. Other MATs require low managerial skills hence they are easy to interpret. Low adoption rates of some MATs imply that there is scarcity in acquisition of resources they are required to adopt them. This includes land, capital and skills to handle the MATs. Full adopters of some MATs in crop farming and animal husbandry have considerable number of resources and therefore display some level of efficiency in adoption of MATs. The high number of partial adopters and a section of non-adopters in animal husbandry can be explained by lack of sufficient resources, correct information and training useful in acquisition and use of MATs.

Recommendations

1. Concerted efforts should be put in place to empower women with resources to acquire MATs suitable to their needs. Therefore, the National and County governments should work towards increasing the subsidies on the farming inputs so as to make farming affordable. The private institutions such as the non-governmental institutions that run socio-economic programmes should be properly linked to women farmers in order to address their adoption needs and aspirations.
2. Women's understanding of usage of modern agricultural technologies should be enhanced by empowering them with appropriate information. Extension services are important in meeting this goal because they come in to complement the low levels of education. However, extension services should be intensified by the county government so as to reach the women. Farmer to farmer as a source of information is important but has to be enriched. The small social units such as women groups should be used as learning groups that are attached to agricultural extension experts. This may enhance their

understanding of MATs and acquisition of managerial skills in handling MATs.

3. More weight should be given to training sessions so as to attract more participants. Timing of the sessions and where they are held should be made in such a way that women find it easier to attend. However, for effective learning, other complimentary channels for imparting information and skills like hands-on training, demonstration plots and creation of farmers groups are needed to enhance effective learning.

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Predictors of Academic Dishonesty among Secondary School Students

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Abstract

The purpose of this study was to investigate the predictors of academic dishonesty among secondary school students. The study sample consisted of 102 (65.4%) female students and 53(34%) male students. The age of the respondents ranged from 15 to 22 years. There was a significant gender difference in academic dishonesty $t(153)=3.56$, $p=.001$. There was a significant positive relationship between age and academic dishonesty ($r=.165$, $p<.05$). There were significant negative relationships between academic dishonesty and school engagement ($r=-.259$, $p<.05$), academic dishonesty and self-efficacy ($r=-.171$, $p<.05$) and between academic dishonesty and psychological wellbeing ($r=-.168$, $p<.05$). Gender ($t=-3.78$, $p<.05$) and school engagement ($t=-2.85$, $p< .05$) were found to be significant predictors of academic dishonesty.
Key words: Academic Dishonesty, School Engagement, Gender

Introduction

Academic dishonesty has become a widespread problem among students (Jensen *et al.*, 2002). It has become a global phenomenon occurring in both developed and developing countries among high school and college students (Manduku, Gichaba & Ruto, 2021; Akakandelwa, Jain &Wamundila, 2013; Jensen *et al.*, 2002). Research on academic dishonesty shows that it is more prevalent than ever. Gillespie, (2003) reports that the current levels of academic dishonesty are as high as 80%. It has become a stumbling block in Learning institutions and defeats the very purpose and essence of learning (Fernandez, 2019). According to PLoS One (2020), academic dishonesty leads to undesirable consequences for both the students and the education system. It affects the integrity of the learning process (Chala, 2021; Davis *et al.*, 2009; Paris & Robert , 2007), the integrity and reputation of the learning institution (Chala, 2021; Sorso *et al.*, 2015; Hayman, 2014), the students long term behavior (Chala, 2021; Lupton &

Chaqman, 2002), students are less motivated to learn (Heyneman, 2011), it undermines the assessment of student's learning, it interferes with the efforts to diagnose problems associated with students learning (Chala, 2021; Jan *et al.*, 2002; Lupton & Chaqman, 2002; Davis et al, 2009), it interferes with the ability of academic institutions to achieve their stated objectives (Chala, 2021; Rana & Ajmal, 2013), it affects research and cripples the talents and potentials of students (Akakandelwa, Jain & Wamundila, 2013). Most importantly, academic dishonesty can lead to graduates who are inadequately prepared for the world of work. According to Amukowa (2018) and Heyneman (2011), employers are likely to avoid candidates from institutions associated with academic dishonesty. In cases where graduates from suspect institutions are employed, Heyneman (2011) explains that they may have to accept lower salaries compared to their counterparts from reputable institutions until they can demonstrate their economic value through on-the-job experience.

Academic dishonesty refers to the act of giving or receiving unauthorized assistance in an academic work or receiving credit for plagiarized work (Storch & Storch, 2002). It may be categorized as either exam cheating or plagiarism based on the nature of the acts (Baroche, 2016; Chala, 2021). Cheating in exams involves copying from others, having or using personal notes, formulas or other information in an electronic device without explicit teacher review and permission, having or using a communication device such as a cell phone to send or obtain unauthorized information, taking an exam for another or on behalf of another student, permitting someone else to take a test for someone else and asking another to give you improper assistance in an test (Baroche, 2016, Etter *et al.*, 2006).

Plagiarism on the other hand involves practices such as giving or getting improper assistance on an assignment meant to be individual work (Baroche, 2016; Mitchell 2008; Brimble & Stevenson, 2005), acting as a provider of paper(s) for a student or students, submitting substantial portions of the same academic work for credit in more than one course without consulting both teachers (self-plagiarism), failing to

properly acknowledge paraphrased materials via textual attribution, footnotes, endnotes and/or a bibliography and citing nonexistent sources (Baroche, 2016; Craig & Dalton, 2013).

According to Baroche (2016,) both forms of dishonesties are observed in academic institutions. However, the former one is prevalent in all academic levels while the later one - plagiarism, is very common in higher education institutions.

Literature Review

Reasons for academic dishonesty. Majority of students (85%) feel that academic dishonesty is a normal part of life (Harding et al, 2001); however, perception on what qualifies as academic dishonesty varies from one student to another (Manduku, Gichaba & Ruto, 2021; Fienberg, 2009). This has been attributed to the differences in socio cultural settings, demographic composition, educational policies and programs (Chala, 2021).

According to Aaron and Roche (2014), academic dishonesty starts early in elementary school when parents get over-involved in their children's assignments, projects or homework hence denying children the chance to do the work by themselves. Our education today focuses on grades and high achievement. The need to excel is inculcated in the school culture. Aaron and Roche (2014) explain that when this becomes the sole motivating factor, the focus of the student shifts from the value of learning to the acquisition of a good grade. This focus continues throughout schooling. The stimulus for cheating is created by the evaluation aspect of the education system which has subsequent life choice implications (Szabo & Underwood, 2004).

Academic dishonesty is considered an intentional and planned behavior by students who seem not to fear the consequences of their actions (Fernandez, 2019). In this paper reasons for academic dishonesty have been classified into two categories; personal factors and institutional related factors

According to the fraud triangle model which is a theoretical concept explaining the prerequisites for participating in fraudulent activities, for a student to engage in academic dishonesty, three conditions namely opportunity, incentive or need and finally rationalization or attitude must be

present (Becker *et al.*, 2006)

Opportunity occurs when students perceive that there is the ability to cheat without being caught (Ramos, 2003). Academic dishonesty has become more prevalent with advancement of information and communication technology (Doherty, 2011; Akakandelwa, Jain & Wamundila, 2013). As a result, getting information is easy as well as finding someone to complete a student's assignment hence presenting an opportunity for the students to cheat.

The second condition, incentive, pressure, or need, can come from a variety of different sources such as the self, parents (Anitha & Sundaram, 2021; Musau & Boidanda, 2019; Guanzon, 2005), peers (Ruto, Kipkoech, & Rambaei, 2011; Wamalwa, 2018; Lecia & Hutapea, 2015), Teachers (Nyamwange, 2018), employers, and learning institutions. The pressure felt by students to get good grades and the desire to be viewed as successful can create the incentive to cheat.

Lastly, the rationalization of cheating behavior can occur when students view cheating as consistent with their personal ethics and believe that their behavior is within the bounds of acceptable conduct (Becker *et al.*, 2006; Ramos, 2003). Rationalization can also occur if students believe that other students are also cheating (Musau & Boiband, 2018), perceive unfair competition, or perceive an acceptance of, or indifference to these behaviors by instructors (Varble, 2014). Some students may also rationalize academic dishonesty by perceiving some courses or subjects as non-essential. According to Shu Gino and Bazerman, 2011), the more one engages in acts of academic dishonesty, the easier it is to rationalize their behavior and cheat.

Other personal reasons that may lead to academic dishonesty include feeling incompetent and/or lack of confidence in one's ability (Oweka, Alonga & Raburu, 2018; Jordan, 2001; Ruto, Kipkoech, & Rambaei, 2011; Warnken, 2004; Whitaker, 1993), a sense of time pressure (Ahmed, 2018; Arhin & Jones, 2009; DeVoss and Rosati, 2002; Sterngold, 2004), a busy social life (Crown & Spiller, 1998), lack of an understanding of what constitutes cheating (Manduku, Gichaba & Ruto, 2021), stiff competition (Nyamwange, 2018), poor preparation (Ruto,

Kipkoech & Rambaei, 2011; Nyamwange, 2018), lack of preparation, failure to attend lectures among college students (Ahmed, 2018; Ruto, Kipkoech & Rambaei, 2011), laziness (Arhin & Jones, 2009), personality traits, study skills (Wendy & Bates, 2003), low self-control (Cochran, 2015; Callender *et al.*, 2010), having a low self-esteem (David, 2015; Williamson & Assadi, 2005) and an external locus of control (Oweka, Alonga & Raburu, 2018). Age and gender are also factors that can influence acts of academic dishonesty. Previous researchers have reported contradicting findings for the influence of the two on academic dishonesty.

> According to Tolman (2017), a primary contributor to academic dishonesty is the existence of a "cheating culture" within learning institutions or at least the **perception** that a cheating culture exists. Because of this, students may be tolerant of cheating, believe that cheating is necessary in order to succeed, and believe that all students are cheating (**Crittenden *et al.*, 2009**). Due to this they may not see the academic environment as one that deserves their honesty (Genereaux & McLeod, 1995).

Institutional policies related to academic standards of a learning institution may also impact academic honesty. Some institutional policies may be too lax, with insufficient or lack of consequences for academic dishonesty (e.g., Akbulut *et al.*, 2008).

Lack of adequate facilities in learning institutions may also contribute to academic dishonesty. This includes overcrowding during examinations (Wamalwa, Okoth & Ochanda, 2020; Ahmed. 2018), accessibility to examination material and lack of teachers/lecturers adhering to policies during administration of exams (Wamalwa, Okoth & Ochanda, 2020). Failure by instructors to complete the syllabus on time and lack of adequate course resources may also contribute to academic dishonesty among students (Ahmed, 2018). Academic dishonesty has also been reported to be more prevalent in institutions with high student to teacher ratio

There are certain schools where teachers provide exam leakage to students

especially for the high-stakes examinations (Bellows, 2018). This often reinforces the idea that cheating is acceptable as long as one does not get caught. Methods of assessment used by an institution may also contribute to academic dishonesty (Peled, Eshet & Rinautsky, 2013; Wendy and Bates, 2003).

Academic Dishonesty in Kenya. Prevalence of academic dishonesty in Kenya has risen drastically over the years (Nyamwange, 2018). Every year, a number of students face disciplinary committees in different universities on the grounds of academic dishonesty (Manduku, 2021). This has also been observed in secondary schools. The number of secondary school students' results cancelled by the Kenya National Examination Council due to academic dishonesty every year is alarming. According to Nyamwange (2018), most reported cases go unpunished because of inefficiencies in the management of exams.

Research has shown that, students exposed to academic dishonesty in secondary schools are more likely to engage in the same acts at college level (Bellows, 2018, Musau & Boibanda, 2018) and this follows through to the labour market (Sorgo *et al.*, 2015). Students who engage in academic dishonesty do not acquire the required skills for their future professional life and this can lead to a number of social ill (Teixeria & Rocha (2006). According to Manduku (2021), for us to restore the glory of education in Kenya, academic dishonesty needs to be drastically addressed

Minimizing Academic Dishonesty. Integrity is a critical bench mark in any profession as a result special attention should be devoted towards addressing academic dishonesty (Saana *et al.*, 2016). Researchers and educators have proposed ways of minimizing academic dishonesty for example, Ourouke *et al.* (2010) proposes that to lower academic dishonesty there is need to lower our level of tolerance for such behavior, control and prevent such behavior by generating different variants of tests. We also need to change students' attitude towards such behavior (Rettinger & Kramer, 2009).

According to Oran (2015), learning institutions need to create programmes that aim at strengthening ethical values

such as honesty, clearly define acceptable and unacceptable behavior, implement policies that encourage academic integrity and impose effective sanctions incase academic dishonesty is detected. Institutions also need to put in place codes of conduct for faculty, administrators and students (Heyneman, 2011).

Educators need to develop instructional strategies that integrate all facets of appropriate digital ethics (Ribbie, 2011) and educate students about plagiarism (Jones, 2011). Wachira (2017), proposes that teachers need to engage in strict supervision of exams, provide adequate learning resources, screen students before entering exam rooms and change examination venues for different exams done by the students.

According to Heyneman (2011), institutions of learning also need to provide statements of honesty on their websites and provide annual reports to the public on observed changes in the number and types of incidences on a year-by-year basis. Glendinning, Orin and King (2019) recommend that learning institutions should be put in place policies that ensure security of exams and fairness and justice in grading.

In Kenya, the ministry of education has taken certain extra measures to try and minimize the levels of cheating in secondary and primary schools during national examinations. These include banning a range of social activities in boarding schools during third term such as prayer days, family visits, half term breaks, sports, prize giving ceremonies and annual general meetings (Nyamwange, 2019; Wanzala 2016). The ministry has also shortened the exam period for the Kenya Certificate of Secondary Education from six weeks to four and put head teachers directly in charge of the tests in their respective schools. This was done in order to shorten the window of cheating opportunity and to have the head teacher directly accountable (Nyamwange, 2018).

The Kenya National Examination Council and the Ministry of Education have also put in place measures to curb cheating during summative evaluation in secondary schools such as cancellation of examination results, suspension from sitting the Kenya

Certificate of Secondary Education examinations for three years, a jail term of not less than five years and huge penalties (Kimanzi & Thunguri, 2023).

Despite the measures that have been put in place, students still engage in academic dishonesty (Amukowa, 2018; Marcelo, 2003). Academic researchers are interested in establishing the risk factors for academic dishonesty in order to develop appropriate preventive measures (Portnoy et al 2019; Balantine, Larres& Mulgrew, 2014; Laduke, 2013). According to Saana (2016), investigating the correlates of academic dishonesty may provide important information that may help in addressing the vice.

The purpose of the current study was to investigate the predictors of academic dishonesty among secondary school students in Kenya.

Methodology

Participants. The study was conducted in public secondary schools in Siaya county Kenya with a sample of 155 students in their third year of study (form 3). The study sample consisted of 102 (65.4%) girls and 53(34%) boys. The ages of the respondents ranged from 15 to 22 years. The mean age of the respondents was 18 years.

Instrumentation. Four instruments were used for measuring academic dishonesty, school engagement, self-efficacy and psychological well-being. The tools are described below.

Academic dishonesty was measured using 19 items adapted from ***Forms of Cheating Scale*** by Sorgo, Vardi and Cigler (2015). The items were measured on a five-point Likert scale with responses ranging from *never* to *very frequent*. The reliability for the instrument was .83.

School engagement was measured using ***The School Engagement Scale (SES)*** by Fredericks *et al.*, (2005) which measures behavioral, emotional, and cognitive aspects of school engagement. The items on the scale were answered using a five-point Likert scale with responses ranging from *never* to *all the time*. The reliability for the instrument was .75.

Self-efficacy was measured using the ***Generalized Self-efficacy Scale*** by Schwarzer and Jerusalem (1995). The scale consists of 10 items measured on a

four-point Likert scale. The responses on the scale range from not at all true to exactly true. The reliability for the instrument was .69.

Psychological-wellbeing was measured using the **Psychological Wellbeing Scale** by Ryff *et al.* (2007) adapted from Ryff (1989). The scale consists of 42 items measuring six aspects of wellbeing and happiness: autonomy, environmental mastery, personal growth, positive relations with others, purpose in life, and self-acceptance. The items were measured on a six-point Likert scale. The responses on the scale ranged from *strongly agree* to *strongly disagree*. The reliability for the instrument was .67

Results

Preliminary Findings. Prior to data analysis, missing data for the respondents were replaced by the series mean for each item. A total of 156 students took part in the study. Out of this, 53 were male 102 were female and one student did not indicate his/her gender. The ages of respondents ranged from 15 to 22 years. The mean age of the respondents was 18 years. The means for the tested variables were as follows: academic dishonesty (32.02), school engagement (48.19), self-efficacy (29.21) and psychological wellbeing (162.84).

Forms of Academic Dishonesty. To establish the most prevalent forms of academic dishonesty among secondary school students, we presented respondents with a list of 19 items consisting of different forms of academic dishonesty. Descriptive statistics for the different forms of academic dishonesty are presented on Appendix 1.

From the results, the most common form of academic dishonesty among the respondents was "I have allowed schoolmates to copy my homework" *(M=2.43, SD=1.38)* followed by "I have copied homework" *(M=2.25, SD=1.17).* The least common form of academic dishonesty was "I have searched for correct answers using a mobile phone during examinations" *(M=1.18, SD=.63)* followed by "during examinations, I have received or sent solutions to tasks with a mobile phone" *(M=1.30, SD=.80)*

Gender Differences in the Scores of Respondents. To establish gender differences in the scores of respondents in the measured variables, we conducted

independent sample t-tests. The results are presented on Appendix 2. The results show that male students scored significantly higher *(M=36.24, SD=12.39)* than female students *(M=29.91, SD=9.40)* in academic dishonesty *t(153)=3.56, p=.001*. These results suggest that male students are more likely to engage in academic dishonesty that female students.

There was no significant gender difference for school engagement *t (153) =.55, p=.586* despite male students attaining higher scores *(M=48.63, SD= 6.89)* than female students *(M=47.87, SD=8.92).*

The results from this study also show that there was no significant gender difference in self-efficacy *t (153) =-.03, p=.974*. Male students mean score on self-efficacy *(M=29.15, SD=5.67)* was almost similar to that of female students *(M=29.18, SD=5.18).*

Female students attained higher scores on psychological wellbeing *(M=164.49, SD=23.43)* compared to male students *(M=159.69, SD=19.67)* however, the mean difference was not statistically significant *t (153) =-1.27, p=.204*.

Relationship between the Independent and Dependent Variables. To establish the relationship between the independent and dependent variables. we conducted Pearson's product moment correlation. The results are presented in Appendix 3. There was a significant positive correlation between academic dishonesty and age *(r=.165, p<.05).* These results suggest that academic dishonesty increases with age. As students grow older, they are more likely to engage in academic dishonesty.

There was a significant negative relationship between academic dishonesty and school engagement *r=-.259, p<.05.* There results suggest that students who are more involved in school related activities such as paying attention in class and taking part in learning activities are less likely to engage in academic dishonesty.

There was a significant negative relationship between academic dishonesty and self-efficacy (*r=-.171, p<.05*). These results suggest that students who have higher confidence in their ability to perform academic are less likely to engage in academic dishonesty.

There was also a significant negative relationship between academic dishonesty and psychological wellbeing *(r=-.168, p<.05).* These results suggest that students who are experiencing greater psychological wellbeing are less likely to engage in academic dishonesty.

Significant positive relationships were also observed between self-efficacy and school engagement *(r=.241, p<.05)* and between self-efficacy and psychological wellbeing *(r=.251, p<.05).* These results suggest that higher scores in school engagement correspond to higher scores in self-efficacy and that higher scores in self-efficacy correspond to higher scores in student's psychological wellbeing. Interestingly there was a significant negative relationship between age and self-*efficacy (r=-.181, p<.05).* These results suggest that confidence student's ability decreases with age.

We conducted multiple regressions to predict academic dishonesty from age, gender, school engagement, self-efficacy and psychological wellbeing. This resulted in a significant model *(F(5, 139)=6.34, p<.05,* R^2*= .186).* The predictors explained 18.6% of the variance (See Appendix 4 and 5). The individual predictors were examined further and indicated that gender *(t=-3.78, p<.05)* and school engagement *(t=-2.85, p< .05)* were significant predictors of academic dishonesty while age *(t=1.79, p>.05),* self-efficacy *(t=-.90, p>.05)* and psychological wellbeing *(t=-.93, p>.05)* were not. The results are presented in Appendix 6.

Discussion

The most common form of academic dishonesty among the respondents was "I have allowed schoolmates to copy my homework" followed by "I have copied homework". The least common form of academic dishonesty was "I have searched for correct answers using a mobile phone during examinations" followed by "during examinations, I have received or sent solutions to tasks with a mobile phone". Given that students are not allowed to have mobile phones within the school in secondary schools in Kenya, it is possible that very few students have mobile phones hence few of the students get the opportunity to use phones during examinations.

Significant gender differences were found in academic dishonesty with boys scoring significantly higher than girls.

These results suggest that boys are more likely to engage in academic dishonesty than girls. These results are similar to those reported by Liu and Alias (2023) and Gibson, Schreck and Khey (2008) who found male undergraduate students as more likely to engage in academic dishonesty than female undergraduate students. These results however differ from those reported by Trost (2009) who found no significant gender differences on academic dishonesty behaviors among Swedish university students. There was however no statistically significant gender difference in self-efficacy, psychological wellbeing and school engagement.

A statistically significant positive relationship was found between age and academic dishonesty. These results suggest that older students are more likely to engage in academic students than younger students. Their results differ from those reported by Birks, Smithson, Antney, Zhao, and Burkot (2018) and Gibson, Schreck and Khey (2008) who found that the likelihood of academic dishonesty was higher among younger age groups. There was however a significant negative relationship between age and self-efficacy. These results suggest that as one grows older, their confidence in performing academic related tasks tend to decrease.

There was a significant positive relationship between academic dishonesty and school engagement. There results suggest that students who are more involved in school related activities are less likely to engage in academic dishonesty. When students take part in school activities such as participating in learning activities, paying attention in class and doing their homework they tend to acquire more knowledge hence may not see the need to engage in academic dishonesty.

There was a significant negative relationship between academic dishonesty and self-efficacy. These results suggest that students who have higher confidence in their ability to perform academic tasks are less likely to engage in academic dishonesty. These results are similar to those reported by Baran and Jonason (2020), Kucuktepe (2010) and Mufarrihah (2022) that self-efficacy and academic dishonesty among high school and university students had significant negative correlation. Given that self-efficacy

comes from previous learning experiences and past accomplishments it is possible that students with high self-efficacy are well aware of their ability and therefore see no need to engage in acts of academic dishonesty.

There was also a significant negative relationship between academic dishonesty and psychological wellbeing. These results suggest that students who are experiencing greater psychological wellbeing are less likely to engage in academic dishonesty.

Significant positive relationships were also observed between self-efficacy and school engagement and between self-efficacy and psychological wellbeing. These results suggest that higher scores in school engagement correspond to higher scores in self-efficacy and that higher scores in self-efficacy corresponds to higher scores in student's psychological wellbeing. Interestingly there was a significant negative relationship between age and self-efficacy. These results suggest that confidence in student's ability decreases with age.

Conclusions and Recommendations

Academic dishonesty in secondary schools in Kenya has continued to persist over the years despite the tough measures put in place by the Kenya National Examination Council and the Ministry of Education. These measures include cancellation of examination results, suspension from sitting the Kenya Certificate of Secondary Education examinations for three years, a jail term of not less than five years and huge penalties (Kimanzi & Thunguri, 2023). There is need for the government and stakeholders to put in place policies that guide and prevent students from engaging in acts of academic dishonesty during the learning process instead of waiting to implement suctions as students do their final secondary school examinations.

During the learning process, acts of academic dishonesty by students should form part of their disciplinary records. This will make students realize the seriousness attached to the offense. School administrators may also cancel the students' results and suspend students found engaging in acts of academic dishonesty. This may help

inculcate the value of honesty in students.

Based on the results from the current study we concluded that gender and school engagement are significant predictors of academic dishonesty. Teachers need to encourage students to take part in school activities especially learning activities in order to reduce academic dishonesty. School administrators' and teachers also need to create a conducive learning environment in school so that learners can enjoy their stay in school which may intern lead to better school engagement.

Students also need to practice concepts taught more often and study in order to increase their confidence in tackling academic related challenges. This will boost their self-efficacy hence leading to decreased academic dishonesty. The students' psychological wellbeing should be a top priority to educators as greater psychological wellbeing leads to decreased academic dishonesty.

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Appendices

Appendix 1: Forms of Academic Dishonesty

	N	Min score	Max score	Mean	Std. Dev
I have searched for correct answers using a mobile phone during exams	156	1.0	5.0	1.183	.6369
During examinations, I have received or sent solutions to tasks with a mobile phone	156	1.0	5.0	1.303	.8062
During written exams, I have copied from others	156	1.0	5.0	1.349	.8670
I have helped other students to cheat	156	1.0	5.0	1.397	.9684
I have lent my mwakenya/short notes to classmates during exams	156	1.0	5.0	1.409	.9613
I have forged a grade or an apology after missing an exam	156	1.0	5.0	1.419	.9630
I have allowed schoolmates to copy answers during written exams	156	1.0	5.0	1.438	.9560
I have avoided taking an exam	156	1.0	5.0	1.471	1.0116
I have used my mwakenya/short notes during examinations	156	1.0	5.0	1.500	1.0112
I have copied a part or a whole essay and submitted it as my own work	156	1.0	5.0	1.578	1.0082
I have obtained test questions illegally before the test	156	1.0	5.0	1.581	1.1064
I have communicated with classmates during written exams	156	1.0	5.0	1.591	.9772
I have whispered to classmates during oral or written exams	156	1.0	5.0	1.742	1.1796
I have cheated in school	156	1.0	5.0	1.837	1.1610
I have obtained a higher score in an exam with the help of friends	156	1.0	5.0	1.982	1.3889
I have lied to the teacher	156	1.0	5.0	2.201	1.3411
I have observed other students cheat in an exam in school	156	1.0	5.0	2.227	1.2574
I have copied homework	156	1.0	5.0	2.247	1.1767
I have allowed school mates to copy my homework	156	1.0	5.0	2.423	1.3868

Appendix 2: Independent Sample t-test

		N	Mean	SD	T	df	Sig.
Academic Dishonesty	Male	53	36.24	12.39	3.56	153	.001
	Female	102	29.91	9.4			
School Engagement	Male	53	48.63	6.89	.55	153	.586
	female	102	47.87	8.92			
Self Efficay	Male	53	29.15	5.67	-.03	153	.974
	female	102	29.18	5.18			
Psychological Wellbeing	Male	53	159.69	19.67	-1.27	153	.204
	female	102	164.49	23.43			

Appendix 3: Correlation Analysis (n=156)

	Academic Dishonesty	School Engagement	Self Efficacy	Psychological Wellbeing	Age
Academic Dishonesty	1				
School Engagement	-.259**	1			
Self-Efficacy	-.171*	.241**	1		
Psychological Wellbeing	-.168*	.136	.251**	1	
Age	.165*	.005	-.181*	-.079	1

Appendix 4: Model Summary

R	R Square	Adjusted R Square	Standard Error of the Estimate
.431	.186	.157	9.99

a. Dependent variable: Academic Dishonesty

b. Predictors: Age, Gender, School engagement, Self-efficacy, Psychological wellbeing

Appendix 5: ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig
Regression	3168.01	5	633.60	6.35	.001
Residual	13876.73	139	99.83		
Total	17044.74	144			

a. Dependent variable: Academic Dishonesty

b. Predictors: Age, Gender, School engagement, Self-efficacy, Psychological wellbeing

Appendix 6: Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig
	B	Std Error			
Constant	51.414	12.432		4.136	.001
Gender	-6.648	1.760	-.291	-3.777	.001
Age	.874	.487	.140	1.793	.075
School Engagement	-.292	.102	-.224	-2.849	.005
Self-Efficacy	-.147	.164	-.073	-.896	.372
Psychological Wellbeing	-.035	.038	-.074	-.927	.356

a. Dependent variable: Academic Dishonesty

Predicting Informal Waste Picking Hotspots for Greening Mombasa: A GIS Analysis on Settlements

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Abstract

Greening Mombasa initiatives has often overlooked informal waste pickers in green waste strategies. The lack of clear determinants for green growth hampers the ability to provide proper guidance to policymakers on waste management, circular economy, green jobs and food systems security interventions. The study objectives sought to predict hotspots within urban settlements in Mombasa County using a GIS besides analyzing the extent of waste picking hotspots for greening Mombasa. Hotspot analysis identified groupings of settlements within 1metre distance, representing locations that are hard to access by trucks. Corresponding to hotspots. Spatial autocorrelation Moran's – I analysis showed clustering of waste-picking hot spots existed with Moran's I of 1.003. High waste-picking hotspots wards include; Mikindani, Tudor, Mjambere and Kongowea wards. Contributing factors to incidences of hotspots are identified, such as mangroves, land use type, and naturals in high hotspot wards with a significant level of 99%. Graphical weighted regression shows a 57% relationship between 1,000m mangrove buffer radius and hot spots settlements. Multiple buffers of 500m, 1,000m, and 1,500m radius within hot spot settlements of z-score > 4.7 revealed hotspots are at points where land use and natural activities are mainly industrial, meadow, construction, quarry, and forests, respectively. Investment in greening of waste picking within hot spot settlements is essential. Thus, the study recommended County agents and waste stakeholders should implement cost-effective waste management policy measures such as information, training of waste stakeholders, adoption of modern solid waste management practices, and investment in waste management by collaborating and incorporating informal waste pickers in greening Mombasa County. Thus, enhancing urban food systems security and value addition.

***Key words*:** Greening Mombasa, hotspot analysis, waste management, municipal waste collection, GIS mapping, waste pickers

Introduction

The Department of Planning, land, and Housing reported that 65% of the residents of Mombasa are housed in informal settlements. The rising urbanization in the county results in an

increase in the quantities of solid waste produced consequently an increase in demand for solid waste management services.

Mombasa generates approximately 2200 tons of waste and only 65% are collected and 13% of household's access county (local authority) waste management services due to mismanaged primary collection points. Recent data shows that 68 percent of the waste generated in Mombasa is organic while 30 percent is recyclable. Therefore, it has led to the emergence of private waste handlers who lack resources as well as capacity (Wekisa, & Majale, 2020).

The literature is scarce on the relationship between solid waste management and informal inaccessible settlements in Jordan (Al Tai *et al.,* 2021) and in cities of the North (Porras *et al.,* 2021). The study revealed unconventional measures, unreliable solid waste collection strategies, inadequate urban regeneration and renewal programs were used to control and manage waste in informal settlements in the city. (Hiltunen, 2010; DL & Moja, 2014) reported that in Nairobi Kenya informal waste pickers are not incorporated in the waste management system though municipalities claim to have incorporated them. Imperfections in waste management systems are covered by informal urban waste pickers whose work can be seen as a helping hand for municipalities. Gall *et al.,* (2020) concluded that post-consumer plastic wastes sourced from informal waste pickers in a lower-middle-income country can be processed into materials that are comparable to state-of-the-art recyclates obtained from an advanced formal recycling system in a high-income country in terms of both composition and basic engineering properties. If the right model of cooperation is found, this can come along with socio-economic and societal improvements for the people working and living in the informal sector.

Forty eight percent of waste is 'informally managed', most commonly burnt, buried, or dumped illegally (Palfreman & Clark, 2015). The public policies currently prioritize prohibitions and persecution, often paralleled with

social policies. Yet, there are few policies capable of recognizing the environmental benefits of waste picking and looking to integrate waste pickers into the social fabric.

Evariste and Theobald (2021) identified measures such as strengthened awareness at the local level as well as appropriate and negotiated civic actions initiative that facilitate the building of communities of stakeholders working together to inform policy-making. However, in their review, David, John and Hussain (2020) noted an effective waste system should involve financial, skilled human capacity, technical, social, resource recycling, educational awareness programs, active public participation and technological proficiency besides policies formulation.

A case study, conducted over 5 months in 2018, involving 21 waste picker cooperatives in the metropolitan region of São Paulo, Brazil by Gutberlet (2021) demonstrated the impacts of the work of organized waste pickers on SDGs (goals # 1, 5, 8, 11 and 12). The study showed that when organized and supported by public policies and inclusive governance, these groups address social (poverty, hunger, gender equality, and social inequality), economic, and environmental targets by building resilience and reducing vulnerabilities (Buch *et al.,* 2021). Their role is especially relevant in developing nations where the recycling industry is in the early stages of modernization (Abdel-Shafy & Mansour, 2018). Waste management and circular economy interventions can make a significant contribution to reducing energy usage and pollution, add value, and provide more jobs than landfilling or burning waste (ILO, 2018b; Bureau International du Travail, 2018). The massive size of this informal industry of waste pickers is reflected by their existence in various cities around the world, including 40,000 in Cairo, Egypt; 17,643 in Lima, Peru; 8,850 in Pune, India; and 10,105 in Quezon, Philippines (Alfaia, Costa, & Campos, 2017). These figures reveal the enormous scope and scale of the informal solid waste collection industry.

Ferronato *et al.* (2020) assessed the main challenges and opportunities for implementing the circular economy in

developing regions. Findings revealed that the inclusion of informal recycling, the activity of waste pickers allows for reducing the expenses by about 10%, increasing the recycling rate of about 3.5%, and reducing the distances travelled with compactor trucks of about 7%. The study by Yu, Blaauw and Schenck (2020) investigated the labor market of waste pickers in the Bellville CBD. It highlighted their socio-economic vulnerability, and revealed that waste pickers provide an invaluable service to local authorities. Therefore, practitioners and policymakers need to urgently engage in facilitative processes to dignify their working conditions. Examples include supportive policies such as the provision of adequate personal protective equipment and more awareness programs on the related health risks (Uhunamure, Edokpayi, & Shale (2021). In addition, the work that they are doing should be valued (Uddin *et al.*, 2020).

An assessment by Asif (2023) considered the implementation of sustainable waste management methods such as trash reduction, recycling, and energy recovery as a potential solution to limited infrastructure, weak governance, and a lack of public knowledge in Pakistan's municipal solid waste (MSW) management. To the best of our knowledge, the application of GIS to the collection of waste management is still not well documented in the literature. A few studies have quantified the spatial variations in collected waste based on residential areas. The use of spatial statistics tools such as hot spot analysis in assessing the variation of municipal solid waste collection is one of the key approaches, but which remains unexplored.

The spatial data generated using hotspot analysis is useful for predicting waste-picking hotspots for greening Mombasa and answering the question to what extent is the GIS analysis of settlements predict waste-picking hotspots for greening Mombasa? Thus, a useful input to further implement cost-effective waste management policy measures such as information, training of waste stakeholders, adoption of modern waste management practices, and investment in waste management in Mombasa County and the rest of the world.

Theoretical Basis

The analysis of the hotspot is aimed at identifying groupings within a region. Such groupings can represent either high or low values of a given parameter, corresponding respectively to hotspots and cold spots (Sánchez-Martín *et al.,* 2019). A hotspot analysis (Getis-Ord Gi*) is performed to classify these spots, which can be implemented via ArcGIS (Prasannakumar *et al.*, 2011; Getis & Ord, 1992). Hotspot analysis is used to find the similarity pattern. Z-scores and *p*-values for each polygon and statistically significant hotspots and cold spots are identified. An area was considered statistically significant if its *p*-value was below 0.05.

The Getis-Ord local statistic is given as

$$G^*_i = \frac{\sum_{j=1}^{n} w_{i,j}x_j - \bar{X}\sum_{j=1}^{n} w_{i,j}}{S\sqrt{\frac{\left[n\sum_{j=1}^{n} w^2{}_{i,j} - \left(\sum_{j=1}^{n} w_{i,j}\right)^2\right]}{n-1}}} \quad \text{.....(1)}$$

Where x_j is the attribute value for feature $j, w_{i,j}$ is the spatial weight between feature $i \; and \; j, n$ is equal to the total number of features and:

$$\bar{X} = \sum_{j=1}^{n} x_j \quad \text{..... (2)}$$

$$S = \sqrt{\frac{\sum_{j=1}^{n} x^2{}_j}{n} - (\bar{X})^2} \quad \text{.....(3)}$$

The G^*_i statistic is a $z - score$ so no further calculations further calculations are required.

Methodology

Figure 1 is the analytical framework used in this study. The independent variable is the type of building in Mombasa County Urban Settlement. These spatial data could be buildings occupied by humans, commercial buildings or industrial buildings. It was hypothesized that the nature of such buildings impacted on the intensity of waste picking hotspots (low, medium, high). There were other spatial data which were considered as intervening factors.

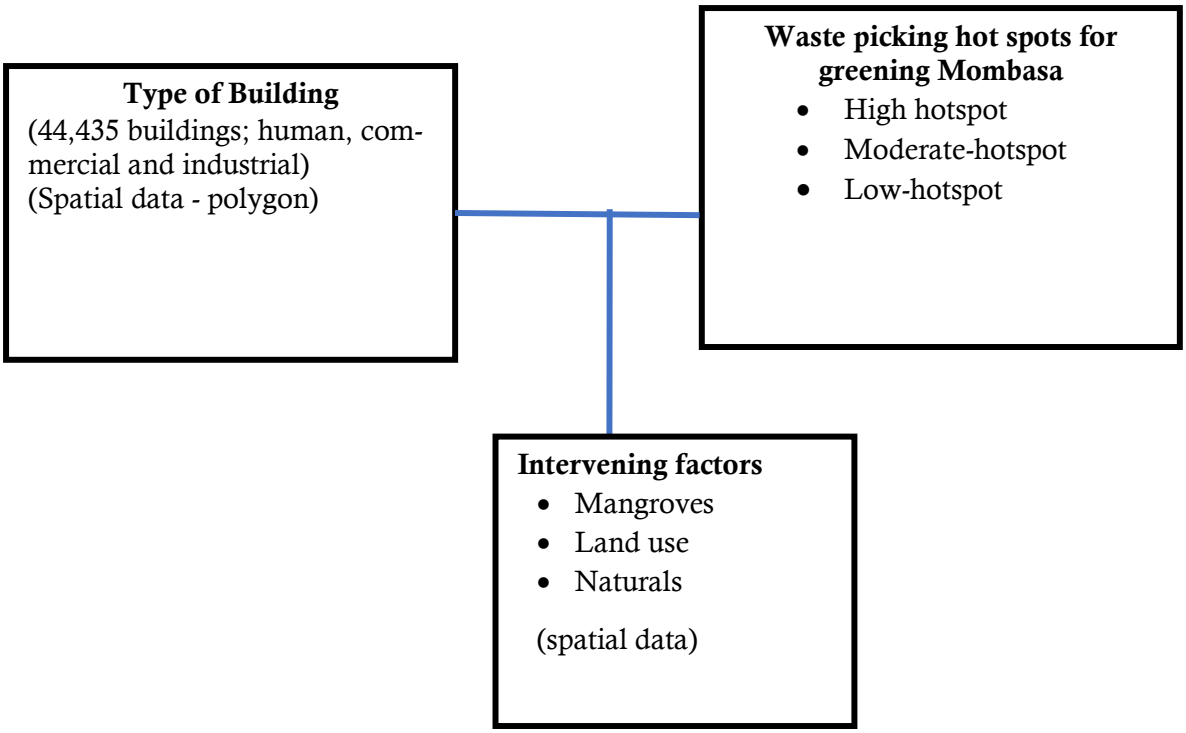


Figure 1: Analytical framework (Author)

The software used in the study was ArcMap10. Shape file polygon data of urban settlements (44,435 buildings, consisting of human settlements, commercial, and industrial) in Mombasa County was clipped from the total 47 counties in Kenya. The data was projected to WGS_1984_UTM_Zone_37S. The building polygon was converted to point data. An integrate feature tool was used to snap together a copy of all buildings within 1 metre. One metre was chosen to identify all buildings that are hard to access by trucks. All the points that were snapped together were counted. Hotspot analysis was performed using the collect event data. Interpretation of data to show urban settlements with hotspots and cold spots was made. Optimized hotspot analysis was further done from the hotspot data where the incident data aggregation method of snapping nearby incidents to create weighted points was selected. The higher the *z*-score the higher the cluster (Hot spot). The lower the *z*- score the lower the cluster (cold spot). A continuous surface density was generated from the optimized hot spot analysis data using the IDW

interpolation tool. Zonal statistics based on mean statistics type were computed from the interpolated data to obtain the hot spot Wards in Mombasa County. The national census' data with 47 counties was clipped to obtain the Mombasa County administrative boundaries with censor data which formed the study area. A column was added to the national censor's data attribute table for population density. Ward population was used to calculate population density by dividing the ward population by the area of each ward. A geo-processing tool was run to intersect census data (study area) and waste-picking optimized hot spot data. A total of 12,294 optimized hot spot features were formed consisting of both hot and cold spots. "Select by attribute tool" was used to select features with *z*-score >= 4.7. A total of 1,392 new features were formed consisting of only hot spot regions. Buffer analysis was carried out using the arc toolbox to generate a multiple buffer radius of 500m, 1000m and 1500m within the 1,392 hot spot features. The "select by location" tool was used to select target data layers (mangrove forest, naturals and land use) that are completely within each of the selected buffer radii 500m, 1000m and 1500m of the source 1,392 hot spot data and new features renamed as high, medium and low factor respectively. The new select features consisting of land use, naturals and mangroves completely within each of the buffer radius 500m, 1000m and 1500m attribute tables were copied into an Excel sheet for further analysis.

Results

Table 1 shows the results for high factor land use within 500m waste-picking hotspot radius.

Table 10: High factor land use within 500m waste-picking hotspot radius

Type	Frequency	%
Industrial	9	43
Construction	2	10
Residential	3	14
Quarry	1	5
Grass	1	5
Meadow	4	19
Recreation Ground	1	5
Total	**21**	**100**

Industrial activity was the major factor contributing to hotspots within a 500m waste picking hotspot radius at 43%, meadow at 19%, construction at 10%, residential at 14%, quarry at 5%, grass at 5%, and recreation ground at 5%. This means that industrial, meadow, and residential are major factors contributing to waste-picking hotspots within 500m waste-picking hotspot radius at an aggregate of 76%.

Table 2 shows medium factor land use within 1000m waste-picking hotspot radius. The Table indicates that industrial use is the major factor contributing to hotspots within a 1000m waste-picking hotspot radius at 83% and residential use at 17%. This means industrial use is a major contributor to hotspots within a 1000m waste-picking hotspot radius.

Table 11: Medium factor land use within 1000m waste-picking hotspot radius

Type	Frequency	%
Industrial	5	83
Residential	1	17
Total	**6**	**100**

Table 3 contains findings on low factor land use within 1500m waste-picking hotspot radius. It shows that industrial buildings are a major contributing factor to hotspots within a 1500m waste-picking hotspot radius at 60%, grass at 20%, and meadow at 20%.

Table 12: Low factor land use within 1500m waste-picking hotspot radius

Type	Frequency	%
Industrial	3	60
Grass	1	20
Meadow	1	20
Total	**5**	**100**

These results imply that industries are major contributors to hot spots within a 1500m waste-picking hotspot radius.

Table 4 contains findings on high factor naturals within 500m waste-picking hotspot radius. It is evident that forests are major contributors to hotspots within a 500m waste-picking hotspot radius at 93%, park at 7%.

Table 13: High factor Naturals within 500m waste-picking hotspot radius

Type	Frequency	Percentage
Park	1	7
Forest	14	93
Total	**15**	**100**

These results imply forests are major contributors to hotspots within a 500m waste-picking hotspot radius. Figures 3-7 and Table 8 below provide further evidence of the study findings as discussed in the next section.

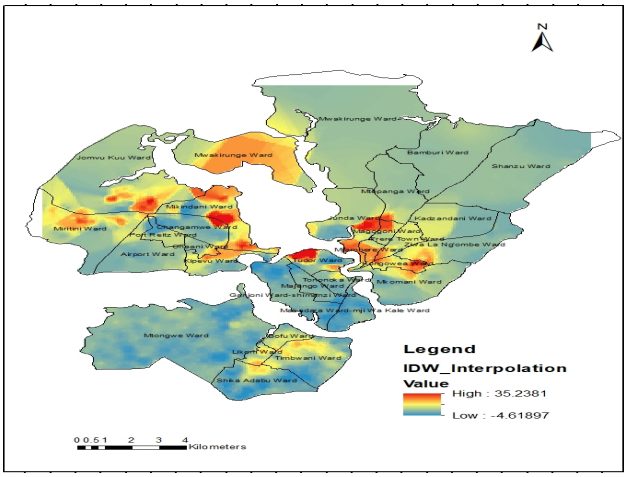


Figure 3: Optimized hot and cold spot

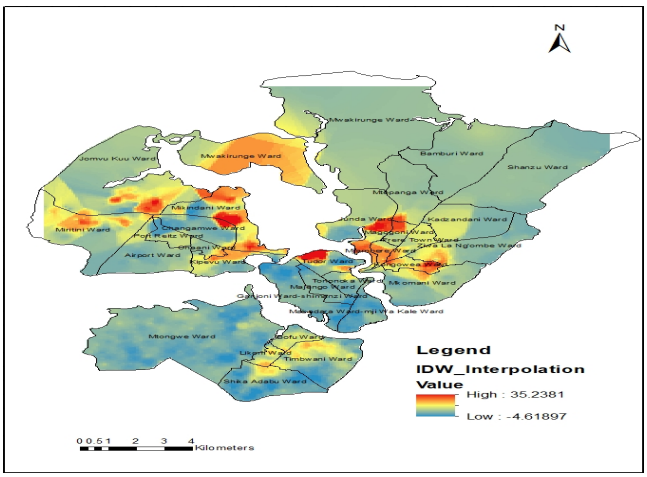


Figure 4: IDW Interpolation of hot and cold spot

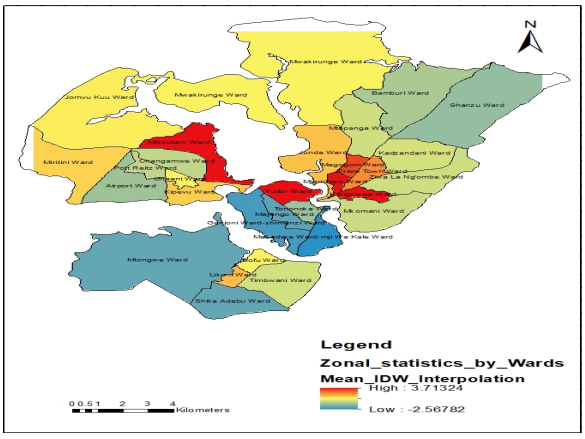


Figure 5: Mean Zonal statistics

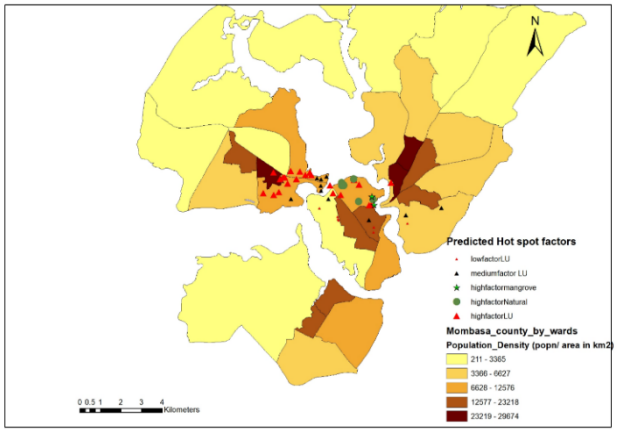
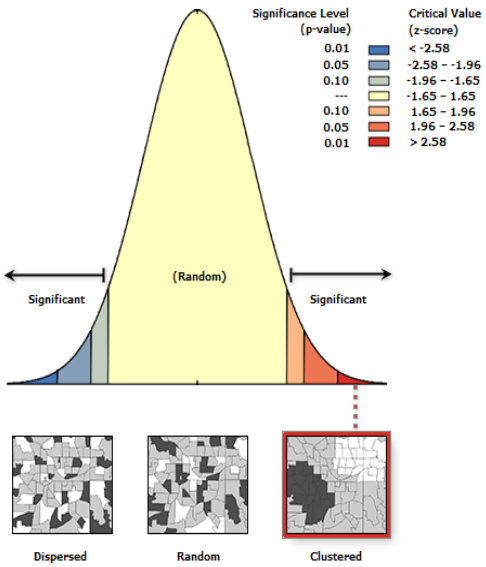


Figure 6: Land use naturals and mangroves within waste picking hotspot radius of 500m, 1000m, and 1500m



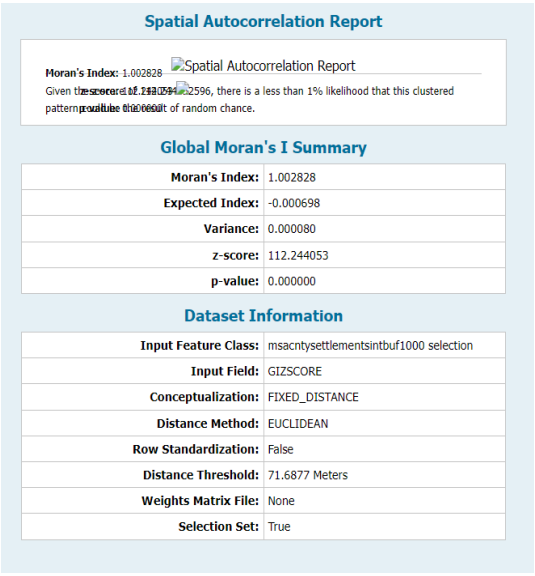


Figure 7: Spatial Autocorrelation Moran's I Report

Table 8: ***Graphical Weighted Regression Results***

Executing: Geographically Weighted Regression "msacontysettlementsintbuf1000 selection" Gizscore FID_mangro C:/Users/Yvonne/Documents…	
Start Time: Mon Feb 19 09:14:04 2024	
Bandwidth	0.01135078515077775
Residual Squares	30893.1620215654
Effective Number	10.110614927382384
Sigma	4.6579310428711826
AICc	8490.5028784427395
R^2	0.57682591303239239
Succeeded at Mon Feb 1909:14:34 2024(Elapsed Time 30.04 seconds)	

Discussion

Spatial autocorrelation Moran's - I analysis determined whether indeed clustering of hot spots existed (Fig. 7). The spatial autocorrelation report showed clustering of waste-picking hot spots existed with Moran's I of 1.003 which is a strong correlation of hotspot settlements in Mombasa County. Hotspot settlements were observed with a significance level of 99% (Fig. 3).

The data sets are in discrete form. The Inverse Distance Weighting (IDW) analysis, interpolates the large data sets by collecting similar data sets together into continuous data sets (Fig. 4).

The zonal statistics aggregated the continuous data sets based on mean within the administrative boundaries (Fig. 5). Hot spot wards were observed in Mikindani, Tudor, Mjambere and Kongowea wards (Fig. 5). These are the statistically significant wards. Thus, there exists at least 30 groups of hotspot settlements within 1metre distance, representing locations that are hard to access by trucks. Multiple buffers of 500m, 1,000m, and 1,500m radius within hot spot settlements of *z*-score > 4.7 revealed hotspots were at points where land use activities are industrial, meadow, construction, quarry and natural activities are mainly forest and mangroves.

Contributing factors to incidences of hotspots were identified such as mangroves, forest, construction and meadow in Tudor; Industrial, construction/quarry, and meadow in Mikindani; residential in Mjambere; and Industrial in Kongowea (Fig. 6). Graphical weighted regression showed a 57% relationship (corresponding to 0.57 strong correlation) between 1,000m mangrove buffer radius and hot spots settlements. (Fig. 8).

Conclusion

The main objective of this paper was to identify hotspots within settlements and analyzing waste picking hot spots for greening Mombasa. Graphical weighted regression showed a 57% relationship between 1000m mangrove buffer radius and hot spots wards. High-priority waste-picking hotspots wards include Tudor, Mikindani, Mjambere and Kongowea.

Contributing factors to incidences of hotspots were identified. These included mangroves, forest, construction and meadow in Tudor; Industrial, construction/quarry, and meadow in Mikindani; residential in Mjambere; and Industrial in Kongowea.

Investment in solid waste management and environmental education among waste stakeholders including local community members is essential in these wards. Thus, enhancing food systems security by ensuring sustainability of waste picking while preserving the environment and economic base of the community within hot spot settlements. Industrial waste may pollute the nearby soil or adjacent water bodies, and can contaminate groundwater, lakes, streams, rivers or coastal waters.

Quarrying can contribute to climate change by damaging the landscape, which can lead to erosion, landslides, and flooding. Quarrying can also release toxic substances into the air and water, which can harm aquatic life and pollute groundwater.

Construction causes habitat loss, ecosystem disruption, air and noise pollution, water pollution, and waste generation. Sustainable construction practices are essential to mitigate these impacts.

Meadow functions typically assist surface storage, reducing downstream flooding, re-charging the aquifer during floods, supporting a shallow water table with native vegetation that minimizes erosion. Marine and coastal resources such as mangrove forests with rich fisheries resources play an important role in sustaining livelihoods. However, they are threatened by factors such as overexploitation and pollution as informal settlements increases. This has drastically depleted fish stocks and destroyed their habitats.

Mangroves have potential socio-economic benefits such as protecting the shoreline from storm and soil erosion, flood and flow control, acting as a carbon sink, provides a fertile breeding ground for marine species and fauna. A good site for beekeeping activities and controlled aquaculture farming. It also acts as a source of income by providing various forest products.

To ensure sustainability and wellbeing, informal waste pickers should be incorporated

in the waste management system with smaller, simpler and more appropriate vehicles such as human powered, animal powered or even motorised at primary collection services. Collection service can have different variations, self-delivered-in, summoning by a bell to bring the waste to a collection vehicle, door to door service where a collector knocks on each door to obtain separated waste and a kerbside service where residents leave their waste at the kerbside for collection. A secondary collection point would be created where separated collection waste is then disposed or stored in large container hauled systems and stationary systems. The waste would then be transported with a larger vehicle to a recycling, treatment or disposal facility.

The spatial data generated is useful for analysing waste-picking hotspots for greening Mombasa and can be a useful input to further implement cost effective solid waste management policy measures such as information, training of waste stakeholders, adoption of modern solid waste management practices, decision making and investment in solid waste management in Mombasa County and the rest of the world. Co-management and collaboration among all stakeholders in solid waste management should be emphasized and a system established by policy makers to ensure sustainability and wellbeing.

Recommendations

The study recommends that the county agents should:

i. Have initiatives developed especially for vulnerable groups waste pickers and community-based organisations and be incorporated in co-management of waste collection points, services and accessing thirty percent of county government contracts.

ii. Facilitate market linkages between local and external investors of unrecycled waste streams or waste types for purposes of supply chain management on behalf of waste pickers.

iii. Have access to information dissemination through radios, Television, smartphones SMS, toll-free hotlines including conferences, workshops and seminars to share their experiences, opinions and views about becoming organized.

iv. Mobilize informal waste pickers for capacity building on group dynamics, management, leadership, group advocacy strategies for sustainability and wellbeing.

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Utilizing Epistemic Rights to Combat Online Misinformation

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Abstract

This study investigates the significance of epistemic rights in curbing the rapid propagation of online misinformation, including text, images, audio, and video. It maintains that the diffusion of misinformation constitutes an urgent worldwide challenge that has prompted numerous reactions from scholars, policymakers, civil society, and industry. Utilizing a qualitative approach via a literature review, the paper assesses the importance of epistemic rights for limiting misinformation, asserting that social epistemology examines how we depend rationally on others to achieve our epistemic goals. The online sphere is saturated with misinformation; knowledge presupposes belief, so reluctance to adopt beliefs restricts opportunities for knowledge. The article argues that the presence of misinformation can hinder knowledge acquisition; individuals may be dissuaded from engaging in activities that would produce true beliefs, not because they think deception is inevitable, but because they realize that in an information landscape rife with falsehoods, trustworthy inquiry is likely to be labor-intensive. The paper concludes that in the contemporary digital era, the simplicity of sharing information online has rendered misinformation a widespread epistemic problem. We heavily rely on one another for epistemic resources-information about reality, comprehension of complex issues, and knowledge. These interdependencies expose us to intellectual fragility, creating a demand for epistemic rights.

Key words: Beliefs, Epistemic Rights, Misinformation, Social Epistemology.

Introduction

The problems caused by online misinformation and how big social media platforms affect our media environment and public discourse have drawn more attention from academics and business. Numerous significant epistemological inquiries have emerged regarding online misinformation, and in recent times, worries have intensified regarding its impact on our beliefs. The notion that we are experiencing a truth crisis has gained widespread acknowledgment, as truth is crucial for the process of knowledge acquisition. Carlson (2020) noted that online misinformation results in both epistemic and psychological damage for those affected, causing an exclusionary effect on the public sphere that forces marginalized groups to self-censor their information to prevent harassment.

Misinformation refers to narratives and interpretations of events that present alternative views, diverging from the narratives shared by the news media, thus contributing to a crisis regarding authority and legitimacy. It encompasses all types of false or misleading information, regardless of the intent behind it (Altay et. al. 2023). False information, on the other hand, refers to information that is intentionally created or distributed to deceive, incite skepticism, exacerbate political divisions, undermine political figures, and create confusion at both national and global levels. Wardle (2017) defined misinformation as inaccurate or misleading information disseminated unintentionally, and disinformation, the deliberate spread of falsehoods for strategic manipulation. The same information may be categorized as either misinformation or disinformation based on the motives of the sender. It is often challenging in practice to determine the intent behind spreading false information. Typically, those who spread false rumors are unlikely to reveal their true intentions, and it is often challenging to trace the origins of misinformation.

The article contends that the mounting

dangers to many of our important epistemic institutions have made the concept of epistemic rights more urgent. These institutions, which include public education, media, cultural organizations, public healthcare, and various social services, are at risk of being severely compromised. (Watson, 2021, p.7) defines epistemic rights as rights pertain to access to knowledge—not simply about being informed, but being truthfully informed, understanding the importance of information, and utilizing it effectively for personal and societal well-being. Groce (2023) observed that Watson conception of epistemic rights mandate actions and omissions that aim at protecting right-holders from harm. Rights to do so by playing constraints on our behaviour for the sake of the right-holders' wellbeing. Epistemic rights are complex entitlements that provide justification for the performance and probation of actions and omissions concerning epistemic goods. The paper argues that epistemic rights also encompass measures such as epistemic reparations in instances of severe violations and injustices. It emphasizes that every individual holds the epistemic right to acquire knowledge, contribute to its production, make use of it, and share it with others.

Research Objectives

The objectives of this research are to:

(a) Address the negative epistemic effects of misinformation found online.

(b) Analyze how online misinformation affects learning.

(c) Evaluate the reasons why remedies, such as truth-based fact-checking of verifying the accuracy of online information are ineffectual.

(d) Evaluate how online misinformation affects economy and the society.

(e) Recognize the importance of epistemic rights for curbing the propagation of online misinformation.

Research Questions

The following research questions guided the study:

(a) What are the negative epistemic effects of misinformation found online?

(b) How can online misinformation affect learning?

(c) Why are truth-based remedies, such fact-checking, ineffective against online misinformation?

(d) What are the effects of online misinformation on the economy and society?

(e) How important are epistemic rights for

curbing the propagation of online misinformation?

Methodology

Through a literature review, this study employs a qualitative methodology to investigate the significance of epistemic rights in relation to knowledge in light of the threat posed by online misinformation. Access to and availability of all relevant and accurate information are part of the epistemic rights. Epistemic rights, as a concept in social epistemology, are about knowledge and the availability of relevant and accurate information, both of which are essential for preserving democracy and ensuring that citizens have equal access to knowledge. Epistemic rights must be protected if a democratic society needs accurate information to run its affairs.

Review of the Literature: Epistemology and the Challenge of Online Misinformation

Examining how appearances might consistently diverge from reality and considering the implications of such deviations for human comprehension constitute an essential component of epistemology. Historically, ancient skeptics probed how the constraints and idiosyncrasies of our sensory systems, coupled with the conditions of our physical bodies, could distort our perception of the external world. In a similar vein, the ancient Chinese philosopher Zhuangzi and early modern thinker René Descartes questioned whether our experiences might be mere illusions—perhaps dreams or deceptions orchestrated by a powerful, deceptive force. (Auxier and Anderson 2021). Moving into the twentieth century, philosophers contextualized these concerns within contemporary frameworks, imagining situations where human experience might be artificially manipulated by malicious intervention using neuroscience.

Apuke and Omar (2020) observed that political actors and their online armies frequently used fabricated news pieces, altered photographs and videos, and provocative social media postings. However, the context we inhabit can either facilitate or impede the development of beliefs that possess favorable epistemic status such as rational, justified, or warranted beliefs, as well as knowledge related goals when online misinformation becomes more integrated into our information. It is undeniably true that our views' credibility is imparted by the reality around us, the accuracy of our beliefs depends on the status of the world. The epistemic rights were presented in this article as a crucial tactic to mitigate the spread of online misinformation.

In recent years, epistemologists have developed detailed thought experiments examining how the presence of fake elements

in one's environment might hinder the process of acquiring knowledge. This makes the epistemological exploration of online misinformation a natural extension rather than a significant departure from existing practices. It essentially involves applying established conceptual frameworks to contemporary, real-world situations. Online misinformation has emerged as a pressing issue over the past few years. It materializes through false or misleading content such as fake news, conspiracy theories, click-bait, and propaganda, each playing a role in shaping major political and social events. Lewandowsky et.al. (2017) noted that misinformation is usually transmitted without the intention of being misleading, it is commonly viewed as erroneous as or faulty information. It may be unintentional, resulting from misreporting, misunderstandings, or inadequate comprehension. While outright false claims are the most overt form of misinformation, truth can be manipulated in subtler ways. For instance, certain truth statements, whether individually or collectively, can mislead by implying inaccuracies. A notable example is the misapplication of the principle of balanced reporting, which can give the impression of a debate where none truly exists.

Epistemic rights encompass equal access to and availability of accurate and relevant information related to issues of will formation and decision-making. They also include equality in developing the ability to critically evaluate and apply knowledge for both personal and collective benefit, participation in public discussions on matters of shared interest, and the freedom to make choices without external coercion or undue influence (Nieminen, 2023, p.14). However, states and intelligence agencies have inundated social media with misinformation designed to create confusion, manipulate public opinion, and influence electoral outcomes. This struggle for control over public perception has taken on new dimensions where not only do governments produce propaganda and misinformation, but various entities have refined these practices, turning them into profitable ventures. Yet, an important question arises: is online misinformation always intentionally deceptive? The reality is that some instances of online misinformation undoubtedly are crafted with deliberate intent to mislead, accept falsehoods or distorted truths.

Stanley (2016) noted that when political motivations are at play in the production of propagation of online misinformation, there is a clear intention to make people believe falsehoods or misleading truth. Dentith (2014) observed that conspiracy theorists typically do not view themselves as individuals deliberately deceiving others. Information is a critical epistemological resource - without it,

ignorance prevails. For information to fulfill its purpose, it must be grounded in truth. If a society relies on truthful information to function effectively, it must safeguard the epistemic rights essential for fostering accuracy and reliability.

Gerken (2020) highlighted several ways in which misleading impressions can be created, including the act of refusing to comment, which may appear incriminating. Moreover, the improper use of statistics, quoting statements out of context, and employing specific labels or framing techniques can shape perceptions in a misleading way. Importantly, misleading effects can arise not just from content but also from how information is presented. For example, some sources of fake news intentionally imitate the style and format of reputable mainstream newspapers to appear more credible. Oreskes and Erik, (2010) noted that conspiracy theorists certainly don't think of themselves as intentionally misleading people and the same goes for strong political partisans who present misleading takes on politically relevant information. Instead, they see themselves as correcting mainstream misinformation. Clickbait writers also don't mislead people intentionally. Their goal is to get enough clicks to make some money and they don't care about whether they convince anyone of anything, as long as people click (Cassam, 2019).

Oreskes and Erik (2010) observed that purveyors of misinformation adopt the general strategy of sowing as much confusion as possible, rather than trying to convince anyone specific claims. In so far as they mislead intentionally, it is not but convincing people of specific substantive claims, but by promoting false higher-order beliefs about the evidential situation-beliefs that there are more uncertainty and confusion than there really is. So, there is both intentionally misleading and unintentionally misleading misinformation. In ordinary usage, misinformation stands for false misleading information that has a systematic or structural quality to it, or that is not transparently presented as non-veracious. This rules out honest mistakes in reporting. With an honest mistake, the falsity or misleadingness is an accident and does result from structural features of the way the information is produced and spread about.

It is bad to acquire false beliefs and to be confronted with misinformation regularly. Even if you don't think it is definitely

instrumentally bad. If you make decisions based on bad information, you will run into problems sooner or later. Healthy democracy depends on a well-informed citizenry. When misinformation proliferates, it becomes normalized, thus creating a culture in which respect for truth erodes and facts matter less. It is trivially true that the epistemic status of our beliefs depends on the world around us: whether our beliefs are true or false depends on what the world is like. But it is also true in a more interesting sense. The environment in which we find ourselves can be more or less conducive to the formation of beliefs with positive epistemic status (rational, justified, or warranted belief, knowledge, understanding). People usually acquire false beliefs, the same way people consume information that is strictly speaking true but nonetheless misleading, they acquire misleading beliefs. Such beliefs may not undermine our epistemic aims immediately, but they do put us at greater risk of acquiring false beliefs, because it is easy to infer false beliefs from misleading ones.

Nozick (1981) noted that for your belief that p to be sensitive, it needs to be the case that, if p were false and you were to use the same method of belief-formation as you do in the actual world, you would not believe p. To evaluate sensitivity, we don't look at nearby worlds in which p is true, but we consider the nearest worlds in which p is false. Suppose that, in the actual world, you believe on good testimonial grounds that the Russian Sputnik V Covid-19 vaccine is safe and effective. Given what we know about Russian propaganda and international politics, in the nearest worlds in which the vaccine is unsafe or ineffective, there will still be plenty of misleading reports claiming that it is safe and effective, so you would still form a belief to that effect. This shows that your actual belief is not sensitive.

Accepting falsehoods or distorted truths undermines the foundation of reliable knowledge. Dentith (2014) noted that conspiracy theorists generally perceive themselves not as deliberate deceivers but as seekers or conveyors of alternative understandings. Information, being a vital epistemological asset, is crucial - without it, ignorance thrives. For information to serve its purpose effectively, it must be rooted in truth.

A society that depends on truthful information for its proper functioning must protect the epistemic rights necessary to ensure accuracy and dependability.

Gerken (2020) observed various ways in which misleading impressions can emerge, such as the refusal to comment, which can often be interpreted as an implicit admission of guilt. Additionally, tactics like manipulating statistics, taking statements out of context, and using specific labels or framing techniques can distort public perception. Significantly, the potential to mislead lies not only in the substance of the content but also in its presentation. For instance, some sources of fake news deliberately mimic the style and formatting of credible mainstream newspapers to enhance their appearance of legitimacy. Acquiring false beliefs and being constantly exposed to misinformation is harmful. Even if one may not view it as inherently problematic, relying on inaccurate information for decision-making invariably leads to difficulties over time. A thriving democracy relies on having citizens who are well-informed, yet when misinformation becomes widespread, it starts to seem normal.

This normalization fosters a culture where truth loses its significance, and facts carry less weight. The connection between our beliefs and the reality around us is evident: whether beliefs are true or false hinges on the actual state of the world. But this relationship is deeper than it appears. The environment we inhabit plays a crucial role in shaping our capacity to form rational, justified, or knowledgeable beliefs. False beliefs are commonly acquired in the same way that individuals might consume information that is technically correct yet intentionally misleading, often leading them to adopt misleading beliefs. Although such beliefs may not immediately compromise our ability to achieve epistemic goals, they heighten the risk of acquiring false ones. Misleading beliefs easily pave the way for further incorrect assumptions. Nnabuife (2022) noted that alongside poor digital literacy, media scepticism aggravated the vulnerability of news and information pollution worse.

Levy, (2017) highlighted how the impact of false and misleading information can be incredibly subtle. Misinformation's cognitive effects can persist within our mental framework and influence both thought processes and actions, even when individuals no longer consciously subscribe to the flawed ideas or have corrected their prior mistakes. Pollock (1986) noted that misinformation causes trouble for other epistemically upstanding beliefs, leaving us with less justified, rational, or responsible beliefs and knowledge than we would have had in its absence. It does so by giving you misleading defeaters, either by directly contradicting them (rebutting defeaters) or by discrediting their

source or grounds (undercutting defeaters). The presence of misinformation causes the average reliability of testimonial sources, such as online information to decrease. Since the acquisition of testimonial justification or knowledge requires that testimonial sources be reliable, it becomes harder for people to acquire justified testimonial belief. This, however, is too coarse-grained.

Misinformation can slip through the cracks of otherwise reliable sources and accidentally be reported as true. This effect increases when there is more and more sophisticated misinformation. However, well-funded major news organizations have resources to weed out most misinformation, but for those on smaller budgets operating under more pressure, this is harder to accomplish. As much as forms of branded content count as misinformation, the reliability of individual sources that run this sort of content goes down. This includes several of even the most reputable news organizations. With more misinformation around, your chances of accidentally consulting an unreliable source go up. Reductionists in the epistemology of testimony hold that knowledge from testimony requires a hearer, or reader or viewer to have positive evidence about the reliability of the testifier. Misinformation makes it harder to obtain such positive evidence.

When misinformation mimics the form of reliable scientific sources, easily ascertainable facts about a report's pedigree and appearance may cease to be sufficient positive evidence for reliability. Rather than just trusting a website appearance, you may have to check the exact URL. Coady (1992) observed that anti-reductionists in the epistemology of testimony argues that acquiring knowledge or justified belief through testimony does not necessarily require positive evidence about the reliability of the source. However, misinformation contaminates the pool of testimonial reports with false or misleading information, making it increasingly challenging for individuals to distinguish credible reports from unreliable ones. Faulkner (2018) highlighted the indirect negative effects of misinformation by analyzing how to impacts the modal properties of our beliefs. Modal analyses of knowledge have greatly influenced contemporary epistemology, and many scholars agree that the modal characteristics of ones' beliefs play a significant role in determining their epistemic value.

However, addressing the problem of misinformation involves difficulties in reaching those affected and altering their perceptions. Fact-checking initiative tends to prioritize identifying and validating false information over reshaping public beliefs. These efforts aim to determine the veracity of

specific content as part of resolving misinformation issues. Venon et. al. (2016) emphasize that fact-checking practices must consider the nature of misinformation challenges, identify them effectively, and work towards innovative solutions. Fact-checking involves the regular publication of evaluations that scrutinize the validity of claims made by various sources, including government bodies, politicians, institutions, news organizations, and social media users. These practices rely on models to classify statements as either true or false (Jiang & Wilson, 2018). While fact-checking has achieved significant progress in countering the persistent spread of harmful online misinformation and continues to be essential for verifying credible information, it is unlikely to address the incentive structures that perpetuate misinformation solely by determining its factual accuracy.

The beliefs of two people with similar cognitive abilities or intellectual virtues, who conduct their cognitive lives in similar ways, might have very different epistemic status, depending on the environments they find themselves in. The degree to which our beliefs have positive epistemic status can depend on factors entirely outside of our own cognitive agency. Kallestrup and Pritchard (2013) call this epistemic dependence*:* there is both a negative and a positive dimension to epistemic dependence. In the negative sense, factors that are completely external to one's cognitive agency can prevent one from having knowledge that one would have otherwise possessed. Environmental thinking helps to conceptualize the effects of misinformation at scale. Fake news degrades our epistemic environments by introducing spurious relevant alternatives to our knowledge claims or misleading defeaters, and by making our epistemic institutions, such as testimony, less reliable and trustworthy.

Misinformation introduces more pollution in our epistemic environments: false claims presented as true, true claims with misleading implications, conspiracies, doubt-mongering, etc. In other words, our environments become more deceptive, riskier, and epistemically less safe. To think about the epistemic quality of information environments, we can consider how well they function from the perspective of belief formation. Given our broad characterization of the epistemic perspective, we shouldn't expect there to be a single scale for measuring the epistemic performance of an environment. Rather, there are several relevant dimensions: *does our environment help us form true beliefs? avoid false beliefs, prevent mistaken inferences from true beliefs, correct false beliefs we have inadvertently formed, and update our outdated belief. How fast does it do these things? how reliably and exhaustively? how transparently? how accessibly? and about what sorts of topics and questions?* Other things being equal, epistemic environments

will be better to the extent that they help us form more true beliefs and less false beliefs, that they do so quickly, reliably, exhaustively, and transparently, with reasonable efforts on our part, and about those issues that matter to us.

The effects of misinformation, some might argue, could also hold a silver lining. They emphasize the enduring importance of the enlightenment principle of independent thought and intellectual autonomy. In a sense, misinformation serves as a harsh reminder that responsible belief formation requires effort and critical reflection. Navigating this new reality demands individuals take ownership of their intellectual rigor and conduct thoughtful investigation. It is true that excessive credulity is detrimental, and exercising proper epistemic vigilance is vital at all times. However, expecting everyone to adhere strictly to an individualistic notion of epistemic responsibility - where success in discerning truth rests solely on the individual - is overly simplistic. Zagzebski (2012) observed that the unavoidable dependency we all have on others and our environments for much of what we know and believe, intellectual self-reliance, while valuable, has its limits in the interconnected web of human knowledge. Therefore, while a degrading information environment may spur individuals to think more critically and scrutinize the quality of their information sources more closely, it ultimately poses significant risks. Not everyone can or should be expected to develop the deep expertise and advanced cognitive tools required to meticulously evaluate the overwhelming volume of information encountered daily.

Our complex world necessitates an information ecosystem that performs some level of pre-vetting and quality assurance. The average person cannot realistically take on the role of an investigative journalist or research scientist for every topic. However, people still have a responsibility to apply reasonable caution and judgment when consuming online content. By now, we all recognize that statements like "I saw it on Facebook" carry limited credibility. Misinformation - whether in the form of fake news, conspiracy theories, clickbait, or propaganda - harms individuals and society alike. Most misinformation shares a common feature, it originates from processes that are inherently unreliable, whether through deliberate manipulation or unintentional error. What makes this particularly insidious is that such unreliability is not always immediately apparent to most people. The harm caused by misinformation extends beyond individuals who internalize false beliefs.

It has broader, more subtle consequences: it disrupts the process of acquiring knowledge through reliable testimony, undermines trust in sources, and weakens the foundation of

justified beliefs. Essentially, misinformation contaminates the shared information environment upon which we depend. This erosion of epistemic trust makes it harder for us to participate in collective knowledge-building and exacerbates the challenges of navigating an already complex world. The balance between our cognitive efforts and the support provided by our environment has increasingly tipped against us. We now bear a greater responsibility for acquiring and maintaining well-founded beliefs.

Firstly, misinformation is not a single, uniform phenomenon. It encompasses various types, including those aimed at deception, confusion, or persuasion. While it may often carry political motivations, it can also serve commercial interests or personal gain. The intentions behind misinformation span a spectrum from honest mistakes to deliberate dishonesty. Secondly, its effects are equally far-reaching and diverse. Misinformation impacts both those who directly consume it and those who do not, creating significant disruptions in our broader information ecosystems. Thirdly, in the context of online learning, misinformation manifests in numerous ways, including:

i. False educational content: Unverified materials circulated on digital platforms, often presented as credible sources of instruction.
ii. Misinterpreted scientific data: Research findings misused or oversimplified, leading to erroneous conclusions.
iii. Misleading sources: Deceptive videos, images, and info graphics designed to manipulate.
iv. Misattributed quotes: Statements wrongly credited to authoritative figures, misleading learners about the reliability of the information.
v. Pseudoscientific theories: Assertions lacking empirical evidence but cloaked in scientific language to appear legitimate.
vi. Click bait titles: Headlines or summaries exaggerated to capture attention but often distorting the underlying content.
vii. Skewed visual data: Charts or graphs manipulated to present false narratives.
viii. Propagation of discriminatory or biased narratives: Content disguised as educational material but promoting stereotypes or prejudice.
ix. Fraudulent online courses: Programs that promise learning or certification but deliver misleading or unrelated information.

Addressing these diverse manifestations requires collaborative, system-wide efforts alongside individual vigilance to combat the

misinformation crisis effectively.

Misinformation has long been a pervasive issue, impacting various fields, including education. Social media, blogs, and online forums often function as major sources of information for students and teachers, enabling falsehoods to spread quickly and extensively. As highlighted by Bialik and Matsa (2017), the digital nature of education combined with the complexities of misinformation has led to a significant increase in the dissemination of false content in online learning environments. This challenge is closely tied to the rising use of social media among younger populations. The widespread circulation of misinformation within education creates a set of distinct obstacles for effective learning outcomes.

Relevance of Epistemic Rights

Although misinformation is not a new issue, the scale at which it spreads and its resultant impact have been greatly amplified by digital platforms and social media. This makes it a critical area of focus in the modern educational landscape. The shift towards online learning has exacerbated these challenges, as digital platforms - despite their advantages - have become central sources of educational materials. These platforms not only offer accessibility and convenience but also inadvertently enable the rapid propagation of unchecked and misleading information, creating significant barriers for both educators and learners. To address the issue of online misinformation, the assertion of epistemic rights is particularly important, with the following key aspects standing out.

(a) Equitable Access to Truthful Information

Equitable access to truthful information is fundamental to achieving sustainable development and promoting inclusivity across societies. Unfortunately, in many regions where such access remains a privilege rather than a right, transparency often exists more as an ideal than in practice. This is especially evident across much of Africa. According to Nieminen (2023), epistemic rights emphasize that every society has an obligation to ensure its citizens are provided with reliable information and knowledge, along with the skills to use this information for personal and societal benefit. However, systemic issues in economic and political structures often deeply entrench inequality within the information sphere. Existing frameworks for news and information dissemination frequently undermine the opportunities available to historically marginalized groups, reflecting widespread structural imbalances.

(b) Knowledge-based Proficiency

Knowledge-based Proficiency refers to acquiring essential skills like media literacy

and critical thinking. These skills enable individuals to access, and utilize knowledge effectively while identifying and challenging misinformation. This concept emphasizes equitable access to intellectual resources so that learners can achieve mastery and be recognized as credible knowledge holders. To develop such proficiency, learners must interact with three key types of knowledge: (1) Propositional knowledge (know-what): involves understanding facts and theoretical information. (2) Procedural knowledge (know-how): Focuses on practical skills and the ability to perform tasks. (3) Explanatory understanding (know-why): Centers on grasping the principles and reasoning behind information. According to (Flew, 2023, p.90), the Digital Services Act (DSA) seeks to secure fundamental rights in the online world while balancing safeguards for freedom of information and expression. This act introduces measures to address illegal content online, enhance algorithmic transparency and accountability, regulate online advertising more stringently, and impose specific duties of care on very large online platforms (VLOPs). Furthermore, it is critical to diminish the financial incentives for spreading misinformation online.

Watchdog organizations have raised concerns that vague or overly broad definitions of illegal content might empower private companies to over-censor content to avoid fines. This could unfairly impact a wide range of platforms and services. Amid these challenges, the role of reliable journalists becomes crucial. The general public depends on reporters who can simplify complex developments and provide clarity on the rapidly evolving dynamics of social, economic, and political events.

(c) Independence from External intrusion

Through stricter real name policies and enforcement against misinformation, account firms can achieve this through real name registration which is the requirement the internet users have to furnish the hosting of platforms with their authentic identity. (Gunther, 2015, p. 2) observed that this is the mechanism that Facebook uses, fakebook's name policy states: Facebook is a community where people use their authentic identities. You are required to provide the name they use in real life, that way, you always know who you are connecting with. This helps keep our community safe. The company require users to verify their names if flagged, providing identity which verification in one of three ways, (1) A government-issued ID that contains a name and date of birth, (2) Two different forms of documentation such as a bank statement or school record, one include photo or date of birth, two forms of ID from the second option plus a government ID that includes photo or date of birth.

Technology companies should ensure that hoaxes cannot become profitable, making it harder for malicious actors to monetize false information. Ensuring Freedom from External Interference Strengthening real-name policies and enforcing regulations against online misinformation can significantly combat the spread of harmful content. Real-name registration requires internet users to provide platforms with their verified identities. While this measure aims to promote accountability.

(d) Equality in Public Discourse

This refers to the right to participate equally in public conversations and to have one's input regarded as credible, which helps combat testimonial injustice often exploited by online misinformation campaigns. This erosion of public trust in online misinformation poses a serious threat to democracies. When online misinformation shifts from being occasional and random to organized and systematic, it becomes a misinformation campaign capable of disrupting political campaigns and governance across an entire country. Okoro and Emmanuel (2018) observed that online misinformation leads to instability, fear of violence, and even actual violence within democratic systems. Nigeria faces numerous security challenges, and the spread of fake news, rumours, hoaxes and online misinformation worsens the political climate, increasing chaos and instability. Therefore, ongoing awareness initiatives are essential to promote responsible online information sharing, including the use of social media.

(e) Epistemic Parity

Epistemic Parity relates to online information and data science. It describes a situation where conclusions drawn from synthetic or privatized data match those that would be drawn from the original real-world data. This concept suggests that synthetic data can serve as a trustworthy substitute for real world datasets, enabling public administration release without compromising privacy or research integrity often masquerades. Pennycook and Rands (2021) observed that online misinformation can be challenging to verify its accuracy. Online platforms frequently experience epistemic injustice, where algorithms or social structures suppress marginalized voices. Epistemic parity seeks to address this by ensuring that diverse perspectives are fairly valued and shared. Researchers, policymakers and media professionals continue to work toward reducing the spread of misinformation. Genuine news can be overshadowed by fake news, authentic scientific findings by pseudoscience, real photographs by deep fakes, and authentic information and sources may be difficult to distinguish from their counterfeit versions.

(f) Accountability within an organization

By holding platforms accountable in the fight against online misinformation, this requirement introduces a degree of state mediation into the modern content moderation process. Platforms have a significant impact on shaping and sometimes restricting public discourse, according to researchers and policymakers. Moderation, on the other hand, is one of the core platforms' services (Miller & Viccari, 2020). Platforms are inherently accountable for what goes on their feeds. Platform accountability in content moderation and the fight against online misinformation require regulation involving state actors.

Conclusion

Epistemic rights are central to fundamental human rights, equal rights to trustworthy information and knowledge are basic to epistemic rights. When it comes to critically evaluating and applying knowledge for their own and the public good, citizens must have fundamental epistemic rights. When misinformation aligns with preexisting beliefs, elicits an emotional response, or originates from a reliable source, people are more likely to believe it. Most of the time, a falsehood would have ruined the victim's image, sparked a crisis, or alienated people before it could be proven to be false. Social media users who are constantly in competition with one another do everything in their power to make their timelines attractive by publishing false reports and other pieces of information that would attract audiences in order to become more popular than others. On the other hand, some other verified users make money by spreading fake news frequently. These users do this for financial reasons, as the more people who read, comment, or watch content on their timelines, the more money they make. As a result, they publish false information at the risk of enriching themselves.

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Green Marketing and Consumer Brand Positioning in Western Kenya: A Critical Review

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Abstract

This study reviews the role of green marketing in shaping consumer brand positioning in Western Kenya, using the Theory of Planned Behavior (TPB) as a conceptual lens. With increasing global environmental concerns, the research examines how local businesses adopt green strategies and how consumers perceive and respond to them. A qualitative review of literature and empirical studies highlights that while green marketing can enhance brand image, loyalty, and trust, its effectiveness is constrained by economic limitations, low environmental literacy, weak regulatory enforcement, and prevalent greenwashing. Although consumers often hold positive attitudes toward sustainability, these intentions rarely translate into behavior due to affordability and limited access to credible green products. Subjective norms and perceived behavioral control are weakened by poor community awareness and lack of social reinforcement. Nevertheless, youth-driven activism, digital storytelling, and localized sustainability messaging present opportunities for greater brand engagement. The study concludes that green marketing strategies must be credible, affordable, culturally contextualized, and supported by stronger institutional and educational frameworks. Recommendations include targeted support for SMEs, third-party eco-certification, improved communication of environmental benefits, and further empirical research on green consumer behavior in diverse market segments.

Key words: Green Marketing, Brand Positioning, Sustainability, Consumer Behavior, Western Kenya

Introduction

Globally, escalating environmental challenges, including climate change, biodiversity loss, pollution, and unsustainable consumption, have compelled businesses and consumers to rethink conventional practices, catalyzing the rise of green marketing, which strategically promotes products and services prioritizing environmental sustainability (OECD, 2021). In developed regions, green marketing has evolved into a core element of corporate strategy, supported by robust policy frameworks and exemplified by companies like IKEA, Siemens, Tesla, and Patagonia, while Latin American markets such as Brazil and Chile show rising consumer demand for certified green products (ITC, 2022; World Bank, 2023). In Asia, countries including Japan, South Korea, and India are advancing green technologies and sustainable policies, demonstrating the potential for environmental

stewardship to drive innovation and brand differentiation (Salleh *et al.*, 2024; OECD, 2021).

Environmental degradation has compelled businesses and consumers worldwide to reconsider traditional production and marketing practices. This shift has accelerated the adoption of green marketing, defined as the strategic promotion of products and services that emphasize environmental sustainability. Green marketing aligns with broader movements toward sustainable lifestyles and production systems by embedding ecological responsibility into business strategy and consumer engagement (OECD, 2021).

In developed regions such as Europe, North America, and South America, green marketing has evolved from a niche initiative to a central pillar of corporate branding. Countries like Sweden, Germany, and the Netherlands have implemented strong policy frameworks supporting environmental labeling, product certification, and eco-innovation. Corporations such as IKEA and Siemens exemplify the integration of circular economy principles and sustainability-driven product design. In the United States, brands like Tesla and Patagonia have embedded environmental values into their core identities, leveraging sustainability for market differentiation and legitimacy. Latin American economies, including Brazil and Chile, reflect similar trends, where rising middle-class awareness and civic engagement have increased demand for certified green products (ITC, 2022; World Bank, 2023).

Asia has also made significant strides. Japan and South Korea are advancing in green technologies and sustainable urban development, with companies like Toyota leading the hybrid vehicle market and South Korean firms investing heavily in clean tech. India's Green India Mission signals growing governmental support for green entrepreneurship. These developments underscore a global recognition that environmental stewardship can drive innovation, brand competitiveness, and long-term profitability (Salleh et al., 2024; OECD, 2021).

Despite this progress, the global green marketing landscape remains uneven. Differences in regulatory support, consumer awareness, and corporate engagement across regions highlight the need to contextualize green marketing strategies within specific economic and cultural environments.

In Africa, the adoption of green marketing varies widely due to differing infrastructural, economic, and social conditions. South Africa has made notable progress in agriculture, renewable energy, and ecotourism, supported by advanced regulatory frameworks and growing consumer awareness. In contrast, many African countries face challenges such

as low environmental literacy, economic constraints, and limited infrastructure, which often prioritize affordability over ecological considerations (UNIDO, 2023).

Within East Africa, Rwanda has emerged as a leader through its strict plastic bag ban and rigorous enforcement of environmental policies. Uganda has promoted sustainable farming and environmental education. Kenya has also made policy strides, including the 2017 ban on plastic carrier bags and the National Climate Change Action Plan (2018–2022), aligning with global commitments under the Paris Agreement and the United Nations Sustainable Development Goals (Ministry of Environment and Forestry, 2018).

Institutional efforts to promote green marketing include the Kenya Bureau of Standards' eco-labeling guidelines, the Kenya Export Promotion and Branding Agency's push for sustainable branding, and the Medium and Small Enterprises Authority's frameworks to support MSMEs in adopting greener practices (KEBS, 2021; KEPROBA, 2022; MSEA, 2023). However, implementation remains uneven and largely concentrated in Nairobi and select urban centers. Outside these hubs, businesses face barriers such as limited access to green technologies, weak institutional support, and low consumer demand for sustainable products (UNDP, 2022).

Western Kenya—including Kisumu, Kakamega, Bungoma, and Vihiga—offers a strategically important yet under-researched context for green marketing. The region's economy is anchored in agriculture, small-scale manufacturing, and informal retail, sectors closely tied to environmental sustainability. Urbanization and increased media penetration, especially in Kisumu and Kakamega, suggest growing exposure to sustainability messaging. Rising digital connectivity and educational attainment among youth further indicate potential for environmentally conscious consumption.

This review explores how businesses in Western Kenya adopt and communicate green marketing strategies, how consumers interpret and respond to these messages, and whether such efforts contribute to brand trust, loyalty, and differentiation. It also identifies structural and behavioral barriers that limit the effectiveness of green marketing in the region (UNEP, 2021).

Theoretical Review: Theory of Planned Behavior

This study adopts the Theory of Planned Behavior (TPB) as its primary theoretical lens to examine how green marketing influences consumer brand positioning in Western Kenya. Developed by Ajzen (1991), TPB explains human behavior through the interaction of behavioral intentions and three key determinants: attitude toward the

behavior, subjective norms, and perceived behavioral control. The model has been widely applied to pro-environmental behavior, particularly in contexts where ethical considerations intersect with practical constraints (Yadav & Pathak, 2016).

In applying TPB to this study, the objective is to understand how consumers in Western Kenya form intentions to support environmentally branded products, and what barriers or facilitators influence whether these intentions translate into actual purchasing behavior. Given the region's economic limitations, infrastructural challenges, and uneven environmental awareness, TPB provides a structured framework for analyzing the cognitive, social, and structural dimensions of green marketing outcomes.

The relevance of TPB to green marketing lies in its ability to integrate individual psychological factors with broader social influences. In Western Kenya, where green branding is still emerging, consumers often make decisions in environments marked by limited product availability, inconsistent messaging, and varying levels of eco-literacy. TPB enables the analysis of both motivational drivers and contextual limitations like affordability and access (Otieno, 2019).

Attitude Toward the Behavior This construct reflects a consumer's evaluation of environmentally responsible purchasing. It includes beliefs about whether green products are beneficial, trustworthy, or superior to conventional alternatives. In Western Kenya, attitudes are increasingly shaped by awareness of environmental degradation, such as plastic pollution and deforestation. However, these attitudes often do not overcome cost sensitivity or skepticism about green claims (Mwaura et al., 2021). For instance, a consumer may value eco-friendly packaging but still choose cheaper alternatives if green options are perceived as less effective or more expensive. This highlights the need for credible messaging and clear demonstration of tangible benefits.

Subjective Norms Subjective norms refer to perceived social pressure to engage in or avoid a behavior. In collectivist communities across Western Kenya, decisions are influenced by peers, family, religious leaders, and community norms (Anyango et al., 2021). A consumer may be encouraged to support a green business if such behavior is promoted within church groups or youth clubs. However, social pressure to consume sustainably remains limited. Green purchasing is often viewed as an urban or middle-class concern. While digital activism and school-based environmental education are emerging, broader community endorsement is needed to normalize sustainable behavior.

Perceived Behavioral Control This construct assesses whether individuals feel capable of performing the desired behavior. In Western

Kenya, financial constraints, limited access to certified green products, and confusion over eco-labels reduce perceived control (Mwaura et al., 2021). Many consumers support green ideals in principle but feel unable to act due to high prices or lack of trust in product claims. Without affordable alternatives and reliable third-party verification, even strong attitudes and supportive norms may not lead to behavior change.

While TPB offers valuable insights, it has limitations when applied to green marketing in low-income and informal economies. One critique is its reliance on rational decision-making, which may overlook habitual, emotional, or culturally embedded behaviors. For example, practices like reusing containers or minimizing waste may be driven by economic necessity rather than environmental concern. TPB might misinterpret such actions as evidence of strong green attitudes, thereby misrepresenting the underlying motivation.

Another limitation is TPB's limited capacity to account for structural and systemic barriers, such as weak policy enforcement or inadequate market regulation. In Western Kenya, fragmented eco-certification systems and inconsistent labeling reduce consumers' ability to make informed choices. While perceived behavioral control attempts to address these constraints, it assumes individuals are fully aware of the barriers they face, an assumption that may not hold in low-literacy or informal market settings.

To address these gaps, scholars have proposed integrating TPB with complementary theories. For example, adding moral norms and emotional drivers such as guilt or pride can enhance explanatory power. In Southeast Asia, Kamalanon *et al.* (2022) found that young consumers were more influenced by moral obligations than by intention alone. Similarly, combining TPB with Social Practice Theory can offer deeper insights into behaviors shaped by routines and social roles. For Western Kenya, such hybrid models may better capture the interplay of structural constraints, cultural influences, and personal values in shaping sustainable consumption.

Applying the Theory of Planned Behavior to green marketing in Western Kenya reveals several strategic implications for businesses and policymakers. First, businesses must actively shape consumer attitudes by delivering clear, relatable, and trustworthy environmental messaging. Green claims should be substantiated through credible third-party certifications and should address locally relevant issues such as water conservation, deforestation, and public health. This approach can help overcome skepticism and build consumer confidence in sustainable products (Mwaura *et al.*, 2021).

Second, efforts to influence subjective norms should engage community leaders, religious institutions, and youth organizations. In rural

and peri-urban areas, where social influence plays a significant role in shaping behavior, these actors can help normalize sustainable consumption and foster collective endorsement of green brands (Anyango *et al.*, 2021).

Third, improving perceived behavioral control requires making green products more affordable, accessible, and easy to understand. Policy interventions such as targeted subsidies, expanded distribution networks, and standardized eco-labeling systems can reduce barriers and empower consumers to act on their environmental intentions (Otieno, 2019).

Conceptual Review

The Concept of Green Marketing

Green marketing refers to the strategic process by which organizations design, promote, and deliver products and services in ways that reduce environmental harm and support long-term sustainability. It encompasses not only product features but also the entire lifecycle of production, distribution, and disposal, aligning with global environmental objectives such as the United Nations Sustainable Development Goals (Singh, 2025).

Globally, firms in advanced economies such as Germany, Canada, and Japan have adopted green marketing to meet rising consumer demand for ethical and environmentally responsible brands (Alkhatib *et al.*, 2023). However, in many developing regions including Western Kenya, this transition remains in its early stages. Environmental concerns are often secondary to affordability, accessibility, and brand familiarity (Mwaura *et al.*, 2021).

In Kenya, the government has introduced policies to support green marketing, including the 2017 plastic bag ban and the development of eco-labeling standards (Ministry of Environment and Forestry, 2019; Kenya Bureau of Standards, 2021). Despite these efforts, implementation gaps, low consumer awareness, and inconsistent marketing practices continue to hinder progress, particularly in rural and peri-urban areas (Kiptoo & Otieno, 2021).

Eco-Labeling and Market Differentiation

Eco-labeling refers to the practice of marking products with symbols or information that indicate environmental benefits. It plays a vital role in consumer decision-making by enhancing transparency and trust in sustainability claims (International Trade Centre, 2022).

In Western Kenya, the adoption of eco-labeled products remains limited due to low awareness, high certification costs, and skepticism about label credibility. The informal economy, lack of standardization, and limited consumer understanding of environmental symbols further restrict the

effectiveness of eco-labeling. Most small and medium enterprises have not yet incorporated eco-labels into their branding strategies (Micro and Small Enterprises Authority, 2023).

Eco-Branding and Brand Identity

Eco-branding involves integrating environmental values into a brand's identity, visual presentation, and communication strategy. Globally, companies use biodegradable packaging, carbon neutrality claims, and sustainability narratives to appeal to environmentally conscious consumers (Mwaura et al., 2021).

In Western Kenya, eco-branding is rarely practiced. Many businesses do not consistently communicate their environmental contributions or differentiate their products through sustainability. This weak alignment between brand messaging and environmental values limits their ability to build consumer loyalty or gain competitive advantage. Additionally, misleading environmental claims have contributed to consumer mistrust and reduced the impact of genuine eco-branding efforts (Kiptoo & Otieno, 2021).

Environmental Advertising and Consumer Engagement

Environmental advertising promotes the ecological benefits of products or company initiatives and serves as a tool for building awareness and trust. In global markets, such advertising is supported by certifications, storytelling, and digital campaigns that influence consumer values and perceptions.

In Western Kenya, environmental advertising is infrequent and often lacks clarity or relevance. Few businesses invest in sustainability messaging, and when they do, the content tends to be urban-focused and fails to engage rural consumers. These communities, despite being more affected by environmental degradation, are less exposed to environmental communication (Omondi et al., 2023; Anyango et al., 2021).

The Kenyan Regulatory and Market Landscape

Institutions such as the Ministry of Environment, Kenya Bureau of Standards, and the Micro and Small Enterprises Authority have developed frameworks to support green production and branding (Kenya Bureau of Standards, 2021; Micro and Small Enterprises Authority, 2023). However, coordination among these bodies is limited, and enforcement is inconsistent, especially in informal sectors that dominate Western Kenya.

Despite environmental challenges such as soil erosion, irregular rainfall, and poor waste management, local businesses rarely incorporate these realities into their brand strategies. This represents a missed opportunity to build emotionally resonant and

sustainability-driven brands (Omondi *et al.*, 2023).

Green marketing in Western Kenya remains largely aspirational. While policy frameworks and theoretical models exist, their translation into consumer-facing brand strategies is weak. Key components such as eco-labeling, eco-branding, and environmental advertising are underdeveloped or inconsistently applied, limiting their influence on consumer perception.

There is a clear need for culturally relevant, trust-based, and resource-sensitive green marketing approaches. Future research should focus on Western Kenya's unique consumer behaviors, informal market dynamics, and brand development ecosystem. Without these adaptations, green marketing risks remaining a peripheral compliance measure rather than a strategic driver of sustainable brand growth.

Consumer Brand Positioning and Sustainability

Consumer brand positioning is widely recognized as a strategic tool for differentiating brands by shaping consumer perceptions and aligning with their values (Kotler et al., 2021). Within the sustainability discourse, integrating environmental responsibility into brand identity is often linked to enhanced reputation and consumer loyalty (Singh, 2025).

However, while the literature highlights these benefits, it tends to present an overly optimistic view of the ease and impact of green brand positioning, without fully addressing contextual challenges in emerging markets such as Western Kenya. Successful sustainable brand positioning requires a nuanced understanding of target audiences and authentic alignment with environmental values. Yet, much of the supporting evidence comes from developed markets, with limited empirical research on how these principles apply in socioeconomically distinct regions.

For example, although firms globally use biodegradable materials and community conservation efforts to enhance credibility, the capacity of small and medium enterprises in Western Kenya to adopt such practices is constrained by financial and infrastructural limitations (Micro and Small Enterprises Authority, 2023).

The growing environmental awareness among youth in Western Kenya, particularly those active on digital platforms, presents an opportunity for green brand narratives (Anyango et al., 2021). However, the literature often overlooks the complexity of local cultural dynamics and economic disparities that shape how these messages are received. Assuming that younger consumers uniformly prioritize sustainability ignores the tension between environmental ideals and affordability challenges.

Greenwashing remains a critical concern.

Although its negative impact on consumer trust is acknowledged (Kiptoo & Otieno, 2021), there is limited analysis of effective regulatory or market-based mechanisms to prevent misleading claims in Kenya. Weak enforcement of eco-labeling standards and the absence of transparent verification processes in Western Kenya contribute to consumer skepticism.

Moreover, sustainability messaging must be culturally relevant. Environmental challenges such as water scarcity and land degradation require brands to move beyond generic global narratives and develop content that resonates with local experiences (Anyango et al., 2021). Building emotional and ethical connections between consumers and brands depends on this localized approach, which remains underexplored.

Green Consumer Behavior in Emerging Markets

Green consumer behavior refers to the adoption of environmentally sustainable consumption patterns, including preferences for eco-friendly products, waste reduction, and support for responsible brands. The Theory of Planned Behavior (Ajzen, 1991) remains a dominant framework, explaining such behaviors through attitudes, social norms, and perceived behavioral control (Yadav & Pathak, 2016).

While this theory offers valuable insights, its application in emerging markets such as Western Kenya reveals significant contextual complexities. Studies show that younger, urban consumers in the region express strong intentions to purchase green products (Anyango *et al.*, 2021). However, the gap between intention and actual behavior is widened by socioeconomic barriers such as high product costs and limited market availability.

In many cases, sustainable practices like reusing containers or minimizing waste are driven more by economic necessity than environmental values. This challenges the assumption that visible green behaviors always reflect ecological commitment and may lead marketers to overestimate consumer motivation and willingness to pay a premium.

Consumer skepticism and weak eco-labeling systems further hinder the adoption of green behaviors. Although third-party certification is recommended to build trust, enforcement and public awareness remain limited. Price sensitivity and resistance to behavioral change are additional challenges that are acknowledged but rarely addressed with context-specific solutions.

Encouragingly, community-based and culturally aligned interventions show promise in shifting social norms and promoting green consumption. Emphasizing traditional environmental stewardship and engaging local influencers can make sustainability messaging more relatable and effective. However, the

literature lacks longitudinal studies to determine whether these interventions lead to lasting behavioral change.

In conclusion, while green consumer behavior theories provide a useful foundation, their relevance in Western Kenya is constrained by economic realities, cultural nuances, and institutional weaknesses. A more critical and localized approach is needed, one that considers affordability, authenticity, and cultural resonance to foster genuine and sustained green consumption in emerging markets.

Green Marketing in the Kenyan Context

Green marketing in Kenya has gained traction as a strategic response to growing environmental challenges and shifting consumer expectations. Government policy interventions, including the 2017 plastic bag ban, Kenya's commitments under the Paris Agreement, and the National Climate Change Action Plan, reflect institutional recognition of the need for sustainable development (Ministry of Environment and Forestry, 2018; United Nations, 2018).

However, critical reviews highlight significant regional disparities in policy implementation. Western Kenya often lags behind due to infrastructural limitations and economic constraints. This uneven rollout raises concerns about the uniform effectiveness of national policies in promoting green marketing practices across diverse local contexts.

Sectoral adoption of green marketing shows gradual but uneven integration of sustainability into business strategies. In agriculture, efforts such as organic certification and climate-smart farming aim to serve both domestic and export markets (Anyango *et al.*, 2021). In the renewable energy sector, eco-friendly technologies are marketed to address health and affordability concerns in underserved communities. Despite these advances, some critiques suggest that sustainability narratives are occasionally used more as promotional tools than as genuine commitments, which risks eroding consumer trust.

Challenges to effective green marketing remain significant. Low levels of environmental literacy and fragmented certification systems undermine consumer confidence in green claims, particularly in rural and peri-urban areas where verification is difficult (Mwangi & Wasike, 2021). This skepticism contributes to the intention-action gap described by the Theory of Planned Behavior (Ajzen, 1991), where perceived behavioral control and supportive social norms are weakened.

Additionally, the high costs of sustainable production and inconsistent labeling standards limit the ability of firms to offer affordable and credible green products. These constraints

reduce market penetration and slow consumer adoption. On a more positive note, digital platforms have emerged as effective tools for engaging Kenya's youth, enabling brands to communicate environmental values and foster community dialogue (Omondi *et al.*, 2023). Collaborations with non-governmental organizations and third-party certifiers also help build credibility, although their reach and impact remain uneven.

Importantly, marketing efforts that localize sustainability narratives—such as addressing plastic pollution in Lake Victoria or promoting soil conservation—tend to resonate more deeply with local consumers. These approaches are more likely to catalyze normative change and foster community engagement in Western Kenya.

The literature reveals a persistent tension. While green marketing holds promise as a driver of both environmental and economic progress, its success depends on authenticity, cultural relevance, and structural support. Without addressing underlying infrastructural and economic barriers, green marketing risks remaining a niche strategy rather than becoming a mainstream pathway to sustainable consumption and production in Kenya.

Empirical Review

Empirical studies consistently affirm the strategic role of green brand positioning in shaping consumer purchase intentions and brand perceptions across various markets. For example, Krissanya *et al.* (2023) present evidence from Indonesia's beauty and body care sector showing that green brand positioning directly influences consumer purchase intention. Their findings also highlight that such positioning enhances consumer attitudes and knowledge about green brands, reinforcing the value of environmental messaging in markets sensitive to ecological concerns.

Similarly, Situmorang *et al.* (2021) found that in Central Java, green brand positioning significantly affects repurchase intentions for eco-friendly cosmetic products, with consumer attitudes serving as a partial mediator. This supports the broader marketing literature, which emphasizes the importance of affective engagement beyond cognitive awareness. Notably, their study reveals that product knowledge alone does not guarantee repurchase behavior, suggesting a complex relationship between awareness, attitude, and action.

Wang *et al.* (2022) contribute further by focusing on university students, a demographic often considered environmentally conscious. Their research shows that both green brand positioning and perceived green customer value significantly

influence purchase intention. Attitude toward green brands mediates these relationships, while green trust acts as a moderator, underscoring the importance of credibility in converting marketing efforts into actual consumer behavior.

While these studies reinforce the importance of green brand positioning, they also expose critical gaps. Much of the empirical work focuses on youth and educated urban populations, which may limit its applicability to broader consumer segments in emerging markets like Kenya. Rural dynamics, lower environmental literacy, and limited access to green products are often underexplored.

Another recurring limitation is the insufficient examination of greenwashing and consumer skepticism. Although trust is identified as a key factor, few studies investigate how misleading claims or inconsistent eco-labeling erode consumer confidence. This is particularly relevant in markets with weak regulatory oversight, such as Western Kenya.

Future research should explore how green brand positioning interacts with local cultural values, regulatory environments, and varying levels of environmental literacy. Such studies would provide deeper insights into how green marketing strategies can be tailored to promote sustainable consumption across diverse socioeconomic groups.

Empirical evidence highlights the multifaceted nature of green marketing components, such as eco-labeling, sustainable packaging, and product attributes, in influencing purchase intention. Majeed *et al*. (2022) demonstrate that these elements significantly affect consumer decisions, with the relationship strengthened by a positive green brand image and environmentally responsible attitudes. This suggests that brand credibility and value alignment are central to converting awareness into action.

Mwaura *et al*. (2021) emphasize the combined influence of environmental knowledge and green attitudes, showing that green brand image and brand trust mediate their impact on purchase intention. Their findings support the view that information alone is insufficient unless accompanied by consistent and transparent brand messaging. Trust emerges as a foundational element in fostering brand loyalty, especially in contexts where environmental claims may be met with skepticism.

Kamalanon *et al*. (2022) offer a comparative perspective by examining functional versus emotional green brand positioning strategies. Their results indicate that while both approaches positively influence brand attitudes, the most effective strategy combines functional benefits, such as product performance and environmental efficacy, with emotional appeals that resonate with consumer values. This insight is particularly

relevant for developing countries like Kenya, where green awareness is rising but often tempered by practical concerns.

Despite these contributions, several challenges persist. The role of trust is well established, yet few studies explore how it is undermined by greenwashing or inconsistent practices. Emotional appeal, though shown to be effective, is often under-theorized in relation to local cultural contexts, where traditional values and communal environmental stewardship may shape consumer responses differently than in Western markets. Moreover, much of the existing research is conducted in controlled settings or focused on specific product categories, limiting its generalizability to everyday consumer decisions in regions like Western Kenya. There is also limited investigation into the long-term sustainability of trust and emotional engagement in driving repeat purchases, especially amid changing environmental and economic conditions.

Future research should contextualize these psychological constructs within the lived realities of Kenyan consumers. Exploring how green brand image, trust, and emotional appeal interact with local norms, regulatory frameworks, and exposure to greenwashing would offer a more comprehensive understanding of how green marketing can support both consumer engagement and authentic sustainability outcomes.

The strategic role of targeting and market segmentation in green brand positioning is increasingly recognized as a key determinant of marketing effectiveness. Stoica (2021), through qualitative analysis in Romania's organic food sector, illustrates how companies tailor their positioning strategies based on consumer profiles. Firms targeting niche green consumers tend to emphasize explicit environmental attributes, fostering stronger brand identities. In contrast, those aiming for mass-market appeal often dilute their green messaging, which can weaken differentiation and reduce consumer engagement. Supporting this, Chandra *et al*. (2019) demonstrate that green brand positioning, combined with consumer knowledge, significantly shapes brand image and drives purchase intention. Their findings emphasize the importance of educational campaigns in enhancing consumer understanding and acceptance of sustainable products. This aligns with the broader consensus that informed consumers are more receptive to targeted green marketing.

However, several challenges remain. Targeting niche green consumers may marginalize broader segments with varying levels of environmental concern, limiting scalability in emerging markets like Kenya. Additionally, many segmentation strategies assume rational consumer behavior, overlooking socio-cultural factors and

behavioral economics that influence decision-making. In Western Kenya, cultural values, economic constraints, and trust issues complicate the effectiveness of segmentation models based solely on knowledge and attitude.

Moreover, while brand education is essential, it must be complemented by structural interventions. Product availability, affordability, and verification mechanisms are critical to ensuring that targeted positioning translates into actual consumer adoption. Without addressing these systemic barriers, even well-designed segmentation strategies may fall short.

Future research should explore hybrid targeting models that combine niche appeal with inclusive outreach. These models should integrate psychographic insights with local environmental realities, socio-economic diversity, and infrastructural considerations to foster broader engagement and sustainable market growth in Kenya.

The literature consistently highlights the importance of communication strategies in shaping green consumer behavior. Almoussawi *et al.* (2022), studying university students in Iraq, affirm that green brand positioning and marketing efforts positively influence purchase intention, with green trust acting as a key moderator. This underscores the need for credibility and consistency in sustainability claims, as consumer skepticism can significantly undermine marketing effectiveness.

Hossain (2025) adds to this by identifying the persistent attitude-behavior gap, where consumers express environmental concern but fail to act on it. Barriers such as perceived inconvenience, higher costs, and doubts about product efficacy illustrate the practical challenges marketers face beyond awareness creation. These findings suggest that green advertising must address both psychological and structural constraints to be effective. Liao *et al.* (2020) show that green customer value and positive consumer attitudes significantly influence purchase intention, with psychological benefits such as moral satisfaction and connection to nature playing a central role. This supports marketing approaches that appeal not only to rational decision-making but also to emotional and ethical sensibilities.

Kao and Du (2020) demonstrate that green advertising using self-referential and morally evocative appeals enhances effectiveness. Campaigns that resonate with consumers' identities and social responsibilities are more persuasive, especially in contexts where emotional resonance is as influential as functional benefits.

Despite these insights, limitations persist. Most studies focus on university or urban populations, which may not reflect the diverse socio-economic realities of consumers in

regions like Western Kenya. Literacy levels, access to green products, and cultural attitudes toward sustainability can significantly moderate psychological drivers and communication outcomes.

Additionally, reliance on experimental and survey-based data may not capture the complex, non-linear processes through which green communication influences behavior. Informal networks, traditional knowledge, and peer influence remain underexplored yet potentially powerful channels for shaping green behavior. In conclusion, while communication and psychological factors are critical to green marketing success, strategies must be tailored to local realities. Bridging the attitude-behavior gap requires credible, culturally sensitive, and practically feasible interventions that resonate with consumers and support long-term sustainable consumption.

Methodology

This study employed a non-empirical, literature-based design, utilizing secondary data derived from existing literature, industry reports, and policy documents on green marketing and consumer behavior in Western Kenya. The sources included peer-reviewed journal articles, government publications, and NGO reports, selected for their relevance to the regional context and their alignment with the Theory of Planned Behavior (TPB).

Inclusion criteria encompassed studies that examined consumer attitudes, behavioral intentions, environmental literacy, and brand perception in Kenya or comparable emerging markets. Exclusion criteria eliminated sources that were outdated, non-region-specific, or lacking sufficient empirical or conceptual rigor.

Data collection involved a systematic review and synthesis of relevant literature, guided by a structured data extraction form designed to capture key themes such as consumer perceptions, structural barriers, and opportunities for green marketing. Each source was evaluated for relevance, credibility, and applicability to Western Kenya's socio-economic and cultural context.

For analysis, thematic synthesis was employed to identify recurring patterns and insights across studies. Themes focused on the influence of attitudes, subjective norms, and perceived behavioral control on green consumer behavior, as well as structural and institutional constraints affecting green marketing adoption. This approach enabled the integration of findings from diverse sources to build a coherent understanding of the interplay between green marketing strategies and consumer brand positioning in the region.

Findings and Discussion

The study found that green marketing in

Western Kenya is still emerging, with adoption mainly in urban centers like Kisumu and Kakamega. While some businesses integrate sustainable practices into branding, systemic barriers limit broader uptake. Economic realities further constrain consumer prioritization of sustainability, favoring affordability and convenience. Compared to developed regions where green marketing is mainstream and supported by robust regulation and consumer awareness, Western Kenya faces structural, institutional, and informal market challenges. Nonetheless, digital technologies, youth activism, and community engagement present opportunities to advance adoption. Application of the Theory of Planned Behavior shows that positive consumer attitudes exist, but actual sustainable purchases are moderated by perceived behavioral control and limited social norm reinforcement.

Conclusion

It is concluded that green marketing offers strategic potential for brand differentiation and consumer engagement. However, mistrust from unclear claims, low eco-label awareness, and weak regulatory enforcement continue to undermine effectiveness. Current efforts focus on urban, educated consumers, with limited reach to broader populations due to affordability and communication gaps. Emerging trends suggest gradual progress, contingent on strategies that are authentic, affordable, and locally contextualized.

Recommendations

The following recommendations are pertinent to the findings of this study:

i. Businesses should endevour to develop culturally relevant sustainability strategies targeting local environmental issues, leveraging digital platforms, and partnering with credible certifiers to build trust.
ii. Policymakers should enhance regulatory enforcement, support SMEs through subsidies and capacity building, and promote environmental literacy via community programs and school curricula.
iii. Researchers and development partners should conduct empirical studies across diverse consumer segments, refining frameworks like the Theory of Planned Behavior to incorporate emotional, cultural, and structural factors, and explore sector-specific models in agriculture, retail, and renewable energy for scalable green brand positioning.

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Social Challenges Faced by Internally Displaced Persons in Kenya: A Case Study of Ndonga Farm – Subukia

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Abstract

The general objective of this study was to examine the social challenges faced by Internally Displaced Persons (IDPs) in Kenya with a case study of Ndonga farm in Nakuru county. The study was guided by three specific objectives: to examine the access to education services by IDPs in Kenya, to assess the access to health-care services by IDPs in Kenya, and to examine the relationship between the host community and the IDPs in Kenya. The study was guided by the social exclusion theory. The study utilized the descriptive research design, collecting data by use of both qualitative and quantitative methods. Data was analysed using percentages and thematic analysis. Findings of the study established that the Internally Displaced Persons have no access to education or health services due to factors like financial hardships and long distances to the nearest schools and health care services. Additionally, the IDPs have tense relationships with host community members who refer to them as squatters due to issues revolving around the land. The study concluded that government response and lack of policies to the challenges have been ineffective for 18 years as these IDPs in Ndonga farm have not been resettled. The study recommends that future research should consider assessing the impact of government interventions to the IDPs living in Ndonga farm with a goal of resettling these IDPs.

Key words: Internally Displaced Persons, Education, Health care, Host community.

Introduction

Internally Displaced Persons are persons or groups of persons who leave or flee their homes or residential areas forcefully to avoid the consequences of armed conflicts, violence, violation of human rights, or natural or man-made disasters and remain within their country's boundaries (Okon, 2018). Kenya experiences internal displacement of persons caused by natural calamities such as floods, famine, landslides, drought, violence, and conflict- and development-induced displacements (Kamungi, 2011). According to UN Secretary-General Ban Ki-Moon, displacement arguably remains the world's most significant humanitarian challenge (Eweka & Olusegun, 2016). In the 21st century, there has been an escalation in the number of internally displaced persons around

the globe, leading to the United Nations High Commission for Refugees enhancing efforts to address and curb the number of internally displaced persons. The major causes were violent conflicts and environmental disasters, which led to a total of 31.1 million internally displaced persons in 2016 (Onumonu, 2019). However, according to the 2021 reports of the UNHCR, there are 79.5 million forcibly displaced persons, 45.7 million IDPs, 26 million refugees, 4.2 million asylum seekers, and 4.2 million stateless persons (Atar, 2021).

Background

Internally Displaced Persons are the biggest humanitarian challenge faced by national governments and international organizations like the United Nations High Commissioner for Refugees (Kiboro,2017). Kenya, a developing country, is ranked 7th with the highest IDPs in Africa (Getanda *et al.*, 2015). The major causes of displacement in Kenya are conflict-induced displacements like ethnic conflicts, social/communal tensions, politically influenced violence, development evictions, and disaster-influenced displacements (Getanda *et al.*, 2015).

The notion of Internally Displaced Persons became more intense in Kenya after the post-election violence, 2007/8, following the announcement of President Mwai Kibaki as president, which was opposed by the supporters of Raila Odinga, leading to widespread violence between the supporters of the Presidential candidates (Getanda et al., 2015). This resulted in 1,133 lives lost, 78,254 houses destroyed, and the displacement of 663,921 people. Of the 663,921 displaced persons, 350,000 resided in camps for refuge, 313,921 were integrated into communities and 640 fled to Uganda (Sitienei & Chumba, 2020).

As a result, the Government of Kenya established 118 camps nationwide to resettle the IDPs in the various 47 counties across the country (Getanda et al., 2015). However, it is in these camps that the IDPs face worse living conditions due to overcrowding, poor sanitary conditions, unemployment, and insecurity (Itumo & Nwefuru, 2016).

Therefore, this study aimed to examine the social challenges faced by IDPs in Kenya, like access to education and health services, and the relationship between the host communities with IDPs, because the resettlement initiatives have not been fulfilled for 18 years on.

Literature Review

Social challenges faced by IDPs

IDPs face social challenges like lack of access to basic needs like education and healthcare services, vulnerability to unemployment, discrimination leading to harsh relationships with their host communities, poverty, poor housing, poor sanitation, and malnutrition issues. All these social insecurity factors promote their exclusion because they lack material resources like income, proper

housing, and other resources. These factors are linked to their inferiority status as IDPs and enhance their exclusion based on gender and ethnicity. Factors such as marginalization, insufficient social integration, and inadequate provision of social services caused by displacement because of conflict or disasters leading to the destruction of the necessary infrastructure, shortage of funds, and inadequate support, that is humanitarian assistance, hence limiting their access to social security through exclusion (Jafer et al., 2022). Therefore, although governments assist IDPs with the provision of food, water supply, healthcare education services, and others, government support is lacking and always inconsistent, exposing them to socio-economic issues related to health problems.

Access to education

In emergencies, approximately 27 million children or more face the likelihood of having no access to education, the majority being internally displaced children. They lack access not only to education but also to other basic necessities. Internal displacement affects children's access to education and the quality and outcomes of learning, which depend on factors like gender perspectives and disability (Mooney & French, 2005). The most vulnerable groups are women and children in displacement and face challenges disproportionately. Women and girls are always subject to gender-based violence and sexual violence. Over congestion in IDP camps and informal settlements exposes children with no access to education to armed force recruitment (Ellison & Smith, 2012).

According to French and Mooney (2005), several factors hinder IDP children from having access to education. The results illustrated a lack of infrastructure; schools are often destroyed or targeted in many war-torn countries, and teachers are scarce. Education services are limited in IDP camps compared to refugee camps; they are under-resourced and overcrowded. Children in IDP camps in Liberia in 2004 had no access to education services due to a lack of supplies in blackboards, books, and even roofs.

Security issues deprive children of access to education, as the only schools available where children can learn are at far distances, jeopardizing their safety. They get exposed to landmines and military and insurgent checkpoints, often making them liable to forceful conscription, and in the case of girls, they are exposed to violence, sexual and physical, while en route, forcing them to remain home. Findings from Informing Better Access to Education for IDPs, (2022) show that the most common barrier to education access by IDPs is cost. Due to displacement, they lose their livelihood and have no access to employment opportunities, and therefore, cannot afford additional costs related to

education, such as transport and school supplies, such as uniforms and books. It is also noted that for those who were in school, transport costs were the major expense. Literature reveals that several factors exclude internally displaced children from accessing education. Their parents' economic deprivation, lack of access to resources such as schools and teachers, and loss of documents all make the children prone to exclusion.

Access to health services

Internally Displaced Persons are not beneficiaries of support from International legal protection like refugees. As such, they depend on their national governments for support, yet they give them low priority, making them receive less assistance (Swartz et al., 2023). IDPs are prone to poorer health conditions than refugees due to being exposed to infectious diseases as they join new communities, the dire conditions while on the way, or in the new communities and face severe mental health challenges due to the trauma experienced due to forceful displacement and loss of their livelihood and loved ones (Cantor et al., 2021). A study by Cantor, et al indicates that, aspects of gender and age play an important role in shaping the impact of internal displacement on health standards. The research showed that the major health issues faced by IDP had high mortality rates such as diarrhoea, malaria, respiratory diseases due to overcrowding, poor conditions of living, no source of income, and malnutrition. They were prone to communicable diseases like tuberculosis. These were mainly caused by insufficient vaccinations, poor sanitation, overcrowding, and malnutrition, making them vulnerable to vaccine-preventable diseases (Swartz et al., 2023). Mental health disorders and issues are also prevalent among the IDPs compared to refugees. They experienced posttraumatic stress disorder, depression, and anxiety, mainly common among the female gender and males, though, for the males, it is due to high consumption of alcohol. Mental health disorders are attributed to numerous traumatic events, unemployment, poverty, and prolonged and repeated displacement.

A report by Documentation and Access to Health: Challenges and Opportunities for Displaced Persons | NRC 2022 established that, IDPs and refugees face challenges differently; refugees are recognized internationally, having frameworks that protect them, while IDPs have fewer frameworks for protection both at international and national levels and often are not of priority to their national governments.

Relationship with host communities

IDPs often resettle in camps established by governments and, therefore, encounter host community members. Upon arrival, there are friendly relations between the IDPs and host community members, as many of them are

hosted by their relatives or friends. However, over time, the relations are destabilized due to several factors that cause tensions between IDPs and host community members, hence affecting their relations (Kamta & Scheffran, 2021).

Research on the levels of social integration of IDPs in host communities was carried out, and their relations were looked at from various lenses. A socio-psychological lens that deals with IDPs' desires to return to former residential areas, culture, and communication, the right of IDPs to preserve their cultural identity while respecting the cultural aspects of the local populations like values, beliefs, socio-economic, ability to have access to reliable sources of income. Socio-political lens, taking part in the decision-making process in the local communities. All these factors directly influence their well-being and how they relate with host communities (Chuiko & Fedorenko, 2020).

IDPs labeling themselves as marginalized limits their interactions with members of the host communities (Kamta & Scheffran, 2021). This is backed by the research done on social integration levels of IDPs in host communities; the results showed from the culture and communication paradigm, which states that IDPs have the right to maintain their cultural identity while respecting the cultural aspects of the local populations' values, traditions, language, and religion. There are closer relations between IDPs and host communities who share the same cultural aspects, while those with differentiated cultures, there are tense relations, and IDPs are termed as 'separatists', a term which emphasizes that they are different, leading to cases of discrimination in society. This is in terms of restrictions to employment opportunities, state health care, culture, and social institutions, reinforcing their exclusion from fully participating in society (Chuiko & Fedorenko, 2020). Therefore, IDPs are excluded due to their status as displaced persons who have cultural differences from members of the host community and, as a result, are alienated from society, leading to tense relations between IDPs and members of the host community.

Internally Displaced Persons who receive assistance from the government take part in social activities that improve their social well-being and provide them with access to employment opportunities and housing. Therefore, what challenges are faced by the IDPs who are not fully settled, do not have access to a reliable source of income and housing, and need government support? These factors lead to the exclusion of IDPs in host communities, affecting their relations.

Methodology

This study employed a descriptive research design, using data collected from both qualitative and quantitative methods. The

target population for this study was Kenya. The study was geographically restricted to Nakuru County, focusing on IDPs in Ndonga farm of Subukia constituency. Ndonga farm has 267 IDPs, and a random sampling was conducted to pick 16 respondents from a pool of IDPs, community leaders, government official, and members of the host community. The study was guided by the social exclusion theory established by Rene Lenoir in 1974.

Findings

Biodata

The respondents were male and female, with age groups between 19 to 75. Only one of the 16 respondents was employed at the time of data collection. The Assistant Area Chief stated that as they did not have a fixed source of employment, they earn a living from working as part-time farmers on various farms around Subukia and other areas

Social challenges faced by Internally Displaced Persons in Ndonga farm Nakuru- Kenya

The study established that, according to the records kept by the Assistant Chief of the area, there were about 238 households on Ndonga Farm. The first participant indicated that the major challenges IDPs face revolve around poor housing, poor nutrition, insecurity due to conflicts with host community members who are squatters, poor sanitation, and limited access to healthcare and education. The major factors that hinder access to education services and healthcare services are financial hardships since the IDPs do not have sufficient sources of livelihood and depend on the insufficient income earned from offering labor on the various farmlands; there are also no nearby health centres and schools with only one school at the adjacent hill, which is about 700 m from the farm and quite dangerous for the children to access because of the presence of a river that they have to cross while stepping on stones to cross, which becomes dangerous during the rainy season and the forests. The other schools and health centres available are far away. When asked 'How do these challenges affect the IDPs in his community in relation to women, children, and the elderly.' The first participant responded that,

> *'They face frequent illnesses related to sanitary and nutritional issues as well as cases of depression' (participant 1).*

When asked, 'What measures are being taken to ensure IDPs access basic services like water, food, healthcare, housing, and education' The 2nd participant replied,

> *'They just depend mostly on well-wishers, donors, government through their area Member of Parliament for survival. Though there has been limited support from the Government of Kenya. (Participant 2)'*

The first two participants, suggest that the only way to improve the social conditions of the IDPs, as well as the host community members, is through the Government fulfilling its

promise to resettle these IDPs and demarcate land to everyone. With the allocation of land, the IDPs will be able to settle and have land to cultivate since they are limited to the land provided, which is insufficient to carry out commercial farming. This development will enable the IDPs to access a source of income since they now only depend on the insufficient income gained through working on various farmlands to earn a living. Similarly, the demarcation of land will enable developmental projects such as the construction of roads and infrastructure, such as better houses and places of convenience, which will, therefore, aid better communication and living standards.

In a conversation with the Area Chief, he noted that most of the facilities on the farm, like the latrine and the water tanks, were provided by the Japan International Cooperation Agency (JICA) back in 2012 and helped pump water to the farm from a river that is far from the farm, however, the water is not well-treated for safe consumption. He noted how the IDPs face poor communication network issues. This is because the farm is far deep in the mountains, and the network is unstable, hindering communication; that is why when he appears on the farm, the IDPs use the opportunity to tell him their issues.

They also echoed the poor housing facilities of the IDPs, though he noted that after some time, the government aided the construction of the iron-sheet houses from houses that had been built using sacks. He brought to attention that there were no available washrooms on the farm for bathing, and this had led to the IDPs bathing in their houses, not in an inside bathroom but what, in this case, is considered as a sitting room and bedroom only partitioned using a curtain. When it is time to bathe, the parents chase their children away and take a bath. This situation is breeding cases of cholera outbreaks among the IDPs on the farm due to poor hygiene (Refer to Appendix).

All these changes and developments occurred when they had just settled on the farm in 2012, and since then, enhancing the way of life and living conditions of the IDPs has been a challenge. The Member of Parliament only remembers them when it is time for election.

Access to education services by Internally Displaced Persons in Ndonga farm Nakuru-Kenya

Out of the 16 respondents, 15 either had a child or children enrolled in an educational institution. However, even if they have enrolled them in school, they face financial hardships in sustaining their child or children in school, in terms of buying scholarly materials like books, uniforms, and money for transport since they study in different areas at far distances. These area lacks schools, and the only available one is on an adjacent hill where parents who cannot afford to take their

children to schools in different areas enrol their children. Their children face difficulty in accessing the school due to distance, and safety issues as they have to cross a river, which is very dangerous, especially during the rainy seasons, given their tender age. 100% of respondents rated the quality of education of their children as poor. However, they reiterated that, some lucky IDPs amongst them have secured educational support from the government, which provided bursaries through the National Government Constituencies Development Fund (CDF). However, they note that the procedure is lengthy and hectic and takes time to get approval.

Access to health services by Internally Displaced Person in Ndonga farm Nakuru- Kenya

From the 16 respondents sampled, 12 indicated that access to health services was fair as there was a health center in the nearby town while the remaining 4 indicated that, the current health status was poor since they have no access to health services due to financial hardships and the distance from Ndonga farm to the health centres in the next towns is far. 100% of the respondents reported to have experienced stress issues such as depression due to a lack of sources of income and the experiences they faced during the post-election violence of 2007/8 in Kenya that caused their displacement. 3 of the 16 respondents also highlighted the spread of diseases like diarrhoea caused by poor sanitation due to over-congestion on the farm and lack of well-treated water for drinking.

The relationship between the host community members with the Internally Displaced Persons in Ndonga farm-Nakuru Kenya

The study established that, the IDPs are mainly closer to squatters than the host community, and their relations vary between friendly and poor. Twelve respondents indicated that the host community were friendly while 4 of them said that it was poor. Most of the respondents indicated that there were instances of discrimination and cultural differences, especially among Kalenjin, Kikuyu, Kamba, and Turkana. Economic competition also posed a challenge in building relations with the host community. One IDP emphasized that,

" 'Sometimes they do attack us".

(Participant 8)

One participant reported that the main source of conflict between the IDPs, the squatters, and members of the host community is land. He indicated that,

> *'The squatters saw as if they were the ones who were supposed to be given the said land'. 'Also, herders around the area would say that part of the land was supposed to be for their livestock. 'Also, the surrounding community sometimes destroys the environment by illegally cutting down trees and, as a result, causing conflicts trying*

to stop them. ('Participant 2)

According to 2 respondents from the host community, settling of IDPs in the area has had a positive impact on the community since Ndonga farm has had the opportunity of being visited by government officials. They reported frequent interactions as they use the same water source and cultivate together. However, the squatters noted that they do not receive any support due to the presence of the IDPs in the community. The support only caters to the IDPs, and this is a challenge to their relations aside from cultural differences.

The squatters suggested that more inclusive programs between them and the IDPs are needed to build relationships and enhance the spirit of a joint community, 'called one'. Similarly, they voiced the need for land allocation, which will help reduce their conflicts over land. The IDPs echoed these suggestions when they were asked on how to improve their relationships with host community members.

Discussion

Only one school exists near Ndonga farm that serves the entire IDP population which has close to 238 households. The school is 700m away and the children are at risk as they go to this school because they pass through bushes and forests, which is dangerous. Parents to these children note that, aside from the distance that their children journey to attain education, they face financial hardships, which is a major hindrance to accessing education for the IDPs. Most of them are peasant farmers and the income earned is insufficient to sustain their children in schools. In addition, those who have acquired scholarships for their children through the National Government Constituencies Development Fund (CDF) note that the procedure is lengthy and hectic, and it takes time to get approval.

Regarding health services, there is no nearby health center, and many have no access to health services and face financial hardships in accessing healthcare services in the nearby towns. Their living conditions put them at a greater risk of contracting diseases. Poor sanitation leads to the spread of diseases like diarrhoea and cholera, and there is a lack of well-treated drinking water. The risk increases, especially when it rains, leading to contamination of the water source and stagnant water in their homesteads.

The community leader and the area chief suggest that their health standards can improve only if a health center is constructed in the area to cater to their health issues. However, this is only possible with the allocation and demarcation of land because no developments can be carried out on the land. In addition, they suggest that the construction of proper washrooms would be necessary because the only available one was constructed in 2011 when they settled on the

farm. It is currently in a poor state and unsafe for use as it is a habitat for infections and other diseases.

The study also established that, the IDPs are in more proximity to squatters than host community members. Their relations are not so friendly, as the squatters sometimes attack the IDPs on grounds of tribalism. Additionally, factors such as economic competition, land, and support catered to IDPs and not rendered to the squatters also greatly hinder harmonious relations between the IDPs and the squatters.

To achieve great relations between the IDPs and the Squatters, they suggested joint programs to enhance their relationships. Eventually, this will lead to a joint community where they can now perceive one another as 'one'; in other words, the spirit of togetherness. However, the issue of land allocation, as echoed by the IDPs, is also pivotal for enhancing their relations with the IDPs, who feel that the land allocated to them deserves to be theirs. With the allocation of land, conflict with the IDPs will be minimized.

Conclusion

From the findings, it can be deduced that, IDPs are a forgotten lot in Kenya, especially those living in Ndonga farm -Nakuru county. The assumption is that the source of their challenges and being forgotten originates from the fact that there are no internationally legally binding frameworks for their protection, leaving the primary responsibility to their governments who give them low priority, and the IDPs end up facing numerous challenges because their support is inconsistent. It should be noted that Kenya has never adopted the Kampala Convention of the African Union that entered into force in 2012 to provide measures to prevent root causes of internal displacement and provide durable solutions. Kenya, however, enacted its national convention, the Prevention, Protection, and Assistance to Internally Displaced Persons and Affected Communities in 2012. Kenya referred to the Kampala Convention and the Guiding Principles on Internal Displacement to supplement its national convention on IDPs to eliminate causes of internal displacement and durable solutions.

However, according to the research findings, the effectiveness of the government's convention has not played out, and the government response since 2012 has been very inadequate. After settling the IDPs on Ndonga Farm in 2012, IDPs have since faced the likelihood of eviction from the land due to wrangles over the land.

In addition, IDPs face numerous challenges on the farm with limited assistance from the Government of Kenya. From issues of limited access to education, out of the 16 respondents, only 5 have been able to acquire scholarships for their children, yet according to article 23(1)

of the UN Guiding Principles on Internal Displacement states, primary education is compulsory for the displaced children when permission permits, this is yet to be seen in relation to the IDPs on Ndonga Farm. There are nearby schools for the children, but parents have no sufficient income to sustain their children in schools that are at a far distance.

The study's findings highlight the significance of laying its ground on the Social Exclusion Theory. The theory assumes that marginalized groups are excluded from full social participation due to economic deprivations. This has been fully portrayed in the above chapters on how IDPs are unable to have access to education and health services due to financial hardships, which are economic deprivation. Therefore, there is a need to hold the government accountable for the suffering of the IDPs on Ndonga Farm.

Recommendations

The study recommends that:

i. Future research should assess the impact of government scholarships on children's school retention rates and attendance Ndonga farm,
ii. Future research should examine the effectiveness of mobile clinics in addressing issues related to inaccessibility to health-care services due to distance
iii. Humanitarian organizations should give assistance to IDPs in Ndonga farm to improve their living conditions.

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Satellite-Based Assessment of Quarry-Induced Vegetation Degradation at Kaseve Quarry, Machakos County, Kenya (2015–2024)

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Abstract

Quarrying activities are a significant driver of vegetation degradation globally, yet quantitative assessments of their ecological impacts remain limited, particularly in Sub-Saharan Africa. This study evaluates vegetation loss at Kaseve Quarry in Machakos County, Kenya, using Normalized Difference Vegetation Index (NDVI) analysis derived from Landsat-8 and Sentinel-2 satellite imagery spanning 2015 to 2024. The research employed a descriptive and quantitative design, processing multi-temporal satellite data through Google Earth Engine to generate annual NDVI composites. Spatial analysis was conducted across distance-based zones (0-250 m, 250-500 m, 500-750 m, 750-1000 m, and >1000 m reference zone) and directional sectors around the quarry boundary. Ground-truthing validated satellite-derived indices. Results revealed a substantial 49.1% decline in NDVI values within the quarry area (from 0.55 in 2015 to 0.28 in 2024), while the reference area maintained stable values (0.55-0.58). Linear regression analysis demonstrated a highly significant negative trend (-0.0297 NDVI units/year, R^2=0.984, $p<0.001$). Spatial analysis showed a clear distance-decay pattern, with the most severe impacts within 250 m of quarry operations (NDVI=0.24) and near-baseline conditions beyond 1 km (NDVI=0.57). Directional analysis revealed anisotropic impacts, with greatest vegetation loss in the southeast sector (56%), consistent with prevailing wind patterns. Rainfall variability showed no consistent correlation with NDVI decline, confirming quarrying activities as the primary driver of degradation. These findings provide the first spatially explicit, quantitative evidence of quarry-induced vegetation degradation at Kaseve, demonstrating the effectiveness of satellite-based NDVI monitoring for environmental assessment and supporting evidence-based regulation and rehabilitation planning in quarrying zones.

Keywords: Quarrying, Vegetation Degradation, NDVI, Remote Sensing, Landsat-8, Sentinel -2, Machakos County.

1. Introduction

Quarrying activities represent a critical component of economic development globally, providing essential raw materials for construction, infrastructure, and industrial applications. However, these operations are increasingly recognized as significant drivers of environmental degradation, particularly in terms of vegetation loss, soil disturbance, and ecosystem disruption (Avkopashvili, 2024; Darwish, 2011). In Sub-Saharan Africa, where regulatory frameworks are often weak and enforcement mechanisms limited, unregulated quarrying has led to widespread ecological damage, including unrehabilitated extraction sites, unstable slopes, contaminated water sources, and substantial biodiversity loss (Darwish, 2011; Gromnicki, 2025).

Kenya, and specifically Machakos County, has emerged as a quarrying hotspot where unregulated extraction activities have caused extensive vegetation degradation and associated environmental hazards. Kaseve Quarry, located in Machakos County, exemplifies these challenges. Despite visible environmental impacts and community concerns, no comprehensive scientific assessment had quantified the extent and spatial patterns of vegetation degradation at this site prior to this study. This knowledge gap has hindered evidence-based environmental management, regulatory oversight, and rehabilitation planning.

Remote sensing technologies, particularly satellite-based vegetation indices such as the Normalized Difference Vegetation Index (NDVI), offer powerful tools for quantifying and monitoring vegetation changes over time (Li, 2024; Nkonya, 2016). NDVI analysis has been successfully applied to assess mining and quarrying impacts globally, providing spatially explicit, temporally consistent, and cost-effective measurements of vegetation health and productivity (Li, 2024; Nkonya, 2016). The availability of freely accessible satellite imagery from Landsat-8 and Sentinel-2 missions, combined with cloud-based processing platforms like Google Earth Engine, has democratized environmental monitoring capabilities, making rigorous scientific assessments feasible even in resource-constrained contexts.

2. Methodology

2.1 Study Area

The study area encompasses a 1 km² grid centered at UTM Zone 37M, 314111.00 m E and 9831121.00 m S, covering both active and abandoned sections of Kaseve Quarry. Spatial data collection was organized into four quadrants northeast, northwest, southeast, and southwest ensuring systematic coverage of the site. Climatically, Machakos County experiences a temperate highland tropical climate (Köppen Cwb) due to its elevation of approximately 1,600 m above sea level (Kenya Met. Dept.). Average annual temperatures range between 18.9–20.5 °C, with daytime highs of 23–26 °C and cooler nights around 13–16 °C. Humidity levels fluctuate between 66–84%, reflecting seasonal rainfall and dry periods. Rainfall follows a bimodal pattern, with long rains occurring from March to May and short rains from October to December, averaging between 500–1300 mm annually (Indiatsy, 2018). The dry season, typically June to September, is marked by reduced precipitation, soil erosion, and water scarcity, while rainfall remains highly variable and unpredictable.

Geologically, the study area lies within the Eastern Mozambique Belt Segment (EMBS), part of the extensive Mozambique belt east of the Rift System. This belt stretches nearly the full length of Kenya, with the study site situated in the Central sub-area II northeast of Nairobi, bounded by towns such as Thika, Machakos, Embu, Chuka, Kitui, and Mwingi (Fritz, 2013). The surface rocks are predominantly Precambrian metamorphic formations overlain by the Yatta Plateau to the south. Historically, the region was composed of crystalline basement rocks of the Mozambique belt, which were metamorphosed, exposed, and eroded Dodson, 1953). During the Miocene, phonolite eruptions formed the Yatta Plateau, while earlier Archaean compression led to folding, tilting, and transformation of rock successions into schists, gneisses, and granulites (Mathu, 1992).

Hydrogeologically, the area is characterized by complex basement rocks with scarce water-bearing formations. Groundwater occurs mainly in temporary aquifers and fractures, influenced by structural deformations such as the Yatta shear zone (Nyamai, 2004).

2.2 Sampling Technique

For NDVI validation, sampling locations were stratified into four distance bands from the quarry boundary: 0–250 m (high-impact zone), 250–500 m (moderate impact), 500–750 m (low-impact transitional zone), and a reference zone located beyond 750 m. The reference zone

was selected following reconnaissance surveys and satellite image inspection to identify areas with intact vegetation cover, absence of quarry-related disturbance indicators, and comparable environmental characteristics such as elevation, soil type, and land-use patterns. This ensured that differences in vegetation indices between zones could be attributed primarily to quarry influence rather than natural variability. By comparing NDVI trends in the quarry area with those in the control area, we could isolate the effects of quarrying from natural environmental variability. Within each of these zones, purposive ground points were carefully selected to ensure representative coverage and to validate NDVI values derived from Sentinel-2 and Landsat 8 imagery. This stratified approach allowed for a robust comparison between satellite-derived vegetation indices and field observations, enhancing the accuracy and reliability of the remote sensing analysis.

2.3 Spatial Analysis

The methodology involved acquiring Landsat 8 and Sentinel-2 images spanning 2015–2024, which were processed in Google Earth Engine through cloud masking, yearly composite generation, and NDVI computation. NDVI statistics were then extracted for both the quarry polygon and a designated control area to enable comparative analysis. To capture spatial variability, directional and distance-based sampling was conducted across zones of 0–250 m, 250–500 m, 500–750 m, and 750–1000 m from the quarry boundary. Finally, ground-truthing was carried out using handheld Global Positioning System units and direct vegetation scoring, ensuring that satellite-derived indices were validated against field observations for accuracy and reliability.

2.4 Statistical Analysis

NDVI data was analyzed primarily using linear regression to quantify long-term trends in vegetation cover between 2015 and 2024. This method allowed assessment of the rate and direction of vegetation change within the quarry influence zone over time. NDVI values from the quarry area were compared descriptively with those from a surrounding reference area located beyond the zone of disturbance to evaluate spatial differences attributable to quarry activities. Annual rainfall data were examined to provide contextual interpretation of environmental conditions during the study period but were not treated as the primary driver of vegetation change. This approach ensured a clear and robust evaluation of vegetation degradation associated with quarry operations using transparent and reproducible analytical procedures.

3. Results and Findings

3.1 Temporal NDVI Trends (2015-2024)

Table 1 presents annual NDVI values for the quarry area and a nearby reference (control) area with comparable topographic, geological, and land-use characteristics but located beyond the zone of quarry disturbance. The inclusion of annual rainfall data provides contextual information on climatic variability, enabling evaluation of whether vegetation changes could be attributed to natural climatic factors rather than quarry activities.

The results indicate a clear and progressive decline in vegetation health within the quarry area over the study period. NDVI values decreased from 0.55 in 2015 to 0.28 in 2024, representing an approximate 49% reduction in vegetation vigor. In contrast, the reference area maintained relatively stable NDVI values ranging between 0.55 and 0.58 throughout the same period, indicating minimal long-term ecological disturbance. **Figure 1:** NDVI analysis map for Kaseve Area, 2015

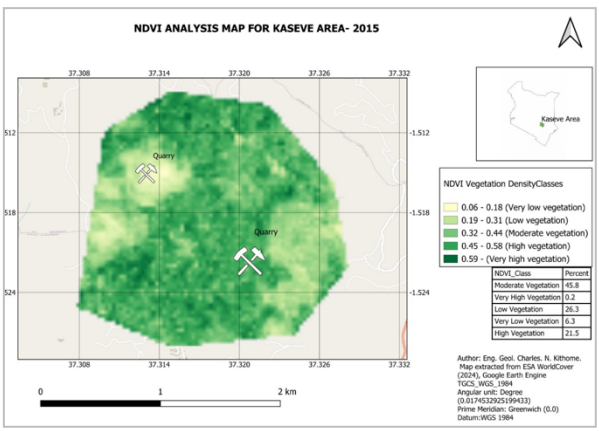
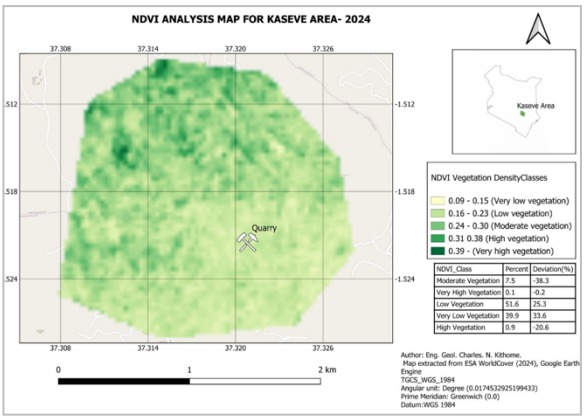


Figure 2: NDVI analysis map for Kaseve Area, 2024



The difference in NDVI between the quarry and reference areas widened consistently over time, from −0.01 in 2015 to −0.29 in 2024, demonstrating increasing divergence in vegetation condition. This progressive separation strongly suggests that quarry operations have had a cumulative impact on surrounding vegetation.

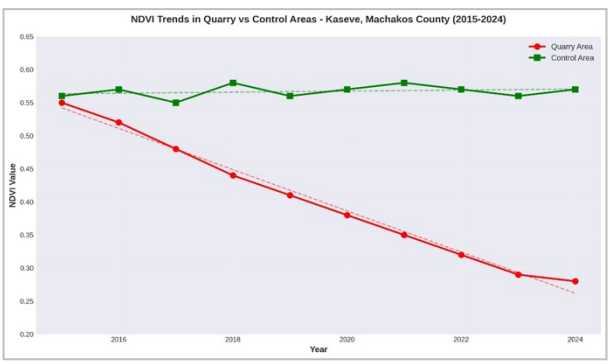
Rainfall variability during the study period did not exhibit a consistent relationship with NDVI decline. Years with higher rainfall did not correspond to improved vegetation conditions within the quarry zone, indicating that climatic factors alone cannot explain the observed degradation. The rainfall data therefore serve primarily as contextual control variables rather than direct drivers of vegetation change. Overall, the stability of NDVI in the reference area, combined with the pronounced decline within the quarry zone,

supports the interpretation that vegetation loss is primarily associated with quarry-related disturbances such as blasting, dust deposition, land clearing, and surface modification rather than natural environmental variability.

Table 14: NDVI Values for Quarry and Control Areas (2015-2024).

Year	Quarry Area NDVI	Control Area NDVI	Difference	Annual Rainfall (mm)
2015	0.55	0.56	-0.01	945
2016	0.52	0.57	-0.05	1020
2017	0.48	0.55	-0.07	780
2018	0.44	0.58	-0.14	890
2019	0.41	0.56	-0.15	720
2020	0.38	0.57	-0.19	850
2021	0.35	0.58	-0.23	920
2022	0.32	0.57	-0.25	880
2023	0.29	0.56	-0.27	810
2024	0.28	0.57	-0.29	900

Figure 3: NDVI Trends in Quarry vs Control Areas - Kaseve, Machakos County (2015-2024)



Linear regression analysis of NDVI within the quarry area revealed a highly significant negative trend, with vegetation cover declining at a rate of –0.0297 NDVI units per year. The model demonstrated a very strong fit, indicated by an R^2 value of 0.984, confirming that the regression explains nearly all the observed variation in NDVI over time. The *p*-value of less than 0.001 further underscores the statistical significance of this decline, providing robust evidence that quarry activities have caused consistent and measurable vegetation loss across the 2015–2024 period.

3.2 Statistical Comparison of Quarry vs Control Areas

A statistical comparison of NDVI values between the quarry and reference areas over the study period confirms substantial differences in vegetation condition. The quarry area exhibited markedly lower NDVI values (mean = 0.402 ± 0.096) compared to the reference area (mean = 0.567 ± 0.010), indicating significantly reduced vegetation health within the zone affected by quarry activities.

The persistent disparity between the two areas across all years demonstrates that vegetation degradation in the quarry zone is systematic rather than episodic. The stability of NDVI values in the reference area further supports the interpretation that the observed decline within the quarry area is attributable to localized disturbances rather than regional environmental variability.

These findings provide strong evidence that quarry operations have produced measurable and sustained impacts on vegetation cover, likely through mechanisms such as land clearing, dust deposition, blasting vibrations, and alteration of soil properties.

3.3 Correlation with Rainfall Variability

An assessment of the relationship between annual rainfall and NDVI was conducted to determine whether climatic variability could account for the observed vegetation decline. The analysis indicated no consistent correspondence between rainfall fluctuations and vegetation condition within the quarry area.

Periods of relatively high rainfall did not result in measurable recovery of vegetation indices in the disturbed zone, suggesting that climatic factors alone cannot explain the observed degradation. In contrast, vegetation in the surrounding reference area remained stable across varying rainfall conditions, indicating greater ecological resilience in undisturbed environments.

These results suggest that quarry-related disturbances are the dominant driver of vegetation decline, while rainfall variability plays a secondary or limited role

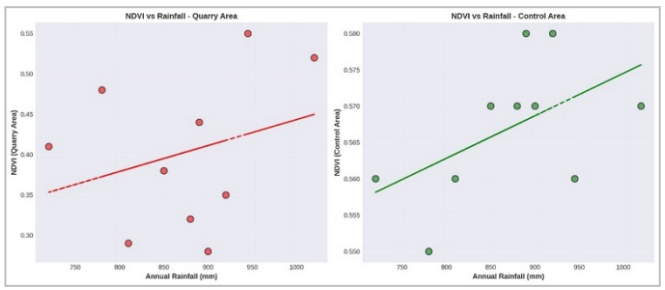


Figure 4: Correlation between NDVI and Annual Rainfall for Quarry and Control Areas

These results demonstrate that rainfall variability does not explain the NDVI decline observed in the quarry area. While some positive correlation exists ($r = 0.48$), it is not statistically significant and accounts for only 23% of variance ($r^2 = 0.23$). In contrast, the temporal trend (declining NDVI independent of rainfall) explains 98.4% of variance. This strongly suggests that quarrying activities, rather than rainfall, are the primary driver of vegetation degradation.

The surrounding area proximity shows essentially no relationship between rainfall and NDVI ($r = 0.12$), indicating that the vegetation in undisturbed areas maintains stable health across the range of rainfall variability observed during the study period.

3.4 Spatial Distribution of Vegetation Impacts

Spatial analysis of NDVI values at different distances from the quarry perimeter reveals a clear distance-decay pattern of impacts (Table 2).

Table 15: Mean NDVI Values by Distance from Quarry (2015- 2024 Multi -Year Composite)

Distance Zone from Quarry	Mean NDVI	Standard Deviation	Number of pixels/ Sample Points
0-250 m	0.24	0.08	45
250-500 m	0.32	0.11	38
500-750 m	0.41	0.09	32
750-1000 m	0.48	0.07	28
>1000m (control)	0.57	0.05	40

The NDVI values presented in Table 3.2 represent a multi-year composite derived from Landsat-8 and Sentinel-2 imagery for the period 2015–2024. Using a composite dataset minimizes short-term climatic variability and provides a more reliable assessment of long-term quarry impacts on vegetation. These data therefore constitute secondary remote-sensing observations validated through field reconnaissance conducted in 2025.

Distance zones were generated using concentric buffer analysis from the quarry boundary within a GIS environment. NDVI values were extracted from all valid vegetation pixels within each buffer, and the reported sample size corresponds to the number of pixels used in statistical calculations. The reference zone (>1000 m) was selected to represent areas with similar elevation, soil characteristics, and land-use conditions but without observable quarry disturbance, ensuring meaningful comparison between impacted and non-impacted areas.

The progressive increase in mean NDVI with distance from the quarry indicates a clear spatial gradient of environmental impact, with the lowest vegetation health occurring within 250 m of active quarry operations and near-baseline conditions observed beyond 1 km.

3.5 Directional Analysis of Vegetation Impacts

Analysis of NDVI patterns in different directions from the quarry reveals anisotropic (directionally dependent) impacts consistent with prevailing wind patterns (Table 3).

Table 16: Mean NDVI Values by Direction from Quarry (Within 500m Buffer, 2015-2024 Composite)

Direction	Mean NDVI	Vegetation Loss (%)	Relative wind position
North	0.34	40%	Upwind
Northeast	0.31	46%	Cross-wind
East	0.29	49%	Cross-wind
Southeast	0.25	56%	Downwind
South	0.27	53%	Downwind
Southwest	0.28	51%	Downwind
West	0.32	44%	Cross-wind

The NDVI values presented in Table 3 represent multi-temporal averages derived from Landsat-8 and Sentinel-2 imagery covering the period 2015–

2024, rather than a single year. This composite approach minimizes the influence of short-term climatic variability and provides a more robust representation of long-term vegetation conditions associated with quarry activities. Although field investigations were conducted in 2025, the satellite data analyzed correspond to the operational history of the quarry during 2015–2024, ensuring temporal alignment with the study objectives.

Sampling locations were established using a stratified distance-based design centered on the quarry boundary. Concentric buffer zones at 250 m intervals were generated in a GIS environment, and sampling points were distributed systematically within each zone to ensure spatial representativeness. Ground reconnaissance in 2025 was undertaken to validate land-cover conditions, confirm accessibility, and verify the absence of confounding disturbances unrelated to quarry operations.

The reference area (>1000 m) was selected following field inspection and satellite image assessment to identify locations with intact vegetation cover, comparable elevation, soil characteristics, and land-use patterns but without visible quarry influence. This ensured that differences in NDVI across zones reflect the environmental impact of quarry activities rather than natural spatial variability.

Overall, the results demonstrate a clear gradient of vegetation condition with increasing distance from the quarry. The lowest NDVI values occur within 250 m of the extraction area, indicating severe vegetation stress, while values progressively increase toward the reference zone, suggesting attenuation of quarry-related disturbances with distance.

4. Discussion

4.1 Vegetation Degradation Patterns and Mechanisms

4.1.1 Magnitude of Vegetation Decline

The remote sensing analysis indicates substantial deterioration of vegetation condition in the vicinity of Kaseve Quarry between 2015 and 2024. Mean NDVI values declined from approximately 0.55 in 2015 to about 0.28 in 2024, representing a reduction of roughly 49.1 percent over the nine-year period. This decline reflects a pronounced reduction in vegetation greenness and productivity within the quarry influence zone.

Spatial analysis shows that the greatest reductions occurred within the immediate operational footprint of the quarry and progressively decreased with distance from the extraction area. Areas located outside the zone of quarry activity exhibited comparatively stable NDVI values during the same period, indicating localized disturbance rather than region-wide vegetation change.

The rate of decline, estimated at approximately 5.5 percent per year, falls toward the upper range reported in quarry environments globally. Comparable studies in mining regions have documented significant reductions in vegetation indices associated

with land surface disturbance and removal of vegetative cover. The magnitude of change observed at Kaseve therefore reflects substantial alteration of surface conditions within the study area.

The observed patterns directly address the study objective concerning vegetation degradation and provide quantitative evidence that vegetation condition deteriorated markedly over the monitoring period. These findings are consistent with the study hypothesis that quarrying activities are associated with measurable loss of vegetation cover.

4.1.2 Spatial Extent of Impacts

The spatial analysis of NDVI values indicates that vegetation degradation associated with quarrying activities at Kaseve extends considerably beyond the immediate excavation area. Results presented in Chapter Three show a clear distance-decay pattern, with mean NDVI values increasing progressively from 0.24 within 0–250 m of the quarry to 0.48 at 750–1000 m and stabilizing at 0.57 in the reference zone located beyond 1000 m. This gradient demonstrates that the most severe impacts occur in close proximity to quarry operations, while vegetation condition improves with increasing distance, indicating attenuation of disturbance effects away from the source.

Directional analysis further reveals that impacts are not uniformly distributed around the quarry. NDVI reductions are greatest within the southeast sector (56% vegetation loss), followed by the south and southwest sectors (53% and 51% respectively), while comparatively lower reductions occur in the northern sectors, particularly northwest (39%). This anisotropic pattern confirms that vegetation degradation is spatially heterogeneous rather than evenly distributed.

Rainfall data presented in Section 3.1 indicate that annual precipitation during the study period ranged between approximately 720 mm and 1020 mm, values consistent with the normal climatic variability of Machakos County. Despite this variability, NDVI decline within the quarry influence zone followed a consistent downward trend independent of rainfall fluctuations, while vegetation in the reference area remained stable across the same period. This suggests that the spatial pattern of degradation is unlikely to be explained by rainfall differences alone.

The observed directional differences are therefore interpreted as reflecting localized environmental disturbance associated with quarry operations rather than regional climatic controls. Factors such as excavation intensity, land clearing, dust deposition, and surface modification may vary around the quarry perimeter depending on operational layout and site conditions, producing uneven spatial impacts on surrounding vegetation.

Overall, the findings demonstrate that quarry-related disturbances at Kaseve extend up to approximately 750 m from the excavation area, with the severity of impacts declining with distance and

varying by direction. These results provide strong evidence that vegetation degradation is primarily driven by site-specific quarry activities rather than uniform environmental factors.

4.2.3 Rainfall-NDVI Relationships

The rainfall data presented in Table 3.1 indicate that annual precipitation in the Kaseve area during the study period ranged between approximately 720 mm and 1020 mm, reflecting normal interannual variability typical of semi-arid environments in Machakos County. Despite this variability, the NDVI analysis showed a persistent downward trend in vegetation condition within the quarry influence zone between 2015 and 2024. In contrast, NDVI values in the reference area outside the quarry influence remained relatively stable over the same period.

The absence of a consistent temporal correspondence between annual rainfall fluctuations and NDVI decline in the quarry zone suggests that rainfall variability alone does not explain the observed vegetation degradation. If rainfall were the dominant control, similar declines would be expected in the reference area subjected to the same regional climatic conditions. The stability of vegetation indices outside the quarry footprint therefore indicates that local site disturbances play a more significant role than regional precipitation patterns.

It is important to note that this study evaluated only rainfall as a climatic variable and did not assess other meteorological factors such as temperature, evapotranspiration, or wind dynamics. Consequently, the results do not imply that climate has no influence on vegetation condition, but rather that rainfall variability during the study period was insufficient to account for the magnitude and spatial concentration of NDVI decline observed around the quarry.

Overall, the findings indicate that vegetation degradation at Kaseve Quarry is more strongly associated with localized environmental disturbances related to quarry operations than with regional rainfall variability. This interpretation is consistent with the spatial patterns documented in Section 5.2.2, where impacts decrease with distance from the quarry and are not uniformly distributed across the landscape.

4.4.4 Alignment with Land Degradation Theory

The decline in NDVI values documented at Kaseve Quarry provides empirical evidence consistent with the principles of Land Degradation Theory, which describes how sustained land disturbance can reduce vegetation productivity and ecosystem function. In this study, vegetation condition declined substantially within the quarry influence zone between 2015 and 2024, while comparatively stable NDVI values were observed in areas beyond the immediate operational footprint. This spatial contrast indicates that degradation is localized rather than regionally uniform.

Land Degradation Theory does not attribute ecological deterioration to a single factor but to cumulative land surface disturbances that modify soil properties, surface cover, and moisture retention capacity. The remote sensing analysis revealed a progressive shift from moderate and high vegetation density classes toward low and very low classes within the quarry zone, reflecting reduced canopy cover and biomass over time. Such transitions are characteristic of disturbed landscapes where surface materials are exposed and vegetative recovery is limited.

The spatial gradient identified in this study, with the most pronounced NDVI reductions occurring near active quarry areas and diminishing outward toward buffer and reference zones, further supports the interpretation of localized land degradation processes. This pattern suggests that the observed vegetation decline is associated with site-specific land surface disturbance rather than broad environmental change. However, the study did not directly quantify individual disturbance mechanisms such as dust deposition, soil compaction, or vegetation removal, and therefore causal attribution to specific operational activities cannot be conclusively established. Within this framework, Kaseve Quarry represents a landscape undergoing measurable ecological alteration as a result of intensive land use. The findings demonstrate how prolonged surface disturbance can lead to progressive vegetation decline and reduced ecological resilience. The results therefore align with Land Degradation Theory by illustrating the cumulative effects of localized land modification on vegetation condition, without requiring assumptions about processes that were not directly investigated.

Conflict of Interest: The author declares no conflict of interest.

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