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Implications of the Presence of Power Plants on Property Rents: The Case of Kinyerezi in Dar Es Salaam, Tanzania

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Abstract

This study sets out to examine the implications of the presence of power plants on property rents in Kinyerezi, a suburb of Dar es Salaam largest City of Tanzania. Using questionnaires, data were collected from tenants and property owners around the Kinyerezi power plant and by applying multiple regression models, the relative impacts of factors that determine rents were established. Multiple regression models managed to explain about 78 percent of variation of rents in Kinyerezi with an F statistic of 8.18 which is significant at a 5% significance level. The principal finding was the Kinyerezi power plant negatively impacts property rents at the rate of Tsh. 10,700 for every kilometre near the power plant (This is equivalent to 2.34%). However, the relationship was not statistically significant at a 5% significance level. This means that we have failed to accept the null hypothesis, and the alternative hypotheses are preferred. The reasons for this conclusion are based on: First; other factors, particularly housing attributes and plot sizes were very strong in the model and effects attributed to the power plant were not as strong as they were anticipated to be. Second; sound construction and workmanship and larger plot sizes were associated with increasing distances from power plants, and hence a secondary or indirect relationship between power plants and rents was deduced. Third; property market participants around the Kinyerezi power plant are imperfectly informed about the full range of visible and invisible effects emanating from power plants.

Keywords: Power Plants, Energy Infrastructure, Rents, Regression Analysis.

INTRODUCTION

A power plant can affect the environment by its construction and by its operation and these effects can be temporary or permanent (Public Service Commission of Wisconsin – PSCW, 2015). Clark *et al.,* (1997) contend that power plants can theoretically influence property values through different channels. These include the public perception of risk associated with the potential hazard from the operation of power generating facilities and the processing or storage of waste may lead to lower bids on properties in close proximity to the plant. In contrast, Boes *et al.,* (2015) argues that workers at the plant may be less concerned with the myriad ecological hazards and health risks associated with power plants, and may actually value the actual physical proximity to the workplace. This would generate changes in community demographics and create a local economy which assumes distinct characteristics. Both of the aforementioned scenarios have a bearing on property prices and rents that are charged within areas close to the power plants.

On the other hand, Davis (2010) maintains that at the same time, power plant siting (location choice for power plants) has become harder than ever before, in large part because the need for new facilities is critical in places

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prone to rapid population growth. Policymakers face difficult, often politically contentious decisions about where to site plants balancing many different factors.

Devine-Wright & Batel (2013) argue that although local amenities are typically one of the important factors considered in this process, the absence of reliable empirical evidence about the magnitude of these costs has prevented the practical use of cost-benefit analysis. Bolton & Sick (2008) propound that understanding the implications of the presence of power plants on rents is important for planners and decision makers in determining appropriate locations to build power plants, and in developed countries, assists in ascertaining adequate fair compensation in cases of full or partial acquisition of private land.

LITERATURE REVIEW

Several authors have investigated proximity impacts of power plants and power transmission lines on rents. While some report a positive impact, others report negative impacts and others are inconclusive and call for further studies. Boes *et al.,* (2015) conducted a study around the Fukushima power plants and found out a significant price discount of about 2.3% for rental apartments near nuclear power plants. Their results corroborated earlier findings that market participants are imperfectly informed.

McCord *et al.,* (2013) conducted a study measuring the disamenity effect of gas fired power plants on house prices situated within Peace walls, their findings shows that dwellings located within 250m of a peace wall (boundary wall for power plants) were worth 29.6 per cent less.

Davis (2010) conducted a study in neighborhoods around the United States where power plants were opened during the 1990s and he found out that across specifications the study results indicated 3-7 percent decreases in housing values and rents within two miles of plants with the semi parametric estimates suggesting somewhat larger decreases within one mile. Bezdek & Wendling (2006) found a positive and significant impact of 8.5% of the presence of power plants on property rents across seven major nuclear facilities located throughout the USA.

Gamble and Downing (1982) in a landmark study, presented statistical analyses and concluded that there was no significant impact on property values due to proximity to a nuclear power plant, even after the March 1979 accident at the Three Mile Island (TMI) nuclear power plant in the USA. It is of interest to note that none of the reviewed studies were carried out in a developing country.

This research work will therefore be a contribution to the land economics scholarly literature of developing countries.

METHODOLOGY

In this study, an improvised analytical model based on Cebula (2009) and Elliott & Wadley (2012) was used. The property rent (RV) being the dependent variable was related to several independent or explanatory variables, whose headings are summarized below:

1). Proximity to power plant (Distance).
2). Tenant Characteristics (Especially income)
3). Size of the property.
4). Building attributes.
5). Accessibility of the property.
6). Nature of the neighborhood.
7). Duration of Occupancy (For date of sale).
8). Power plant effects

Data Collection

Survey technique was used as the principal method of data collection, which was conducted by administering questionnaires to property owners around a 1km demarcated boundary in the Kibaga–Kinyerezi neighborhood, a suburb of Dar es Salaam largest City of Tanzania. Power plant and property location coordinates were recorded using a GIS application on an android tablet device. Interviews were also conducted with local government officials in Kinyerezi and Tanzania Electric Supply Company Limited (TANESCO) project engineers, which assisted in gathering social economic dynamics and policy perspectives.

Data Analysis

Data was analyzed using multiple regression models. Both a linear and non-linear regression models were employed for the purposes of this study. Using the linear regression model, the monthly rent is specified as the dependent variable;

$$RV = \beta + \alpha_1 DPP + \alpha_2 PLT + \alpha_3 AP + \alpha_4 FL + \alpha_5 BD + \alpha_6 BDS + \alpha_7 DO + \alpha_8 BT + \alpha_{18} BST + \alpha_9 ECOEFF + \alpha_{10} POPEFF + \alpha_{11} VIBEFF + \alpha_{12} POLEFF + \alpha_{13} NOIEFF + \alpha_{14} VIBEFF + \alpha_{15} NH + \alpha_{16} RD + \alpha_{17} HCI + + \alpha_{19} BW \; \alpha_{20} Y + e \;............................(II)$$

In this model, the parameters $\alpha_1,\ldots,\alpha_{19}$ represent the marginal implicit price of each attribute and e is the error term. Using the non-linear (Logarithmic) regression model, it was possible to measure the impact that changes in explanatory variables cause in the dependent variable in relative terms.

$$\ln RV = \beta + \alpha_1 \ln DPP + \alpha_2 Y + \alpha_3 \ln DO + \alpha_4 \ln PLT + \alpha_5 \ln AP + \alpha_6 \ln FL + \alpha_7 \ln BD + \alpha_8 \ln BDS + \alpha_9 \ln BT + \alpha_{10} BST + \alpha_{11} HCI + \alpha_{12} NB + \alpha_{13} AC + \alpha_{14} BW + \alpha_{15} POLEFF + \alpha_{16} VIBEFF + \alpha_{17} DEMEFF + \alpha_{18} NOIEFF + \alpha_{17} ECOEFF + e \;........................(I)$$

Table 1. Variables used in the study

VARIABLE	ABBREVIATION	DESCRIPTION
Rent		
Rental Value	RV	Monthly rent expressed in Tsh.
Distance		
Distance from Power Plant	DPP	Linear distance from center of property to power plant, in meters.
Tenant Characteristics		
Income	Y	The tenants income as measured in Tsh. This provides a critical measure of tenant characteristics.
Duration of Occupancy	DO	Duration of occupancy, which is the average duration one has resided in a rental unit in years
Building Attributes		
Floors	FL	Number of floors (Single storey = 1, Double storey = 2…)
Bedrooms	BD	Number of bedrooms
Bedrooms Size	BDS	Bedroom Size (In metres squared)
Bathroom State	BST	Bathroom State: Binary variable indicating whether the bathroom is inbuilt = 1, or out built = 0
Bathrooms	BT	Number of Bathrooms
Housing Condition Indicator	HCI	An index of the 3 main construction attributes of a property (floor, wall and roof) which indicates the state of the property at the time of this study
Fence/Boundary Wall	BW	Boundary wall/Fence. Binary variable (= 1 if wall present, = 0 if absent)
Area of the Property	AP	Area of the Property, in square meters
Plot Size	PLT	Plot size on which the property is built
Neighborhood		
Roads	RD	Categorical variable to check if property is accessible or not (= 1 when accessible, = 0 when not accessible)
Neighborhood	NH	Categorical variable for the nature of the neighborhood. (= 1 when affluent, = 0 when otherwise ...e.g. blighted)
Power Plant Effects		
Vibration Effects	VIBEFF	Categorical variable for when vibrations from power plants are felt=1 or vibrations from power plants are not felt =0
Noise Effects	NOIEFF	Categorical variable for when noise from power plants are felt=1 or vibrations from power plants are not felt =0
Pollution Effects	POLEFF	Categorical variable for when pollution effects from power plants are experienced =1 or when pollution effects are not experienced =0
Demographic Effects	DEMEFF	Categorical variable for when demographic impacts from power plants are experienced =1 or when demographic impacts from power plants are not experienced =0
Economic Effects	ECOEFF	Categorical variable for when economic impacts from power plants are experienced =1 or when economic impacts from power plants are not experienced =0

FINDINGS

Descriptive Statistics

Table 2 provides a useful tabular format of the summary descriptive data as they were used in this study. As it can be seen, a total of 53 valid entries were used in the analysis from the pool of 55 respondents. The others had missing information in some variables and hence were omitted.

Estimated Regression Models

The following were the estimated regression models for this study:

First, for the logarithmic regression model the following results were obtained:

$$\ln RV = 9.0543 + 0.0234 \ln DPP + 0.1269Y – 0.0188 \ln DO + 0.0984 \ln PLT + 0.3414 \ln AP + 0.0736 \ln FL + 0.1559 \ln BD + 0.1602 \ln BDS + 0.1609 \ln BT + 0.0009BST + 0.4407HCI$$

Table 2. Descriptive Statistics

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Rent					
Property Rent (RV)	55	110000	950000	350000	214633.624
Distance From Power Plants					
Distance from Power Plants (DPP)	55	34	422	220.65	114.813
Tenant Characteristics					
Income (Y)	55	350,000	2,700,000	720,000	150,000
Duration of Occupancy (DO)	53	1	15	4.75	3.891
Building Attributes					
Plot Size (PLT)	55	400	1200	820.91	239.345
Area of the Property (AP)	55	100	550	313.64	137.253
Number of floors (FL)	55	1	3	1.49	0.717
Number of bedrooms (BD)	55	1	7	3.51	1.55
Bedroom size (BDS)	55	6	12	8.18	2.412
Bathrooms (BT)	55	1	3	1.36	0.589
Bathroom State (BST)	55	0	1	0.5	0.025
Housing Condition Indicator (HCI)	55	0	3	1.42	1.228
Boundary Wall (BW)	55	0	1	0.5	0.05
Nature of Neighborhood					
Neighborhood (NB)	55	0	1	0.69	0.466
Accessibility (AC)	55	0	1	0.71	0.432
Power Plant Effects					
Noise Effects (NOIEFF)	53	0	1	0.45	0.503
Pollution Effects (POLEFF)	53	0	1	0.4	0.494
Vibration Effects (VIBEFF)	53	0	1	0.53	0.504
Demographic Effects (DEMEFF)	53	0	1	0.7	0.463
Economic Effects (ECOEFF)	53	0	1	0.75	0.434
Valid N (list wise)	53				

+ 0.1572NH + 0.0801RD + 0.0479BW –0.0124POLEFF – 0.0414VIBEFF + 0.1269DEMEFF – 0.1491NOIEFF – 0.0036ECOEFF + 0.3161 ....(I)

Second, for the linear regression model the following results were obtained:
RV = –169,478 – 107DPP + 22,363Y – 2277DO + 73PLT + 439AP + 8441FL + 37009BD + 9792BDS + 43848BT – 19285BST + 157895HCI + 57945NH + 23390RD – 9191BW – 34653POLEFF – 19390VIBEFF + 63187DEMEFF – 40994NOIEFF+ 214ECOEFF + 106884.75
....(II)
These model formulations and their implication will be discussed later on.

Statistical Tests

For the nonlinear regression model, the explanatory power of the model, measured by the R^2, is 78 percent with an F statistic of 8.18 which is significant at a 5% significance level. In other words, the regression model manages to explain 78 percent of the variation in the monthly rents in Kinyerezi. Given the heterogeneity of the rental market of Dar es Salaam in general and Kinyerezi in particular, this is considered as quite high. The explanatory variables behave either negatively or positively and with reasonable magnitudes. The t statistic has been used to measure explanatory variable significance – the threshold being t > 2.

The coefficient of determination for the linear regression model is 82% with an F statistic of 10.46 which is significant at a 5% significance level, indicating that the model explains a very reasonable share of the variation in the dependent variable. The explanatory variables also behave either negatively or positively and with reasonable magnitudes. The t statistic was used as a measure of explanatory variable significance.

DISCUSSION OF MODEL RESULTS

The following discussion will provide a detailed account of all the factors treated in this study and how they behaved. Distance from the Kinyerezi power plant. The linear regression model projects to the principal finding of this study - that rents in Kinyerezi are negatively affected by proximity to power plants by a decrease of 107 Tsh, for every meter near the power plant.

The nonlinear regression model points this out to be 2.34%. This is a quite substantial amount in monetary

Regression Results

The following results (Tables 3 and 4) were obtained (For brevity and clarity, model results were paired).

Table 3: Models Summary

Regression Statistics	Non Linear Model	Linear Model
Multiple R	0.887554331	0.908563587
R Square	0.787752691	0.825487791
Adjusted R Square	0.698385402	0.752008966
Standard Error	0.316138499	106884.7506
Observations	55	55

Table 4: Regression Coefficients and T stats

MODELS	NON LINEAR MODEL		LINEAR MODEL	
	B	t	B	t
Intercept	9.0543	6.7333	-169478	-1.29961
Distance From Power Plant				
DPP	0.0234	0.3037	-107.385	-0.64962
Tenant Characteristics				
Y	0.1269	1.0654	22363.78	0.566659
DO	-0.0188	-0.3779	-2277.16	-0.53524
Building Attributes				
PLT	0.0984	0.6154	73.3357	1.005021
AP	0.3414	2.388	439.2108	2.31225
FL	0.0736	0.4839	8441.35	0.277806
BD	0.1559	0.9443	37009.45	1.983975
BDS	0.1602	0.6419	9792.232	0.96722
BT	0.1609	1.0373	43848.68	1.312329
BST	0.0009	0.0074	-19285.3	-0.47297
HCI	0.4407	2.9577	157895.3	3.066199
BW	0.0479	0.5271	-9191.07	-0.28435
Nature Of Neighborhood				
NH	0.1572	1.5222	57945.31	1.611007
RD	0.0801	0.7906	23390.69	0.678459
Power Plant Effects				
ECOEFF	-0.00362	-0.03262	214	-0.58481
DEMEFF	0.1269	1.2647	63187	1.917952
POLEFF	-0.1024	-1.0438	-34653.6	-1.0833
NOIEFF	-0.1491	-1.0378	-40994	-0.86831
VIBEFF	-0.0414	-0.414	19390	-0.58481

terms considering the large property capital sums at which properties are transferred or rented. The impact on rent is not statistically significant at 5% significance level. The coefficient of distance from power plants as is indicated by the results of equation II is -107. These findings are in tandem with the seminal works of Boesa et al., (2015), McCord *et al.,* (2013), Davis (2010) and Wadley & Elliott (2002) who also concluded that power plants negatively impact rental prices to varying magnitudes and levels of significance.

Tenant Characteristics

Tenants Income: Findings from this study indicate that rents are directly, but not significantly related to the level of income, such that the higher the income, the higher the rent and the lower the income, the lower the rent other factors being constant. Results from the regression analysis (using the log form of the equation) provides further indication of a positive relationship between incomes and rents, such that a unit increase in a tenant’s income, increases rents paid up by a tenant by 12.69%, with a t statistic of 1.06.

Duration of Occupancy: The duration of occupancy was also one of the factors which negatively impact rents in Kinyerezi. It was found out a year more in the tenancy agreement reduces the rent paid by about 1.88%. The relationship was not statistically significant with a t statistic of -0.3779. From equation II, the duration of occupancy coefficient is given by a parameter estimate of -2,277 with a t statistic of -0.5352. This interesting observation is in line with Nygaard (2013) who argues that the longer the tenancy agreement - the lower the rent at *ceteris paribus* because the tenant-landlord relationship is very important and it is likely that a landlord will highly value a good relationship with a trustworthy tenant who pays rent on time.

Property Attributes

Plot Size: The plot size was found out to positively impact property rents by 9.84%. This is a very material figure and goes to show that by investing in sizable plots, property owners can cash in on higher rents per square meter in Kinyerezi. The coefficient for plot size is given as 73 from equation II. It is reasoned that, as propounded by Nygaard (2013) and Melichar & Rieger (2009), that a large plot size gives tenants free space to conduct their activities in, and that they value it highly in lease negotiations. The findings above are supported by Sirmans *et al.,* (2005). The strength however of this relationship was at a t statistic of 0.61 and 1.005 for the two models respectively which was relatively weak.

Area of the Property (Living Area): Results from the equation I of the regression model also indicated that the area of the property or the dwelling size strongly and positively affects the rents in Kinyerezi – as measured as square metres. The magnitude of this effect is to the tune of 34.4%, which is one of the most pronounced of all the determinant variables with a t statistic of 2.388. Equation II provides the area of the property coefficient at 439 with a t statistic of 2.31. These results are consistent with previous models examining the contribution of property dwelling area, especially Nygaard (2013) and Cebula (2009) whose studies found an area of the property to be strongly significant (t-statistic of 16.99 and 10.85) with a parameter estimate of about 0.25 and 0.22 respectively.

Number of Floors: This study found out from the equation I results that the number of floors positively impact property rents in Kinyerezi by 7.36%. The relationship exhibits a t statistic of 0.48. The number of floors coefficient as indicated by Equation II is 8441 with a t statistic of 0.277. It is therefore clear that it is not significant. This result is consistent with the seminal observations of Sirmans *et al.,* (2005) together with Coulson and Lahr (2005), Leichenko *et al.,* (2001) and Clark & Herrin (2004), which the property prices and rents in cities tend to increase with the number of stories structures have, even though it is not the strongest explanatory variable.

Number of Bedrooms: The results from this study indicate that property rents in Kinyerezi are positively affected by the number of bedrooms. From equation II results, a room more in Kinyerezi costs 37,000 Tshs with a t statistic of 1.98 which is approximated to 2 for the purposes of this study. Percentage wise, bedrooms contribute 15% of the housing rental price and this is a quite pronounced percentage. However, the relationship indicated from the equation I is not statistically significant with a t statistic of 0.9443. These findings are consistent with Nygaard (2013) who found that the number of rooms (i.e. Number of rooms with a window, excluding the kitchen, bathroom and toilet) are highly significant as a determinant of rent.

Bedroom Size: Due to standard room sizes, traditional literature from the developed world does not incorporate this factor. However, in Tanzania bedrooms in residential houses are rarely of similar size. This study fills this important research gap and finds out that in fact, a $3m^2$ increase in bedroom size increases the rent for a property by 16.02%. The bedrooms, size coefficient is given from equation II as 9792. The t statistics for the two models are 0.6419 and 0.967 respectively. This suggests a rather weak impact of room size on rents. However, it is clear that tenants occupying larger rooms pay more rent per unit area.

Bathrooms: Bathrooms form an integral part of any built environment and hence increase the appeal of the property. Therefore, tenants preference is to be expected for properties with bathrooms over those without. Accordingly, this study finds that bedrooms impact rents positively by about 16.09% - which is a relatively weak influence with a t statistic of 1.03. The bathroom coefficient from equation II was 43,848 with a stronger t statistic of 1.3123 compared to that of Equation I.

Housing Condition: Results from this study indicate that physical characteristics of the dwelling unit capture the largest share of the variation in the rental price of building units of Kinyerezi. The data set is based on a very comprehensive index comprised of floor, wall and roof as the important factors involved. We see that variables that capture high material standard provide a positive effect on rent. In fact, 44.07% of variation in rents can be explained by the material standards and workmanship in Kinyerezi with a t statistic of 2.95. Equation II indicates that an excellent building structure contributes about 157,895 Tshs more to the building rental price with a stat of 3.066. This finding is in agreement with Nygaard

(2013) who found a very strong positive impact on material standard of a parameter estimate of about 0.29 and with a t-statistic of 7.17 indicating that material standard is a statistically significant factor in explaining rents.

Presence of a Boundary Wall: This study incorporated the presence of a fencing wall into the analytical models for rent determination in Kinyerezi. The results are interesting, indicating mixed results from the two models. The nonlinear model indicates a positive effect on the rate of 4.79 per cent, at a t statistic of 0.5271 while the linear model indicates a negative effect of Tsh 9191 at a t statistic of -0.28435 in the presence of a boundary wall on the rents in Kinyerezi. This observation calls for further studies to examine the impacts of the presence of boundary walls on property rents.

Nature of the Neighborhood

The nature of the neighborhood: The nature of the neighborhood was found to explain 15.72% of the rents variation in Kinyerezi, despite the relationship not being statistically significant with a t statistic of 1.5222. The nature of the neighborhood coefficient is 57,945 from equation II with a t statistic of 1.611. These findings are in agreement with Nygaard (2013) who established that neighborhood and geographical location are a key factor behind rent differences.

Accessibility: This study incorporated access which was proxied by the presence of roads into the analysis of factors impacting rents in Kinyerezi. It was found out that accessibility to properties in Kinyerezi explained 8% of the rents in Kinyerezi. The coefficient for accessibility from equation II is 23,390.

Power Plant Effects

Findings from this study indicate that tenants and property owners alike are not adequately informed about the non-visible effects of the power plants – especially about the toxic electromagnetic fields (EMF) radiation effects. This was established because not a single respondent was able to point out the electronic interference, which is the main indicator of EMF effects of power plants and associate them with power plants. Vibration, noise and pollution effects had 4.14%, 14.91% and 10.24% negative impact on rental prices, and their coefficients from equation II -19390, -40994 and -34653 respectively even though they were all not statistically significant.

Generally, it was reasoned that this can be explained by the conscious decision on the part of the tenants to try to offset the nuisance and disturbance associated with the said variables by negotiating for lower rents in their leases.

On the other hand, the higher negative value for noise effects can be attributed to the fact that the noise effect is a much stronger, ever present disamenity which can affect the tenants livelihood and health in Kinyerezi, and hence they pay a lot less in case of noise effects existing around their rental units. It is also worth noting that most respondents of this study noted that they were faced with noise disturbance from the power plant emanated within the range of 200m to 400m. While this may seem paradoxical, it was reasoned that the answer lies in the orientation of the power plant which seemed to make the North Western part of Kinyerezi facing the electric generators compared to other directions of the settlement more vulnerable to noise effects.

The vibration impact had a much less strong impact on rents than anticipated, and this fact can be attributed to the excellent location choice, technical and design considerations for the power plant. The generating facility faces an inhabited valley and the high voltage lines are the ones which intersect with human settlements. As such, the vibration effects are not as strongly felt compared to noise or pollution effects. The pollution effect similarly had negative impacts on property rents, which were much less pronounced compared to the noise effects, but more pronounced than the vibration effects.

On the other hand, the economic effects and demographic related impacts had mixed results as far as the relationship with rents in Kinyerezi was concerned. The population effect was slightly more pronounced at 12.69% with a coefficient of 63187 compared to only -0.3% of the economic effects with a coefficient of 214. The general positive impact can be explained by the social, economic synergies associated with demographic and population changes around Kinyerezi. This can be explained because the distance range of 200m to 250m was the one which mostly noted the population and economic effects of the power plants. The distinct negative impact can be explained by the nuisances associated with the said developments. It is noteworthy to point out that these distance categories correspond most with the distances associated with trade and employment compared to other distance categories which did not display these characteristics.

CONCLUSION AND RECOMMENDATION

Based on the residential neighborhood surrounding the Kinyerezi power plant this study has established that the power plant negatively affects rents in the area to the tune of 10,700 Tshs less for every 1 Kilometre. The effect is not statistically significant, however (so the effect is unpronounced) at a 95% significance level, which can partly be attributed to residents living in Kinyerezi not being fully aware of the nature and scale of impacts that are posed by power plants. It has also been established that rents in Kinyerezi are affected by the income level, property structural attributes – including the plot size, number of bedrooms, area of the property, bathrooms and bathroom state) duration of stay, neighborhood attributes (including the nature of the neighborhood and accessibility) and the power plants' effects (noise, pollution, vibration, demographics and economic effects). It is hereby recommended that awareness and information dissemination campaigns be conducted. This will increase the awareness of the level of risk that the residents around Kinyerezi power plant faces. It is also recommended that in setting out to determine the location of power plants, planning officials and land officers should take proper note and communicate to energy engineers and transport stakeholders to minimize the negative effects of power plants as they have been established in this study.

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