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RE-THINKING ENGINEERING AND
TECHNOLOGY FOR ENVIRONMENTAL
SUSTAINABILITY IN THE FACE OF GLOBAL
PANDEMIC**

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PREFACE

The second edition of the International Conference on Engineering and Environmental Sciences (ICEES 2021) was co-hosted by the Faculty of Engineering and the Faculty of Environmental Sciences of Osun State University, Osogbo from 23rd-25th November, 2021. The Conference with the theme, “Re-Thinking Engineering and Technology for Environmental Sustainability in the Face of Global Pandemic” took place at a time the world is still re-adjusting to life in the COVID/post-COVID-19 era. The conference which had both on-site and online participants from within and outside Nigeria provided opportunities to foster interactions and collaborations among members of academia, industries and stakeholders across the globe, with a view to proffering informed solutions to various technological and environmental challenges confronting Nigeria and the world at large.

ICEES 2021 brought to the fore, the need for a re-think on how to build our cities, especially as world is working towards exiting the COVID-19 pandemic era. Efficient technologies that make social distancing, regular hand-washing and vaccination possible with little or no stress were highlighted. The need for wider deployment of frontier technologies like Artificial Intelligence, Internet-of-Things, Drones and Unmanned Vehicles, Virtual Reality, Quantum Computing, Renewable Energy, Big Data Analytics, Nanotechnology and Technology-Enhanced Learning in a bid to achieve quick economic recovery, growth and adaptation; combat COVID-19 and improve public health; provide high quality education as well as reduce the global digital divide was emphasized. During the conference, local, national and international participants demonstrated various approaches to the solutions theoretically, empirically and numerically.

Having evaluated, revised and edited the various submissions by the participants to produce this publication, readers of this Conference Proceedings will find in it intellectual treasures. It is our hope that they will also derive from it, inspiration for areas of further research to expand the frontiers of knowledge and produce qualitative works to qualify for the next edition of the ICEES conference.

Finally, our immense appreciations go to the members of the local organizing committee as well as the local, national and international participants for using their time, energy and material resources to make the event worthwhile.

Engr. Dr. S.O.A. Olawale

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ADVANCING PROPERTY INVESTMENT RETURNS THROUGH IMPROVED URBAN NEIGHBOURHOOD INFRASTRUCTURE CONDITIONS IN JOS CITY

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ABSTRACT

Infrastructure is one of the substantial indicators of neighbourhood and urban quality; it possesses the capability to draw and sustain returns on property investment. This study focuses on the urban neighbourhood infrastructure conditions as a pointer to ideal residential property investment returns in Jos city, Nigeria. The study adopted a survey research design using structured questionnaires to gather the required data. The data required are property transaction data on rental value and capital value of residential properties and the conditions of basic infrastructure in the selected neighbourhoods of Jos city. These data were sourced from practicing Estate Surveyors and Valuers practicing in Jos as well as the residents of the selected neighbourhoods. The estimated sampled size was 251 and only 161 questionnaires were recovered. The data collected were analysed using descriptive and inferential statistics. They are mean score, standard deviation, coefficients of variation and Spearman's Rank Order Correlation model. The results of the analysis revealed that residential property investment performed better in Gwang layout and Lowcosts than Rayfield and Kufong areas on the basis of risk-return. The risk-return ratios range between 8% and 38%. Rayfield and Kufong residential market showed high level market volatility indicating the risky nature of these property submarkets. Infrastructure condition indices in Rayfield and Kufong is higher than ideal condition index (Benchmark), ranging between 72%-89% and 81%-94%. Few urban neighbourhood infrastructure conditions in Gwang Layout and Lowcosts are found to be below the benchmark. The study concluded that infrastructure has a strong influence on residential property investment returns in the study areas. It therefore, recommended that infrastructure condition should be given special attention when forming opinion on residential property investment.

Keywords: Residential, Returns, Property investment, Neighbourhood, Infrastructure, Property Market.

1.0 Introduction

Infrastructure is seen as the fundamental facility and system serving a country, city and other areas, including the services and facilities necessary for its economy to function effectively (Tomlinson, 2001). Infrastructure prominently stands out as one of the indicators of an ideal urban economic development and its worth cannot be downplayed because it plays a vital role in the growth and development of any urban setting and its role in-turn creates attraction for all

forms of investments of which real estate investment is one. Property investment is the real estate property purchased with the intention of earning a return on investment either through rental income, the future resale of the property, or both. Ajayi (2014) asserted that property investment is the act of laying out capital in expectation of future return. Further explained that the anticipated reward from property investment may be in form of an income flow (rent) or by the receipt of a single capital sum (sale) or a combination of both (total return).

The property may be held by an individual investor, or a group of investors, or a corporation. Ajayi Cyril (2014) and Ogbuefi (2002) convincingly discussed it that, development of property investments performance indicators such as value indices, yields and total returns promote improvement in the analysis of the property investment returns at every location where invested real estate, especially, residential property is located. Investment's efficiency among others is a function of the return, risk and total cost of an investment management structure and this are subject to the infrastructure functionality and other constraints within which investors must operate (Dubben and Sayce 2009) and investment efficiency should be considered as a combination of financial efficiency and non-financial efficiency. Corgel *et al.* (1998) asserted that infrastructure projects abandonment would always affect property investment values in the vicinity.

Infrastructure, such as water, energy, roads development, transport networks, information, and communication technology for sustainability and these urban services also positively influence the value of real estate as they improve housing conditions and quality (Famuyiwa and Otegbulu, 2012). Olujimi (2009) and Olujimi (2010) opined that whenever infrastructure is inadequately provided, the probability that the expected sustainable real property return will dwindle is very high. Real estate has no value if it has no infrastructure service to effectively support (Ajibola *et al.*, 2013). Gatauwa and Murungi (2015) studied the influence of infrastructural development and real estate investment returns in Meru County, Kenya. The data collected from 955 real estate properties were subjected to regression analysis and the result revealed that, transport and communication factors, social amenities, industrial development, educational institutions and commercial development accounts for 89.3% variation in property investment. The study therefore concludes that infrastructure development has a great impact on real estate investment return among other factors hence infrastructure developments would lead to demand for real estate property and this in turn will affect returns on real estate property.

There is intrinsic problem of lack of functional infrastructure and several attempts had been made by public and private property investors to correct the failure in residential property investment performance in both urban and peri-urban neighbourhoods in Jos city of Nigeria, This paper aimed at examining the effect of infrastructure conditions on residential property investment returns while focusing on residential properties which are meant for investment purpose across the study area.

2.0 Brief Profile Study Area

Jos city is the capital of Plateau State, lies on Latitude 9° 30'N and Longitude 5° 34'E in the North Central Nigeria. Jos is more populated more than any other town in the state. In spite of crisis in the area Jos is still experiencing notable evolution in real estate development and property investment. Jos is endowed with infrastructure essential of a city and there is room for more as the city is expanding on daily basis. (NIEVS, 2017)

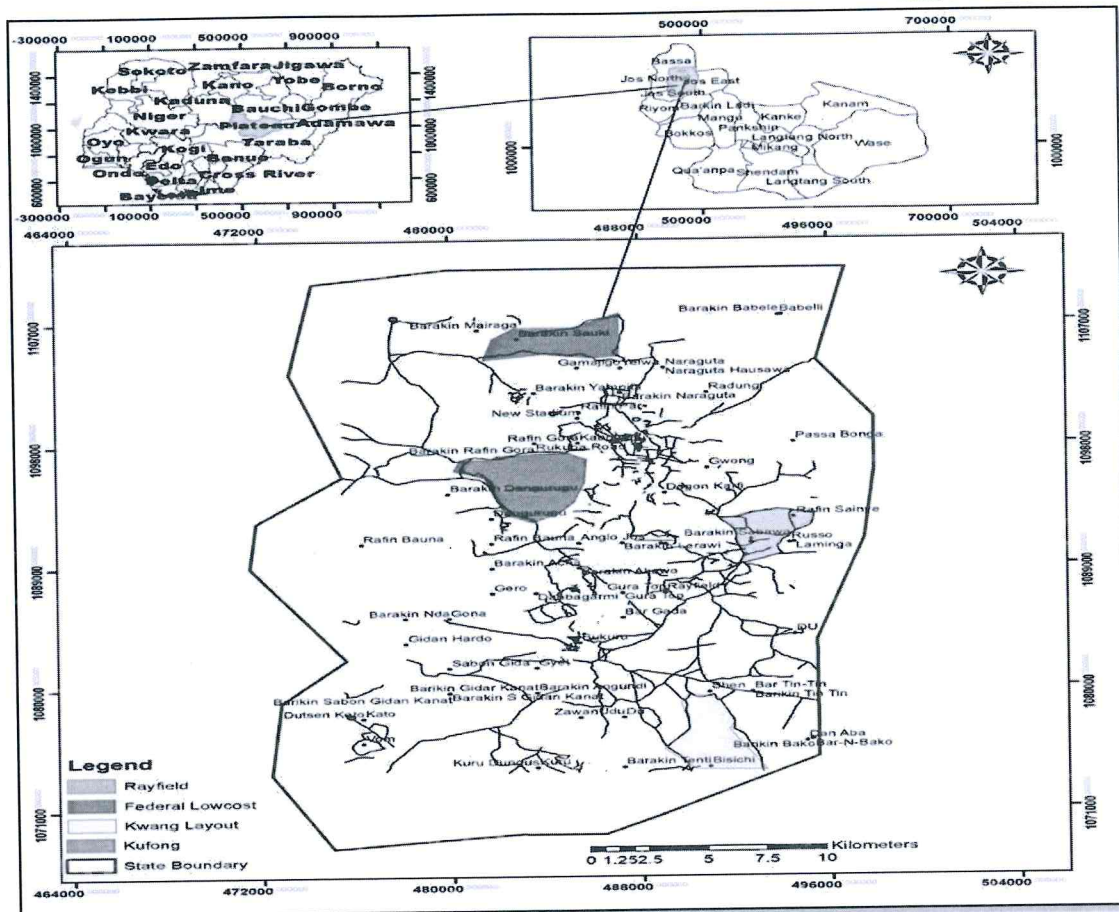


Figure 1: Selected Neighbourhoods in the Context of Jos Metropolis

Source: Plateau State Town Planning Authority Planning Unit, (2021)

3.0 Methodology

This study adopted a survey research design in which structured questionnaire was used to collect the required data. The data were sourced primarily from registered estate firms and residents of the selected neighbourhoods. The sample size for this study was determined using the Frankfort Nachmias 1996 model to arrive at 251 respondents. Only 161 respondents correctly completed and returned the questionnaires representing 64% response rate. The required data are rental and capital values of the sampled 1-bedroom, 2-bedroom and 3-bedroom residential properties in the study areas. Data on the state or condition of basic infrastructure were equally retrieved and analysed using both descriptive and inferential statistics. Likert Scaling was used as a ranking method and benchmark for minimum acceptable standard of condition and infrastructure index was taken. From the rental and capital value data, the total returns on investment were computed and the mean average determined and the associated risk on investment return (risk-return) is determined using the coefficient of variation. The Kendall Coefficient of Concordance was employed to test relationship among the ranked infrastructure factors while the Spearman's Rank Order Correlation was used to determine the relationship between neighbourhood infrastructure condition and residential property investment returns in the study areas.

4.0 RESULTS AND DISCUSSION

This subsection presents and discusses the findings of the study. The total return performance of the selected categories of residential real estate investment and the condition of infrastructure as well as its effect on the performance of real estate investment returns are presented and discussed.

Table 1: Rate of Returns on 1B/R Property Investment in Jos

Year	Kufong	Gwang Layout	Low Cost	Rayfield
2009	9.11	6.79	6.64	14.09
2010	9.99	6.22	6.42	13.49
2011	7.39	5.70	5.88	14.95
2012	8.43	6.89	7.19	12.05
2013	7.66	6.13	6.04	11.56
2014	6.06	6.19	6.53	11.32
2015	5.72	2.33	2.86	11.02
2016	7.65	3.73	3.97	11.15
2017	7.67	6.09	6.47	12.33
2018	3.57	4.95	7.85	27.31
Average Rate of return	7.33	5.50	5.99	13.93
Standard deviation	1.83	1.45	1.49	4.89
Coefficient of variation	0.25	0.26	0.25	0.35

Source: Author's Analysis (2021)

Table 1 revealed that there is a single digit rate of returns on One Bedroom (1B/R) in Kufong, Gwang Layout and Low-cost areas of Jos. This specifies less perform property market areas as compared with Rayfield market which operated on double digit rate of returns which is a signal of good property market performance in 1B/R property market. But the analysis of standard deviation and coefficient of variation that establish the risk content on 1B/R property investment returns revealed that investors in Kufong and Low Costs residential property markets were bearing a risk of 25% so that they can have 7.33% and 5.99% returns on investment. In Gwang-Layout residential market, an investor is undertaking a risk of 26% in order to have 5.50% return on investment, In Rayfield residential market, an investor is undertaking a risk of 35% in order to have 13.93% return on investment. As a result of this, Kufong residential property market is preferred and better for any prudent real estate investor in one bedroom apartment, though Rayfield appeared to be a better investment area due to highest return but only a high risk loving real property investor can investment in such market because the return is magnificent. The results in the context of one bedroom apartment is consistent with the literature of Tomlison that, high risk in real estate investment commands high returns and vice versa.

Table 2 analysed the trend in 2B/R property market and the result showed that Kufong, Gwang Layout, Lowcost and Rayfiel operated on a single digit rate of returns over the period under review. Only a few period in Rayfield showed a double digit rate of returns; indicating a better market in 2009, 2010, 2012, 2013, 2014 and 2018 for 2B/R property investment market in

Table 2: Rate of Returns on 2B/R Property Investment in Jos

Year	Kufong	Gwang Layout	Low Cost	Rayfield
2009	7.29	7.79	6.39	11.19
2010	8.24	7.09	7.29	12.02
2011	7.05	6.86	5.76	8.36
2012	7.15	7.45	7.31	13.26
2013	8.46	6.32	6.54	11.17
2014	8.35	6.93	6.31	12.36
2015	4.97	2.79	5.09	6.49
2016	5.13	4.59	5.22	8.86
2017	7.59	7.72	5.99	7.50
2018	6.50	13.80	7.96	10.50
Average Rate of return	7.04	7.13	6.39	10.17
Standard deviation	1.24	2.82	0.93	2.25
Coefficient of variation	0.18	0.39	0.15	0.22

Source: Author's Analysis (2021)

Rayfield area of Jos. The analysis of individual market was carried out through standard deviation and coefficient of variation on 2B/R property across the selected residential market areas to show the risk contents. In Kufong residential market revealed that an investor is undertaking a risk of 18% in order to have 7.04% return on investment; in Gwang Layout residential property investment market, an investor is undertaking a risk of 39% in order to have 7.13% return on investment; in Low Costs residential property market, an investor is undertaking a risk of 15% in order to gain 6.39% return on investment and investor in Rayfield residential property market is undertaking a risk of 22% in order to have 10.17% return on property investment. This implies that, Low Costs residential property market is considered appropriate and better preferred, because investor is taking a least risk to comparable average returns in other neighbourhoods. Rayfield residential property market appeared more risky than other property investment market in other neighbourhoods. The implication of the results of two bedrooms in the study areas

Table 3: Rate of Returns on 3B/R Property Investment in Jos

Year	Kufong	Gwang layout	Low Cost	Rayfield
2009	7.94	6.21	6.16	10.95
2010	7.48	6.62	6.57	10.46
2011	7.31	6.29	6.26	8.08
2012	7.58	6.21	6.45	11.57
2013	7.69	6.25	6.28	11.25
2014	9.02	6.56	6.14	10.19
2015	4.68	5.02	5.92	7.33
2016	6.73	5.68	6.19	8.49
2017	9.79	6.23	7.14	8.54
2018	11.42	14.25	10.38	12.78
Average Rate of return	7.96	6.93	6.75	9.97
Standard deviation	1.82	2.61	1.32	1.77
Coefficient of variation	0.23	0.38	0.19	0.18

Source: Author's Analysis (2021)

negate the argument of Olujinmi and Bello that infrastructure is not always have influence on property investment performance due to economic menace, but the results shows that however infinitesimal, infrastructure have influence on real estate investment performance.

The annual rate of returns on 3B/R property investment in Jos presented in Table 3 showed that all selected neighbourhood in Jos operated on single digit rate of return, only a few periods in Rayfield maintained double digit rate of returns in 2009, 2010, 2012, 2013, 2014 and 2018. Kufong, Gwang layout, and Low cost maintained double digit at current year 2018. But the analysis of individual market performance on the basis of risk was carried out using standard deviation and coefficient of variation to establish the risk contents on 3B/R property across the selected residential property market areas. In Kufong residential property market, the investor will bear a risk of 23% in order to gain 7.23% return on investment, in Gwang Layout residential property market, an investor will under a risk of 38% in order to have 6.93% return on investment, In Low Costs residential property market, an investor is undertaking a risk of 19% in order to achieve 6.75% return on investment and while investor in Rayfield residential property market will as well undertake a risk of 18% in order to have 9.97% return on property investment. Therefore, Rayfield residential property investment market is adjudged appropriate compare with other residential property market in other neighbourhoods, because investor is taking a reduced risk at comparable average return. Gwang layout residential market appeared more risky than other property market in other neighbourhoods. The results in the context of three bedroom apartment, by implication gives direction to real estate investor in order to take appropriate decision and this in line with Ajibola *et al* which claims that returns on property investment depends on functional infrastructure

Table 5: Analysis of Variance in Residential Property Market in Jos

Source of Variation	SS	Df	MS	F	P-value	F crit
Between Groups	457.3732	3	152.4577	19.32639	0.0000	2.866266
Within Groups	283.9888	36	7.888576			
Total	741.3619	39				
Between Groups	85.54466	3	28.51489	7.404149	0.00055	2.866266
Within Groups	138.6433	36	3.851204			
Total	224.188	39				
Between Groups	65.3243	3	21.77477	5.808334	0.002408	2.866266
Within Groups	134.9598	36	3.748883			
Total	200.2841	39				
Between Groups	32.86023	3	10.95341	2.101209	0.117218	2.866266
Within Groups	187.6647	36	5.212908			
Total	220.5249	39				

Source: Author's Analysis (2021)

The variance in property returns across the market location is presented in table 5 above. The result revealed that 1B/R property market across the study areas showed a significant variation in average return across the study areas since p-value at 0.000 is less than 0.05 level of significance. The result showed a significant variation in average 2B/R property market across the study areas since p-value at 0.00055 is less than 0.05 level of significance. 3B/R property market also showed significant variance in property return across the study areas at p-value of 0.002408 ($p < 0.05$) and 4B/R market also revealed a insignificance variation in property return across the selected location at p-value 0.117218 ($p\text{-value} > 0.05$). The implication is that neighborhood differences associated available infrastructure provided inequality in the distribution which caused preference in location and therefore causes different property market performance.

Table 6 showed the analysis five point Likert Scale used to measure the condition of infrastructure across the study areas. The result indicated the reliability test carried out to establish the degree of internal dependable among the items through the use of Cronbach's Alpha. The result showed that at minimum acceptable alpha at 0.75 (75%), all the items across the study areas maintained high level of internal consistency at 80%, 76%, 85% and 88% for Kufong, Gwang-Layout, Low Cost and Rayfield respectively. The hypothesized mean or benchmark is calculated as $(5+4+3+2+1 = 15/5 = 3)$. Also, any infrastructure with mean condition higher than average threshold or hypothesized mean is referred to as infrastructure with a better condition. Therefore all the infrastructure showed better condition across the selected areas in Jos city.

The hypothesised mean condition index (benchmark) at 0.6 (3/5) for five –point Likert Scale given in table 6 above is used to determined infrastructure with better condition, this implies that, any infrastructure condition index that is more than 60% (0.60) showed a better condition index. Infrastructural Condition Index in Kufong ranges between 0.62-0.81 (62% -81%), in Gwang-Layout, Infrastructure Condition Index (ICI) ranges 0.73-0.88 (73% -88%), in Low Cost, ICI ranges between 0.60-0.79 (60% - 79%) and in Rayfield, ICI ranges between 0.79 – 0.87 (79%-87%). This further signifies that, infrastructure condition in Rayfield is better than Gwang-Layout, Gwang Layout is better than Low cost and Kufong.

The result of strength of relationship between infrastructural index and property performance index is presented in table 7. There is strong positive significant relationship between water supply and property return across the study areas in Jos City. Electricity maintained strong positive significant relationship property return in Low cost and Rayfield. Access road and neighborhood security maintained strong positive significant relationship property return across the study areas of Jos. Drainage maintained positive significant relationship property return in Gwang layout, Low Cost and Rayfield. Waste disposal only maintained strong positive significant relationship property return in Gwang layout. Recreational facilities educational facilities only maintained strong positive significant relationship property return. Rayfield and Low cost respectively. health facilities did not maintain strong positive significant relationship property return across study areas in Jos. Street light maintained strong positive significant relationship property return Gwang layout, Low cost and Rayfield. This indicates that these aforementioned infrastructural variables are likely to cause positive significant change in return on property investment cross the aforementioned areas, they are therefore positively and strongly correlated property investment performance in the study areas of Jos city.

Table 6: Infrastructure Condition Index (ICI) in Jos

Infrastructure	Kufong (Alpha- α @0.80)				Gwang (Alpha- α Low Cost (Alpha- α @0.85) @0.76)				Rayfield (Alpha- α @0.88)											
	N	Sum	Mean ICI	Status	N	Sum	Mean ICI	Status	N	Sum	Mean ICI	Status								
Water supply	169	682	4.04	0.81	Good	165	644	3.90	0.78	Good	171	634	3.71	0.74	Fair	161	645	4.00	0.80	Good
Electricity	169	523	3.09	0.62	Fair	165	600	3.64	0.73	Fair	171	514	3.01	0.60	Fair	161	689	4.28	0.86	Good
Access Road	169	594	3.51	0.70	Fair	165	686	4.16	0.83	Good	171	675	3.95	0.79	Good	161	665	4.13	0.83	Good
Security Infrastructure	169	627	3.71	0.74	Fair	165	722	4.38	0.88	Good	171	611	3.57	0.71	Fair	161	637	3.95	0.79	Good
Drainage System	169	584	3.46	0.70	Fair	165	690	4.18	0.84	Good	171	646	3.78	0.76	Good	161	691	4.29	0.86	Good
Waste Disposal	169	600	3.55	0.71	Fair	165	613	3.72	0.74	Fair	171	576	3.37	0.67	Fair	161	691	4.29	0.86	Good
Recreation Facilities	169	591	3.50	0.70	Fair	165	691	4.19	0.84	Good	171	652	3.81	0.76	Good	161	690	4.29	0.86	Good
Education	169	635	3.76	0.75	Good	165	623	3.78	0.76	Fair	171	647	3.78	0.76	Good	161	650	4.04	0.81	Good
Health Infrastructure	169	600	3.55	0.71	Fair	165	608	3.68	0.74	Fair	171	611	3.57	0.71	Fair	161	657	4.08	0.82	Good
Street Light	169	609	3.60	0.72	Fair	165	665	4.03	0.81	Good	171	590	3.45	0.69	Fair	161	698	4.34	0.87	Good
Valid N (list-wise)	169					165					171					161				

Source: Author's Analysis (2021)

Table 7: Correlation between Infrastructure and Property Investment Performance in Jos

Infrastructure	Kufong ®	N	Gwang Layout®	N	Low Cost ®	N	Rayfield ®	N
Water supply	.65(.032)	183	.72(.002)	165	.67(.030)	151	.76(.001)	123
Electricity	.58(.041)	183	.51(.054)	165	.47(.048)	151	.42(.039)	123
Access Road	.71(.022)	183	.67(.024)	165	.65(.034)	151	.60(.030)	123
Security Infrastructure	.56(.045)	183	.61(.026)	165	.75(.001)	151	.75(.001)	123
Drainage System	.231(.452)	183	.58(.046)	165	.59(.023)	151	.68(.010)	123
Waste Disposal	.34(.385)	183	.49(.073)	165	.41(.104)	151	.44(.341)	123
Recreation Facilities	.41(.214)	183	.37(.122)	165	.34(.263)	151	.58(.025)	123
Education Infrastructure	.31(.308)	183	.41(.101)	165	.48(.047)	151	.43(.263)	123
Health Infrastructure	.21(.422)	183	.31(.213)	165	.38(.243)	151	.212(.432)	123
Street Light	.42(.266)	183	.62(.027)	165	.61(.027)	151	.62(.021)	123

Source: Author's Analysis (2021)

® = Return on Property Investment, N= number of properties

Table 8: Test of Relationship among the Ranked Infrastructure Condition in Jos city, Nigeria

Infrastructure	Jos				T_1	$\sum T_1^2$	W	r_s
	Kufong	Gwang Layout	Low Cost	Rayfield				
Water supply	1	6	4	7	18	324		
Electricity	9	10	8	3	30	900		
Access Road	6	4	1	4	15	225		
Security Infrastructure	3	1	5	8	17	289		
Drainage System	8	3	3	1	15	225	0.801	0.455
Waste Disposal	5	8	7	1	21	441	(0.011)	(0.065)
Recreation Facilities	7	2	2	1	12	144		
Education Infrastructure	2	7	3	6	18	324		
Health Infrastructure	5	9	5	5	24	576		
Street Light	4	5	6	2	17	289		

Source: Author's Analysis (2021)

The result of test of relationship and level of agreement presented in Table 4.21 was carried out using Kendall Coefficient of Concordance to test relationship among the ranked factors and

Spearman's Rank Order Correlation to test the level of agreement toward infrastructure condition. The result of Kendall's Coefficient of Concordance (W) revealed that $W = 0.801$ indicates a statistical evidence of a fair association in the ranking of the infrastructure condition across the study area in Jos, while the average rank correlation of variables between all possible pairs of the areas $r_s = 0.455$ indicating a weak agreement to the condition of infrastructure across the study area. This result in this context indicates that though each neighborhood has its own peculiarity when it comes to infrastructure condition, therefore the overall ranking of these factors across the selected neighbourhoods in the study areas are fairly related.

Recommendations and Conclusion

There is need for quality and adequate provision of neighbourhood infrastructure for residential property investment returns' sustainability.

Once it was discovered that, the infrastructure across the study neighbourhoods in Jos were not properly maintained, therefore, planned and unplanned maintained schedule should be employed fully supported by Infrastructure Policy Performance (IPP) and investors should be provided supporting with infrastructure that will enhance performance of residential investment at low maintenance cost. for residential property investment and economic sustainability

In conclusion, this study provided a statistically significant effect on property investment performance in the Nigeria. The result of the study has shown that return in an ideal residential property investment is hanged on the quality of infrastructure conditions.

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