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The role of universities in the development of smart cities. Case of Harare.

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Abstract. The role of institution of higher education in smart city initiatives is increasing with government`s intervention in the increase of innovation hubs in Zimbabwe. Curriculum alignment through education 5.0 which includes innovation and industrialization is promoting an atmosphere for research and development (Ministry of Higher and Tertiary Education Science and Technology Development, 2019). As a result, a principal component analyses approach was conducted in determining factors which enhance universities` engagement in smart city developments using varimax approach of rotation space (Mishra *et al.*, 2017; Leech et al, 2020). Qualitative approach was conducted on 390 respondents from various universities in Zimbabwe where reliability tests indicated 83% degree at 95% confidence interval using Kaiser Meyer Olkin`s measure of selection adequacy (Bonett and Wright, 2015); (Taber, 2018) . Factors which enhance universities to take part in smart city initiatives were extracted which are smart city education, innovation hubs, financial institutions and government support (Ransom, 2015; Sambuli and Whitt, 2017).
Key words: *Smart City, Principal Component Analysis (PCA), Innovation Hub, government, collaboration*

1 Introduction

The ministry of higher and tertiary learning has expanded its mandate of teaching, research and community service termed education 3.0 (teaching, research and community service) to education 5.0 which includes innovation and industrialisation (Ministry of Higher and Tertiary Education Science and Technology Development, 2019). The purpose of education 5.0 is to inculcate graduates with spirit of innovation concerning communal developments through technology knowledge application that enhance the living standards of city`s inhabitants. As a result, technology knowledge can be applied in the development of smart city applications that serve societal problems. The government of Zimbabwe is using National Science Technology Innovation System (NSTI) for strategic innovations management. Smart city (SC), a repetitively growing thematic domain, looks as an umbrella term that hosts multidisciplinary research on particular areas such as mobility, energy, environmental management, data, and governance. As the term entails, the core of the subject lays in real-life sensations and things in the dynamically varying life environments for a repetitively increasing population all over the world. Cities, as such, involve of vast amount of people and knowhow such as use of big data, internet of things and smart metering for billing that enable constantly advancing abilities for people to perform in better-

quality ways. Universities helps in the improvement of ICT infrastructure as an initiative of smart city development while alleviating the problem of unemployment through intervention of many companies (Brennan and Cochrane, 2019).

Figure 1. Source: Picture taken by the Authors Harare City Copacabana 22 May 2022 time 11:41hrs.

The government of Zimbabwe has made decision to ensure that no one is left behind through development of smart cities through digitization and new technologies like use of Tap-card by Zimbabwe United Passenger Company was useful in Covid-19 pandemic lockdown era (Thupeyo, 2021). As a result, the government sent representatives to United Arab Emirates to study solutions such as autonomous vehicles to tackle some of the transport, urban density, water sustainability and energy resources management problems. This move may result in cities like Harare collaborating with Chinese companies like Huawei to mount closed circuit television cameras (CCTV) as a means to help safety within the city's perimeter (Hove and Saki, 2020)**.**

2 Literature review

The Zimbabwe Global Climate change and lingering economic instability are also contributing to numerous challenges for cities such as economic stagnation, air pollution, traffic congestion, crime and droughts among other natural disasters. Hence going green through smart cities is a solution to rise to basic needs such as health, clean safe drinking water, healthcare and education among other factors (Jiang et al, 2020); (Tawanda, et al., 2020). The relationship between universities and city fathers are altering along with the engagement of universities in public service as they are the most noticeable research institutions (Liu, 2019). As a result, universities can be involved in smart city development through, coming up with actual working solutions as a requirement for students` projects and research collaborations that can generate revenue for the university (Lisdorf, 2020). The position of universities in the development of smart cities is vital as some researchers discovered that, universities act as knowledge managers (janitors, knowledge suppliers and knowledge assessors) (Ardito *et al.*, 2019). Systematic interaction and contextualized learning through organizational capabilities were identified as key mechanisms for strengthening relationships between universities and industry (Brekke, 2021). The concept of triple helix accentuates the relationship between state, companies, and universities. Thus, university can play a big role in innovation of smart cities and facilitating not only as technology and knowledge transfer supporting the economic development but also working as an intermediator and organiser between the other constituents of the ecosystem (Soe *et al.*, 2021).

Table 1. Definitions of key terms.

Key term	Definitions
Smart City	According to OECD (2020), "smart city concept primarily bring up initiatives that use digital and ICT-based innovation to increase the efficiency of urban services and produce new economic opportunities in cities ". While McKinsey Global Institute (2018) defined a smart city as, " an urban set up that applies technology to enrich the benefits and reduce the limitations of urbanization for its citizens". According to Lisdorf (2020), as defined by International Telecommunication Union International, "A smart sustainable city is an innovative city that practices information and communication technologies (ICTs) and complementary resources to improve quality of life, proficiency of urban operation and services, and competitiveness, while safeguarding the needs of present-day and future generations with respect to economic, social and environmental facets."
Smart City Model	Smart city model was established by the Centre of Regional Science at the Vienna University of Technology as indicated by Halegoua (2020). Hence it was defined by Halegoua (2020) as "A set-up of metropolitan management that put emphasis on the importance of intellectual capital and sustainable improvement for local growth". This archetypal is based on six key features which are smart economy, smart living, smart environment, smart people, smart mobility and smart governance (Pawlikowska-Piechotka *et al.*, 2017; Chigwenya *et al.*, 2020).
Smart Economy	A smart economy involves wealth and resources of the city through capacity for transformation, flexible labour market and solid economic reputation. A smart economy encourages human capital development towards smart city projects where population increase will open opportunities to accommodate the needs (Alagan and Waleed, 2019).
Smart Living	Residents are no longer beneficiaries but also players in smart city policies where investment in ethnic and educational facilities, processes to ensure public safety, optimal health, city attractiveness and social cohesion need to be upheld (OECD, 2020a). Hence, improving the standard of living for citizens is critical where these aspects can uphold and bring the cultural agenda and health (Perrone, 2014).
Smart People	Smart people entails placing more value on learning and acquiring new skills, compassion to social and cultural diversity, and inspiration of flexibility, creativity and chipping in public life. As a result, a smart city will advance as long as there are smart people and technologies to support it. Smart people are measured based on their level of knowledge through education, creativity, innovations and participation among other components. The number of people who have undergraduate degree, masters and PHDs within the population can indicate the level of literacy in an economy
Smart Environment	Smart city environment implies that all stakeholders put more effort on the protection of the environment. Likewise this involves a zero tolerance to litter, prohibition of dumping, lower levels foot carbon print, preservation of wetlands and consistently sustainable management of resources and. When breached it attract penalties, fine or lawsuit. The government would want to reduce carbon footprint through upgrading to greener vehicles (electric vehicles like Tesla in United States of America) and more efficient waste management. Hence, a smart environment includes urban infrastructure,

Key term	Definitions
	environmental protection sustainable resource management, water and energy usage and carbon footprint among other factors Halegoua (2020).
Smart Governance	Smart governance involves residents` involvement in the resolution making process, in safeguarding the acceptability and quality of public and social services and also promoting governmental transparency. Each smart city will have its own vision and goals where this results in a new form of economic structure. As for instance in Toronto, there is SmartTrack as regional express rail route which is expected to bring economic soundness to the city (Halegoua,2020).
Smart Mobility	Smart mobility refers to a city that is actually easily reached locally national and on the global market. According to Hernández *et al* (2018), smart mobility places ICT infrastructures at the exposure of all of its citizens, and that uses viable, innovative and secure data transport systems. Transportation is one of the imperative facets of mobility metropolitan where, people need to quickly and efficiently travel from one place to another. As for instance New York has an underground tunnel mass transit (subway) for people to get around, where more efficient and reliable approaches of transportation are essentially considered smarter. Furthermore, the use of cashless system through smart cards like use of Zupco Tap card, pre-booking online in Zimbabwe for transport system is a big trend in many smart cities.
Smart from the start cities	Smart from the start has been adopted in the developing countries like Zimbabwe Mt Hampden investment of a new parliament, malls, offices and other infrastructures. Infrastructure gaps, burdened utility provision and the need for cost effective methods of managing urban activities and monitoring pollution and traffic (Hernández *et al*, 2018). As a result, Smart from the start cities are heavily dependent on the logics of capitalism and complex private and public partnerships like the industry-sponsored advocacy group smart cities council (partners include Microsoft, MasterCard, Intel, Cisco and others). This type of city is an entire city constructed from scrape with digital infrastructure and data analytics as integral facets of the master plan. The Gramercy district under construction near Washington Dulles International Airport in the United States of America (Hernández *et al*, 2018).
Retrofitted Smart City	The assimilation of digital infrastructure and data analytics to drive urban governance and management and respond to and influence urban undertakings is known as retrofitting a city (Pawlikowska-Piechotka *et al.*, 2017; Hernández *et al.*, 2018; Access *et al.*, 2020). As compared to vendor driven, technological determinist approaches incorporate several smart city planners and researchers for strategies that privilege the place of the city, experiences and social exchanges among citizens and place making activities they regularly engage in. According to Katharine Willis and Alessandro Aurigi, the city is viewed as a series of ongoing, socially constructed activities that contextualize technology use in people`s everyday lives Hernández *et al* (2018).
	Social cities are rooted in foundations of civic society such as social cohesion and democratic governance in favor of optimization and environmental

Key term	Definitions
Social Cities	control. As opposed to other types of cities, on engaging the predictive analytics that monitor urban behaviour, urban technologies could be built in consultation with citizens. During the process the city fathers could invite people to collaborate in shaping their urban environments. As a result Hernández *et al* (2018) mentioned that, "Researchers Michiel deLange and Martijn de Waal focused on the relationships between digital media and urban culture and position the social city with conversations about participatory culture, collective intelligence, and do-it- yourself (DIY) hacker cultures and ethics where diverse populations come together to solve shared problems."

Chigwenya (2020) conducted a study on the digital content and urban governance in Zimbabwe using the case of Masvingo. The researcher advised the city of Masvingo to adopt the smart city concept of urban management. The research was conducted using mixed methods approach to inquiry, where both qualitative and quantitative methods were used for data collection. A questionnaire survey was used as the quantitative tool and in depth interviews and field observations were used for qualitative approach. It was found that, Masvingo was lagging behind the adoption of ICTs in urban planning. The government was urged to take a leading role and the private sector was also recommended to be involved in financing the development of infrastructure and networks for digital and e-planning in the city.

Bandauko et al, (2016) conducted a desktop research where they realize the transportation scheme in Harare dominated by private operators alone was unsustainable. The city was characterized by high levels of congestion, travel delays and irregular bus fares among other factors. The introduction of smart urban systems and the use of mass transit were identified as solutions as mass transit systems such as modern trains carry more people, are very fast and more efficiency. Mass transit systems were identified as answers to the economy, public, energy and environmental experiences in the city of Harare as they have lower negative effects on the external environment.

Table 2. Role of Universities in economic development Source: Hirsu et al. (2018).

Harare	Johannesburg	Sanandaj	Dar es Salaam
- Institution of higher education should be at the lead of the economic development drive. -Provide empirical based resolutions -Universities need to contribute to hands-on planning and development (Muchadenyik, 2015). -Universities deliver extension and civic services	-Academies provide high impact industry and commerce development projects. -Permit communities. - Universities offer user activism	- Universities support national development efforts. -Have close link with regional and provincial establishments. -Add to urban advancement by training the labour force. -Offer consultancy and backing to city fathers. -Universities carry out "research, enterprise, and community engagement activities".	-Institution of higher education develop human capital for the government and civil service. -Universities are tools for development. -The institution of higher education`s assignment is agreed in terms of public services outreach and consultancy. -"The 3rd mission is viewed as quite new and not fully operationalized". -Universities are mediators of knowledge transmission and

Harare	Johannesburg	Sanandaj	Dar es Salaam
			commercialization with the public/ private sector.
-Industry creating Hubs	-Town Market system	-Entrepreneurship Units and Growth Centres, Support Incubators, Science and Technology Parks.	-Institution of Production Innovation -Research and development Institutes.

Positioning of various stakeholders, persuasive nature of policy documents and universities' positions where mission narratives should focus on engaging into problem solving of various communities to have an impact (Hirsu *et al.*, 2018). Maphosa, (2020) evaluated the app he termed My Lupane State University app to enhance student engagement and promote a smart town at a rural university in Zimbabwe using case of Lupane State University. His study engaged design science research methodology, an approach used for the development of objects that are aimed at solving societal challenges. The app promoted student engagement as it was easy to use as it enhances smart university towns. University-city engagement is emerging as an important avenue for social innovation, necessitating tertiary institutions to act as change agents in their local settings (Petersen and Kruss, 2021).

3 Methodology and Instruments

A case study approach using city of Harare was adopted using qualitative research in determining the role of universities in smart city development (McLeod, 2008); (Fleming and Zegwaard, 2018). A sample of 315 respondents was drawn from different universities which are University of Zimbabwe (UZ), Harare Institute of Technology (HIT), Zimbabwe Open University (ZOU), Catholic University, Women University, Midland State University (MSU) and National University of Science and Technology (NUST) as stratas and few respondents from other universities. A random sampling technique was used for data collection from respective universities from both staff members and students (Arnab, 2017).

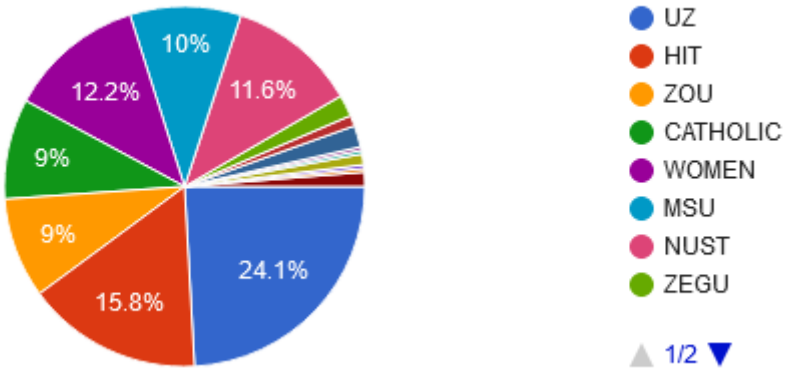

Figure 2. University participants.

3.1 Principal Component Analysis

A principal component analyses approach was performed to select the variables which have direct impact in determining the role of universities in the development of smart cities (Leech et al, 2020).Principal component analysis (PCA) is used to reduce the dimension of data set as there were many interrelated variables, while retaining as much possible of the differences existing in the data set.

This model was first introduced by Pearson in 1901, and later developed independently by Hotelling in 1933 (Jolliff, 2010). As a result, this multivariate analysis was performed to summarize the information relating to the engagement of citizens in smart city initiatives in a reduced set of influences with a least possible loss of reliability. PCA can be generalized as correspondence analysis (CA) in order to handle qualitative variables and as multiple factor analysis (MFA) in order to handle various sets of factors (Abdi and Williams, 2010). An exploratory factor analysis can be performed statistical software for social science (SPSS) (Hernández *et al.*, 2018).

One of the major objectives of PCA is to identify arrays in data through cointegration test among variables, reduce dimension if there is a strong correlation among variables by a linear combination of normalized. The degree of variance explained by the rotated components matrix should be higher than 60% in order for the solutions to be considered to be satisfactory (Hair et al, 1995).

3.1.1 Assumptions

- **Linearity**: Linearity structures the challenge as a change of basis. Numerous areas of exploration have discovered how applying a nonlinearity prior to performing PCA could extend this process known as kernel PCA.
- The principal components are orthogonal. This hypothesis provides an intuitive interpretation that makes PCA soluble with linear algebra decomposition techniques.
- Mean and variance are adequate statistics. The formalism of appropriate indicators captures the notion that the mean and the variance entirely describe a probability distribution. The only zero-mean probability distribution that is completely explained by the discrepancy is the Gaussian distribution (Fosså *et al.*, 2013).

3.1.2 The steps of conducting Principal Component Analysis

- **Step 1**: Getting Some Data for analysis is the first stage which may be a set of questions addressing the research area.
- **Step 2**: Subtracting the Mean is another stage as part of data standardization preceding to PCA since the principal components are susceptible to the scale of measurements.
- **Step 3**: Calculate the Covariance Matrix .Then, we can find correlation matrix or covariance matrix from which eigenvectors and eigenvalues can be extracted.
- **Step 4**: Calculate the Eigenvectors and Eigenvalues of the Covariance Matrix Eigenvalues represent the total sum of variance that can be explained by a given principal component. The eigenvalues should possess positive values where a negative value incur an ill- conditioned model, while those values close to zero indicate that, there is a challenge of multicollinearity in the data set (Syms, 2008; Abdi and Williams, 2010). Eigenvectors signify a weight for each eigenvalue where if we multiply its square root gives the component loadings which can be interpreted as the correlation of each factor with principal component (Sanyanga, 2015); (Fosså *et al.*, 2013) . We then need to arrange eigenvalues in descending order. Further, we select k eigenvectors that represent the largest eigenvalues.
- **Step 5**: Choosing Components and Forming a Feature Vector, from the eigenvectors, we can construct the projection matrix M.
- **Step 6**: Deriving the New Data Set Once (Mishra *et al.*, 2017) Finally, the original data can be transformed to find k-dimension (reduced dimensions) via projection matrix M (Alagan and Waleed, 2019).

3.2 Instrument development and data collection procedures

For researchers to understand group dynamics in smart city development, various research methods were used, surveys and telephone interviews. In case of surveys, data was collected through observations, telephone interviews and e-mailing of questionnaires with help of social media platforms (WhatsApp and Facebook) sharing google form and reminders (Pandey and Pandey, 2015). The questionnaire had

an option for asking consent where 93% of 390 respondents who participated in the research had consent to participate in the research.

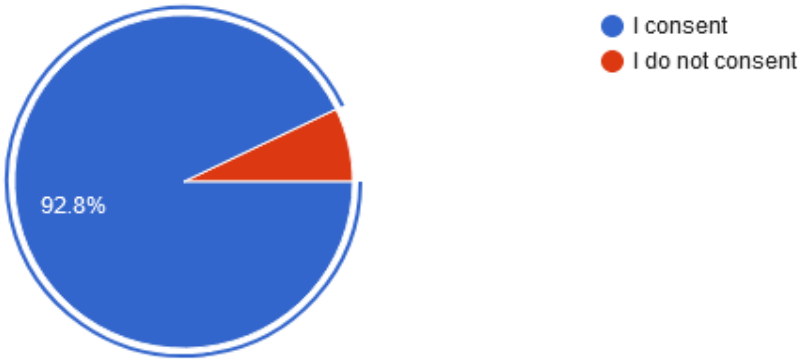

Figure 3. Consent to participate in the research.

3.2.1 Quality Control Protocols

The researchers conducted a miniature data collection where reliability of the instruments used was tested using Cronbach`s alpha in SPSS software. The test of sample adequacy was performed using Kaiser Meyer Olkin`s measure of sampling adequacy to ensure that the data we collected was suitable to run a principal component analysis and for that reason, it determine whether or not we have set out what we intended to measure. A response rate of 83% at 95% confidence of interval was obtained and considered sufficient as it was above 0.5 and the closer it is to 1 the better (Flynn and Kunkel, 1987); (Bonett and Wright, 2015); (Taber, 2018).

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.837
Bartlett's Test of Sphericity	Approx. Chi-Square	1886.173
	df	78
	Sig.	.000

Figure 4. Kaiser-Meyer-Olkin Measure of sampling adequacy.

4 Role of universities in smart city development

The survey that was conducted indicated that research and development and offering incubation facilities should be the key selling point for universities in smart city initiatives of the country as shown on the diagram below.

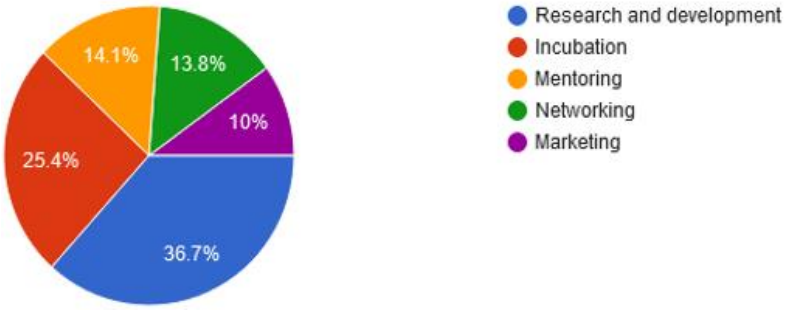

Figure 5. Cointegration Test on smart city variables.

Correlation Matrix[a]

Variables	ROLE	Innovation_Spirit	Innovation Hubs	Educational Facilities	Hub will	Industry Networks	Network Coverage	Market Conditions	RESOURCES	Smart City Education
	Variables									
ROLE	1.000	.000	.045	.016	-.091	.012	-.012	.045	.138	.024
Innovation_Spirit	.000	1.000	.116	.173	-.065	.143	.098	.136	.050	.116
Innovation Hubs	.045	.116	1.000	.157	-.072	.649	.079	.538	.038	.667
Educational Facilities	.016	.173	.157	1.000	-.053	.181	.469	.160	-.042	.158
Hub will	-.091	-.065	-.072	-.053	1.000	.025	-.118	-.019	.045	-.037
Industry Networks	.012	.143	.649	.181	.025	1.000	.107	.516	.066	.740
Network Coverage	-.012	.098	.079	.469	-.118	.107	1.000	.030	-.097	.042
Market Conditions	.045	.136	.538	.160	-.019	.516	.030	1.000	.113	.593
RESOURCES	.138	.050	.038	-.042	.045	.066	-.097	.113	1.000	.027
Smart City Education	.024	.116	.667	.158	-.037	.740	.042	.593	.027	1.000
Government Regulations	.046	.064	.401	.084	-.017	.399	.021	.775	.044	.499
Government Support	.068	.119	.684	.188	-.118	.582	.121	.547	.015	.599
Financial Instituitions	.058	.127	.712	.136	-.033	.650	.047	.592	.048	.649

Figure 6. Correlation Matrix.

There is a strong relationship between industry networks and innovation hubs where proto types commences (0.649), government support and innovation hubs (0.684), financial institutions and innovation hubs (0.712) to mention a few as shown on the diagram above. As a result, as there is relatively high correlations among the variables, it was a good sign for conducting factor analysis (Principal Component Analyses (PCA)) (Shahu, 2013).

4.1 ***Total Variables extracted using Principal Component Analyses***

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.651	35.775	35.775	4.651	35.775	35.775	4.536	34.894	34.894
2	1.530	11.767	47.543	1.530	11.767	47.543	1.569	12.072	46.966
3	1.149	8.842	56.384	1.149	8.842	56.384	1.154	8.879	55.845
4	1.032	7.941	64.325	1.032	7.941	64.325	1.102	8.480	64.325
5	.936	7.196	71.521						
6	.902	6.936	78.457						
7	.789	6.071	84.529						
8	.516	3.972	88.500						
9	.482	3.709	92.210						
10	.307	2.364	94.573						
11	.294	2.258	96.831						
12	.239	1.841	98.672						
13	.173	1.328	100.000						

Extraction Method: Principal Component Analysis.

Figure 7. Total Variance Explained.

Eigenvalues explain variance which is always positive as shown on the diagram above implies that, our model is not ill-conditioned, in other words fits for the data where values close to zero imply there is multicollinearity (Abdi and Williams, 2010).

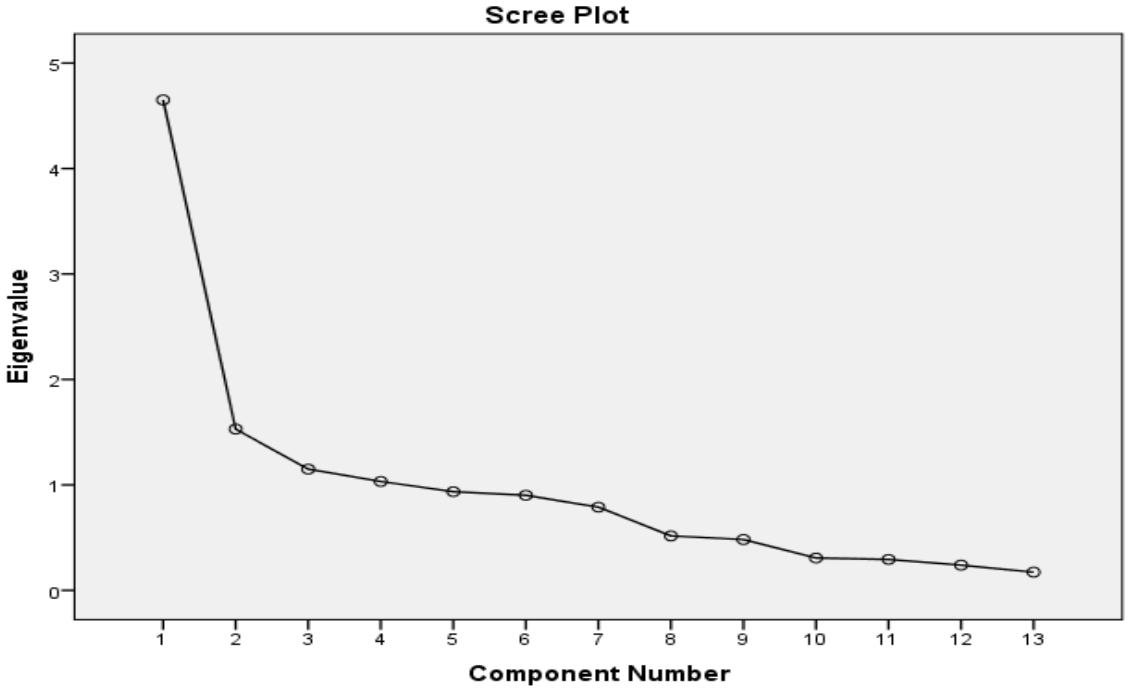

Figure 8. Scree Plot.

The scree plot displays the eigenvalue against the component number, where from the elements that have lesser strength the line start to get flatter, meaning each sequential element is accounting for smaller and smaller amounts of the total variance. In general, we are interested in keeping only those principal components whose eigenvalues are greater than 1, in this case at component number 4 (Beaumont, 2012); (Shahu, 2013). Components with an eigenvalue of less than 1 account for less variance than did the original variable , and so are of little use (Pandey, 2008).

Component Matrix[a]

	Component			
	1	2	3	4
Smart City Education	.841	-.078	-.091	-.025
Financial Instituitions	.836	-.075	-.036	-.062
Innovation Hubs	.829	-.028	-.045	-.104
Government Support	.817	.030	-.002	-.153
Industry Networks	.809	-.017	-.096	.076
Market Conditions	.797	-.140	.042	.098
Government Regulations	.673	-.173	.011	.040
Network Coverage	.140	.806	-.003	.063
Educational Facilities	.264	.748	.045	.242
ROLE	.071	-.056	.756	-.192
RESOURCES	.074	-.275	.611	.488
Hub will	-.073	-.290	-.360	.708
Innovation_Spirit	.201	.308	.226	.372

Extraction Method: Principal Component Analysis.
a. 4 components extracted.

Figure 9. Component Matrix.

Component Matrix contains component extractions, which shows the correlations between the variable and the component. The correlations values should fall between negative one (-1) and positive one (+1) (Brooks, 2008); (Syms, 2008; Mishra *et al.*, 2017; Abrate *et al.*, 2018).

Rotated Component Matrix[a]

	Component			
	1	2	3	4
Smart City Education	.848	.059	-.019	.014
Financial Instituitions	.840	.053	.005	-.047
Innovation Hubs	.828	.081	-.037	-.085
Government Support	.806	.120	-.045	-.160
Industry Networks	.802	.143	.013	.084
Market Conditions	.797	.044	.168	.047
Government Regulations	.685	-.029	.114	.033
Educational Facilities	.124	.821	-.019	-.010
Network Coverage	.006	.791	-.176	-.129
Innovation_Spirit	.109	.459	.308	.082
RESOURCES	.038	-.034	.827	.079
Hub will	-.033	-.080	.161	.829
ROLE	.024	-.041	.523	-.583

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 4 iterations.

Figure 10. Rotated Component Matrix.

The Rotated Factor Matrix diagram articulates factor loadings after rotation (in this case using Varimax approach). **Kaiser normalization** is a technique to retain stability of solutions across samples.

Component Transformation Matrix

Component	1	2	3	4
1	.982	.174	.056	-.043
2	-.159	.926	-.266	-.215
3	-.086	.080	.802	-.586
4	-.053	.325	.531	.780

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Figure 11. Component Transformation Matrix.

Varimax rotation is the most popular orthogonal rotation. The benefit of Varimax rotation is that it maximizes the variances of the loadings within the factors while maximizing differences between high and low loadings on a particular factor (Norman, 2011).

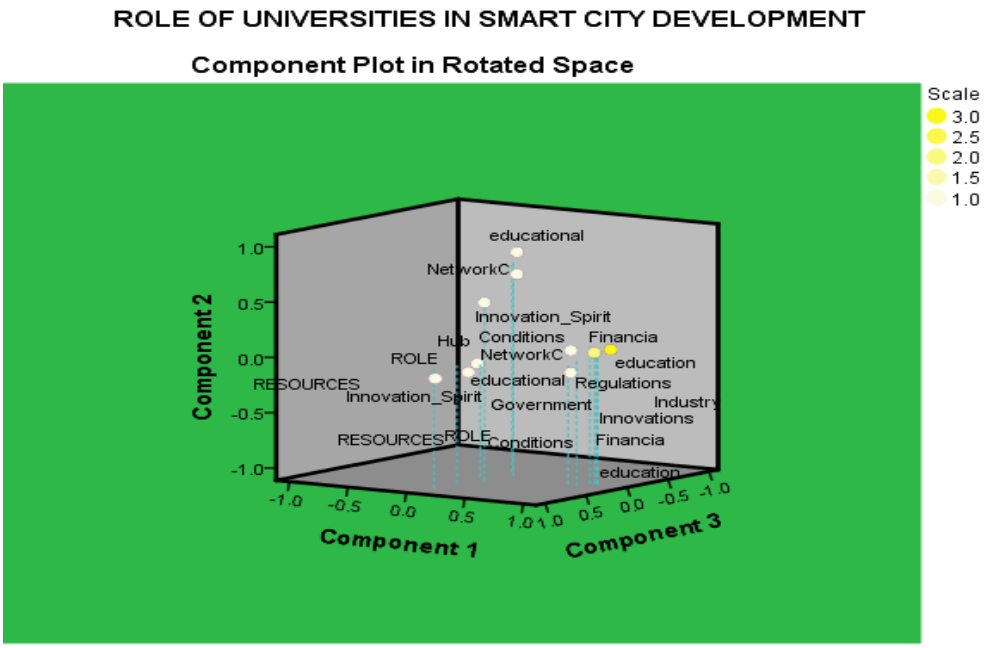

Figure 12. Component plot in rotated space.

The component plot in the rotated space using varimax approach indicated that Smart city education, financial institutions, innovation hubs and government support are the key components that can enhance university`s role in smart city development. Those factors that had an eigenvalue greater than 1 are indicated by the scale which shows the strength of each variable in the rotated space (Fosså *et al.*, 2013).

4 Discussions

The research analyzed the role of universities in the development of smart cities and the requirements that can smoothen the process or initiative (Brekke, 2021). Research and development was established as the primary role that can be played by universities in smart city development through developing and testing new technologies (Ransom, 2015), (Brennan and Cochrane, 2019). A positive relationship was established between smart city education (awareness campaigns and smart city curriculum), innovation hubs (incubation facilities and improves the quality of innovations), financial institutions (creditors, attorneys, banks) and government support (incentives, research grants, policy formulation) (Ardito *et al.*, 2019; Antwi-Afari *et al.*, 2021; Zhu and Alamsyah, 2022) . Government intervention through increasingly opening their data for public consumption in the form of Open Government Data (OGD), can expand the innovative potential and helps avoid duplication and unnecessary reinvention (OECD, 2020b). The growth of incubation hubs has led to the growth use of big data in other countries such as South Africa, Ghana, Nigeria, Kenya among others leading to successful innovations such as mPesa, Esoko, and mPedigree (Owusu, 2016). Smart city education is a basic prerequisite for achieving sustainable development and a key tool for achieving this goal. An education should link and balance the three spheres of thinking: economic, social and environmental, and that requires interdisciplinary teaching (Sukiennik, Zybała and Fuksa, 2021). Governments and policy-makers that are more open, more transparent, collaborative, participatory and accountable, less restrictive financial support where additional government funding could be injected into activities across the innovation ecosystem. This kind of financial support would ease the infrastructure cost burden borne by hubs, such as rent and telecommunications (Sambuli and Whitt, 2017).

5 Conclusions

Principal component analysis (PCA) may supplement and build up the summary of findings by the use of regression modelling techniques (Mikkelsen, 2019). Sound policy that creates an enabling environment and that encourages collaboration with ease. In preparation for the smart city, institution of higher education and city leaders need to collaborate in order to have successful innovations. City fathers should aim to be both 'smart' and flexible, with academies teaching a creative and highly skilled labor force. As a result, connecting with city leaders to use data and technology to mend the urban environment. It was agreed that, problems of the future will increasingly be tackled by cities themselves, supported by universities and a wider system of cities as advocated by (Ransom, 2015); (Kasim *et al.*, 2020); (Brekke, 2021; Petersen and Kruss, 2021).

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