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The Transformative Development Potential of Higher Education in the 4th Industrial Revolution:
A strategic innovation ecosystem approach for technological development and knowledge transfer in the 21st century Cameroon

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Abstract

Strategic innovation ecosystems have complex forces for the transformative development of human society through higher education. The sustainability of socio-economic development of Cameroon requires a robust national and regional innovation ecosystem in which higher education plays an important role in value and wealth creation. The challenge with Cameroon's higher education is a transition from the traditional rigid bureaucratic system to a more dynamic performance-based management ecosystem that can mainstream resilience and recognise excellence. The study adopted the innovation ecosystem approach to explain the transformative potential of higher education, using correlational research design. We selected nine advanced schools of technology, engineering, and management from public and private sectors across four regions of Cameroon, including a purposive and simple random sampling of 370 respondents. Spearman correlational ranking tested our three hypotheses. All three hypotheses were significant at PV=0.000 or 95% with the predictive coefficient of 59.7%, 55.8% and 71.3% respectively. We concluded that the transformative potential of higher education is evident through development of technological knowledge networks, innovation/knowledge clusters, and transformative digital governance in enhancing transformative learning. We recommend that higher education institutional leadership should consider these transformative development indicators as institutional benchmarks for higher education quality assurance, responsiveness assessments, and governance practices. These can ensure the emergence of the clustered innovation ecosystems and competitive intelligence at the national and regional university environments that contribute to sustainable socio-economic development of Cameroon and Africa.

Keywords: *Strategic Innovation Ecosystem, Technological transfer, Transformative Development, Fourth Industrial Revolution, Competitive intelligence, Strategic institutional governance*

Introduction

The sustainability of socio-economic development in Africa requires a robust national and regional innovation ecosystem. Higher education plays an important role in mainstreaming the national and regional development agenda through knowledge production and open innovation ecosystems (Yan, Wang, Yan & Zhai, 2020). In this light, the challenge with Cameroon's higher education is a transition from the traditional rigid system to a more dynamic knowledge society and value creation ecosystem. Over the years, there have been many policy innovations at system level since 2005 leading to new institutional governance (Njebakal, & Teneng, 2017). However, there exist institutional discrepancies in building a robust institutional knowledge actualisation and crystallisation for higher education innovation ecosystem (Fagerberg, 2015). There have been many limitations to research and development in fostering technological innovation and relevant core competencies that respond adequately to competitive leverage of the fourth industrial estate (Fagerberg, 2015).

The fourth industrial revolution is marked by indicators such as virtual reality, the internet of things, artificial intelligence, and block-chain innovations. These variables have had significant but disruptive contribu-

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tions to knowledge management, pedagogic innovation, quality assurance and strategic institutional governance in higher education today (Igel, Ullrich, & Kravcik, 2018). The transformative development in education in Africa and in Cameroon, in particular, requires an endogenous knowledge and competencies built on competitive intelligence as means of guaranteeing new technological transformation for a sustainable and inclusive growth (Arbeiter, & Buča, 2021). These innovative processes need well-developed pre-incubators, incubators, science parks, clusters and international research collaboration networks in scientific knowledge sharing and exchange (Ablaev, 2018). Therefore, adopting the cluster innovation ecosystem, transformative digital governance, digital knowledge networks and strategic-competitive intelligence in innovation development and knowledge provide strategic institutional capabilities of higher education to contribution to sustainable socio-economic development of Cameroon and Africa (Bell, 2016).

Theoretical Framework

Strategic Innovation Ecosystem

> *"The innovation ecosystem is defined as groups of symbiotically interacting 'players' which include companies and other players such as the providers of knowledge, resources, and 'rules of the game'. It is the companies which constitute the economic 'engine' of the ecosystem since they create value for consumer-users, output, and employment."* (Fransman, 2014, p. 5).

The higher education innovation ecosystem will integrate pedagogical innovation research systems, community development systems, and institutional governance systems. The symbioses of these complex transformative systems provide avenues for knowledge distillation and valorisation (Johansen, 2018). According to Godin (2015) the early history of the the term "innovation" gives a pejorative connotation to the concept. To him, the term was first used by anthropologists and sociologists, and it has been popularised by economists and the management world.

> *"Everyone agrees that innovation is crucial for the performance over time of both companies and countries. However, there is far less agreement regarding two key questions: - How does innovation happen? - How can we make innovation happen?"* (Fransman, 2014, p. 5)

Innovation therefore is an important indicator in the transformative development of knowledge economy through higher education. This concept deals with the creation and development of ideas, products, organisations and quality management (Spinoglio, 2015). The implications of globalisation through the development of information and communication technologies demands organisations to be more innovative to be competitive in the local and global knowledge environments (Fransman, 2014). In this line, the "strategic innovation" is crucial to aligning organisational processes and ensuring the success of its managerial operations (Palmer & Kaplan, 2007). Bridging the ecosystem and strategic innovation framework will give an organisation a sustainable strategic performance in the organisational management in the disruptive knowledge ecosystem. The University as a non-profit organisation in the 21st century must adapt to new knowledge changes in order to be relevant to its environment. The effective and efficient deployment of resources depends on institutional innovation strategic ecosystems (Reichert, 2019).

According to Kotsemir, Abroskin, and Dirk (2013), the traditional reading of innovation from the Schumpeterian concept see innovation as "a historic and irreversible change in the production of thing and creative destruction." (p. 4) Our faculties and departments still lack the disruptive and creative destruction potential because there are no practical sites for innovation especially from the organisational configuration standpoint. University knowledge production should be able to build an irreversible change that brings values and wealth creation to the community (Brennan et al 2014). Innovation is the "establishment or enlargement of organisation processes, methods assimilation, and exploitation of novelty" (Spinoglio, 2015, p. 5). Newness and change are the driving forces of innovation which can be manifested in organisational structures or processes. But when institutions are hostile to innovation, rigidity will continue to plague its effective functioning (Lawal, 2017). Innovation is also seen as "incremental." This is the process in which new products emerge. So, as total quality management in educational reforms are built on the strategic innovation, it is then the responsibility of strategic leaders at the corporate level to design the development of strategic innovation (Palmer & Kaplan, 2014) as well as, foster the development of an innovation ecosystem (Reirchart, 2019). These approaches are more pragmatic in skills and competency development. The ecosystem reinforces the university

capacity in knowledge production and dissemination and the interconnected knowledge networks and collaboration. The concept of innovation has received varied scholarly attention since the dawn of the 20th century. Most scholars used innovation and creativity interchangeably, but from the onset they were never use as related terms (Godin, 2015). Innovation is perceived by some scholars as an extension or the modification of invention and production of new ideas (Godin, 2015).

This definition is very applicable in knowledge production and dissemination when it concerns research and development. To improve university teaching, curriculum innovation in Africa is key in the production of relevant content and not the duplication of the western norms. Lotz-Sisitka, (2015) notes that innovations bring competitiveness to the organisation. Also, distinctive innovation deals with development and re-engineering of knowledge, content methodologies and approaches, and disruptive innovation. The term also includes assimilation, transformation, exploitation, and translation of new knowledge in the practical context (Godin, 2015).

> *"Innovation ecosystem as co-innovation networks, in which actors from organizations concerned with the functions of knowledge production, wealth creation and norm control interact with each other in forming co-evolution and interdependent relations (both direct or indirect) in cross-geographical contexts, and, through which new ideas and approaches from various internal and external sources are integrated into a platform to generate shared values for the sustainable transformation of the society."*(Cai, Ma, & Chen, 2020, pp.)

Alkhanbouli (2022) explored the typology of innovation ecosystems based on the university innovation ecosystem in the United Arab Emirate universities. The study explored university incubators and research centres with entrepreneurial mentality. In this typology. The research identified six innovation ecosystems: corporate innovation ecosystem, digital innovation ecosystem, city-based innovation ecosystem, high-tech- SMEs centre ecosystem, hyper-local innovation ecosystem, and university-based innovation ecosystem. In the context of Cameroon all these typologies of the ecosystem can be applicable. These micro innovation ecosystems are interconnected in building the macro higher education innovation ecosystem. Cai, Ma, and Chen (2020) outlined the overarching framework of higher education and innovation ecosystem. Knowledge economy ecosystem, new knowledge and technologies employs an ambidexterity in the exploration and exploitation of knowledge. In the knowledge innovation ecosystem, system relation to the university and economic development are very important. in this way, higher education become a driving engine of economic growth in the macro innovation ecosystem (Fagerberg, 2015). Tierney and Lanford (2016) think that these new trends in public life demands knowledge, innovative frameworks, and social intelligence competences in institutional knowledge management (Viviers, Saayman, Muller, & Calof, 2002). Yan, Wang, Yan, & Zhai (2020) examined the open innovation ecosystem of higher education. In their research, they suggested that the higher education open system concerns the university capability to create open sources of knowledge that contribute to innovation outcomes. The open innovation ecosystem enhances the flow of ideas knowledge, information and data. The open innovation provides opportunities, efficiency in research transformation and valorisation as well as commercialisation. Knowledge-driven innovations in internationalised environment create avenues for the organisational competitive advantage and institutional visibility. The study concluded that the open innovation ecosystem could have a positive effect on the development of higher education. This kind of innovation provides auto-financing strategies and wealth creation opportunities for the universities to fulfill their third mission through knowledge and technological transfer. The research also found that the university innovation ecosystem influences a student's creative potential as they navigate the innovation ecosystems with creative ideas and exchange avenues (Bocket et al 2020).

Ansgar, Bernardo and Gerhard (2016) examined the role of innovation in public policy. Even though innovation has been perceived as more of a business concept, the concept is well-rooted in public policy and corporate governance. Disruptive environmental changes and extensive globalisation informs innovations in public policy. The sustainability and relevance of public policy today relies on the continuous strategic innovation processes in institutional governance. Higher education public policy has equally undergone the innovation processes. The knowledge driven Fourth Industrial Estate demands incessant innovative strategies which mutually build strategic innovation ecosystems for the university in the effective implementation of public policy and

university contribution to national and regional economic development. In the innovation ecosystem, sustainable strategic management is one of the driving forces of imaginative thinking in policy development. In this view, balancing production and governance innovation are some ambidextrous strategies that an institution may harness in order to remain responsive to external environmental exigencies (Akin ,2016). Vlasov (2021) analysed the influence of massification on internalisation and state funding on higher education on innovation development. The internalisation of funding leads to infrastructural development which can mitigate massification challenges, creativities, and innovative competences for the fourth Industrial Revolution (Nakano & Wechsler, 2018).

Stukalenko, et al, (2016) analysed innovation technologies of learning in the modern education teacher's professional preparedness. Higher education innovation ecosystems enable stakeholders to build clusters and incubators which enhance pedagogic transformative proficiency and professional preparedness for the fourth industrial complex (Lawal, 2017). Rashidi, Azma, Sami, and Sobhoni (2020) note that universities in disruptive advanced technologies knowledge-based organisations can only adapt to national and regional economies by reinforcing national relation with industries. They set out to develop a value creation university framework based on higher education innovation indicators. They employed exploratory and taxonomical approaches. The result of the study showed that financial and pragmatic strategies have positive effects on university adaptability. Also, social outcomes and intra-organisational platforms equally have positive effects. Value creation and higher education have positive impacts on institutional change and competitive intelligence (Pellissier & Nenzhelele, 2013).

Lappalainen, Markkula, and Kune (2015) focused on finished construction clusters on building a regional innovation ecosystem. This study involves action research methods, digital modelling, co-development process parallel research, development and innovation, pathfinders, prototype development, radical innovation, human development, and leadership. These are key ecosystem indicators in a knowledge-based economy. In this perspective, Brito (2018) explored deeper understanding and the dynamics of the university as a promoter of the development of innovation ecosystems. In this setting, universities are perceived as leaders and integrators into this ecosystem. Their contributions are in three-dimensions: knowledge, transformative talent of the university, and university industrial linkage as well as long-term relation strategy. However, the Cameroon higher education institutions still need much resource deployment and policy effectiveness for this structural transformation to take place. Institutional leadership in higher education in Cameroon must consider these new strategic innovation approaches to ensure sustainable structural configuration and system innovation. There is also a need for the integrators of diversity of actors' resources and competences. From this approach, we urge that the university role in the innovation ecosystem be adaptive, complex, and dynamic in order to ensure sustainable strategic innovation and knowledge valorisation processes. This strategic management dimension can guarantee sustainable social economic development, specifically in Cameroon and in Africa in general (Cabeza-Pullés, Fernández-Pérez, & Rodán-Bravo, 2020).

Statement of Research Problem

Cameroon, and, in general, Africa, are still facing many challenges in embracing the Fourth Industrial Revolution due to the lack of digital infrastructure that adequately ushers in this industrial estate. The consciousness of African governments and higher education institutions is crucial in this direction. This is kind of industrial estate needs a digital technological cluster, a security cluster, knowledge management clusters, and high levels of digital governance to inform decision-making through data analyses. The combination of these variables will morph into a robust strategic innovation ecosystem. Therefore, to what extent does transformation potential of higher education from the strategic ecosystemic approaches respond to technological development and knowledge transfer in the emerging fourth industrial complex in Cameroon?

Research Objectives

i) To examine the relationship between digital technological knowledge networks and transformative learning in Cameroon's higher education.
ii) To examine the relationship between innovation/ knowledge clusters and transformative learning in Cameroon's higher education.
iii) To examine relationships between transformative digital governance and transformative learning in Cameroon's higher education.

Research Questions

i) What is the relationship between digital technological knowledge networks transformative learning Cameroon higher education? ii) Is there a relationship between innovation/knowledge clusters and transformative learning in Cameroon's higher education?
iii) Is there a relationship between transformative digital governance and transformative learning in higher education in Cameroon?

Research Hypotheses

i) Ha1: There is no significant relationship between digital technological knowledge networks and transformative learning in higher education in Cameroon.
ii) Ha2: There is a significant relationship between innovation and knowledge clusters and transformative learning in Cameroon in higher education.
iii) Ha3: There is no significant relationship between transformative digital governance and transformative learning in Cameroon in higher education.

Significance of the Study

This study is important in that it highlights the current technological and economic changes that are affecting higher education in Cameroon. The adoption of an innovation ecosystem approach to explain digital technological knowledge networks, innovation/knowledge clusters, and transformative digital governance demonstrates the importance of these variables in the Fourth Industrial Revolution. This variable addresses the needs of transformative education at the higher education level. It is necessary for universities in Cameroon to build innovation ecosystems that will create avenues for wealth and value creation, knowledge management and technological infrastructure, as well as human capital. There is need for continuous development of new skills and competences such that higher education can adapt to the complex-dynamics of digital innovations.

Research Methodology

In this study we used the quantitative approach with correctional research design

Sampling Procedures

This study was conducted in nine public and private higher education institutions across four regions of Cameroon. The target population was students in public and private higher education institutions from four regions of Cameroon. These regions include the northwest, southwest, littoral and the centre regions.

Table 1. Sample Distribution

Region	Selected Institution (deidentified)	N
Southwest	Biomedical management institution	25
	Technology & management inst.	20
	University regional campus	35
North-western	Polytechnic campus	45
	University regional campus	50
	Private university inst.	30
Littoral	Advanced engineering university	45
	Polytechnic school	25
	Technology school	25
Centre	Development studies local campu	20
	Advanced engineering school	30
	Technology and management school	20
	Total	**370**

(Sources: higher education annual statistics report, 2022)

Table 1 presents the accessible population comprised of 10,185 students. The respondents were selected through simple random sampling and purposeful techniques that allowed every member of the target population to be selected. In this regard, research students were more involved in pedagogical, administrative, and research activities. In this study, only colleges of technology and engineering were considered. Statistics were drawn from the 2021 Higher Education Annual Statistics. We worked with a sample size of the 370 respondents. After administering 435 copies of questionnaires, 370 questionnaires were submitted with a retention rate of 85.52%. Therefore, 370 respondents were engaged in the study, of which 224 (60.5%) of the respondents were males and 146 (39.5%) of respondents were females.

Data collection instrument

The instrument used for data collection was a questionnaire that was analyzed to measure the relationships between variables. The questionnaire was operationalised into four sections containing the construct of the study. These constructs had seven items each. After the development of the questionnaire, it was submitted for expert evaluation of content validity, clarity, and coherence were confirmed. We also administered the questionnaire to ten students within the target population of the students at 0.85. The questionnaire was shown to be consistent and reliable for our study.

Reliability of the Instrument

After one month of pretesting the questionnaire, it was redistributed to the respondents. From obtaining the copies of the questionnaires, the responses were computed into the SPPS software in which we obtained a reliability coefficient stability score of 0.86. the coefficient showed the coherence and reliability of the instrument after recurring tests.

Data Presentation and Interpretation

Relationship between digital technological knowledge networks and transformative learning

Table 2. Questionnaire Responses - Digital Technological Knowledge Networks

N/I	Statements	$\bar{X}$	SD
1	Your institution promotes digital collaboration and knowledge networking ecosystems	3.35	2.80
2	There exists open access to digital knowledge sharing opportunities and talent development	3.49	3.04
3	Your institution has effective industrial partnerships	2.98	2.22
4	There exist continuous or digital lifelong learning programmes in your institution	3.20	2.56
5	Your institution promotes the development regional of digital knowledge ecosystem	2.73	1.86
6	Your institution creates attractive environment for digital investment	2.93	2.15
7	There are digital opportunities for the commercialisation of research findings	3.19	2.54
	Sum Total	**3.12**	**2.45**

(Strongly Disagreed=1, Disagreed=2, Agreed=3, strongly Agreed=4)

Table 2 shows patterns in respondents' views on digital technological knowledge networks in higher education in Cameroon. The seven items designed to measure digital technological knowledge networks had a mean above 2.5. In the first item, 349 (94.6%) of the respondents generally agreed that "Your institution promotes digital collaboration and knowledge networking ecosystems." The second item shows that 348 (94.1%) of the respondents generally agreed with the statement, "There exists open access to digital knowledge sharing opportunities and talent development in your institutions". For the third item, 333 (90.0%) of the respondents generally agreed that. "There exist continuous or digital lifelong learning programmes in your institution." In the fourth item, 321 (86.7%) of the respondents agreed that their institution promotes the development of regional digital knowledge ecosystems. In the fifth item, 224 (60.5%) of the respondents generally agreed with the view that their institution promotes the development of regional digital knowledge ecosystems. The sixth item shows that 277 (74.4%) of the respondents agreed on the opinion that their institution creates an attractive environment for digital investment. Finally, in the seventh item, 323 (87.3%) of the respondents generally agreed that there are digital opportunities for the commercialisation of research findings. From the results of the research question one, the majority of the respondents generally agreed at an overall percentage of 84.7% that digital technological knowledge networks have significant relation with transformative learning in higher education with a cutoff mean of 3.1 and with a standard deviation of 2.4, which is above a normal cutoff mean of 2.5. Digital technological knowledge networks have significant influence over transformative learning capabilities in higher education.

Relationship between innovation/knowledge clusters and transformative learning

Table 3 presents the results from the respondents' views on innovation/knowledge clusters in higher education in Cameroon. Among the items are ones designed to assess innovation/ innovation clusters in higher education in Cameroon. All seven items had a mean above the normal cut off mean of 2.5. In the first item, 284 (76.8%) of the respondents generally agreed that their institution encourages entrepreneurship and start-up ecosystems. The second item shows that 319 (86.2%) of the respondents generally agreed with the statement, "There are emerging technological-based ventures." For the third item, 327 (98.3%) of the respondents generally agreed with the statement, "There is accessibility to funding and mentoring in innovative research." The fourth item indicated that 189 (51.1%) of the respondents agreed that "There are knowledge brokers and accelerators within the innovation clusters." The fifth item shows that 267 (72.2%) of the respondents generally agreed with the view that "There is the concentration of knowledge and expertise within

Table 3. Questionnaire Responses - Innovation/Knowledge Clusters

N/I	Statements	$\bar{X}$	SD
1	Your institutional encourages entrepreneurship and start-up ecosystems	3.12	2.43
2	There are emerging technological - based ventures	3.03	2.30
3	There is accessibility to funding and mentoring innovative research	3.06	2.32
4	There are knowledge brokers and accelerators within the innovation clusters	2.49	1.55
5	There is the concentration of knowledge and expertise within clusters	2.77	1.92
6	Knowledge clusters have industrial-relevant skills and competences	2.91	2.13
7	Your institution ensures the Stimulation of local economic growth through research and cooperation programmes	2.95	2.18
	Sum total	**2.9**	**2.12**

(Strongly Disagreed=1, Disagreed=2, Agreed=3, strongly Agreed=4)

clusters." The sixth item shows that 255 (66.9%) of the respondents agreed with the opinion that "There is the concentration of knowledge and expertise within clusters and knowledge clusters have industrial-relevant skills and competences." Finally, in the seventh item, 288 (78.0%) of the respondents generally agreed that "Your institution ensures the stimulation of local economic growth through research and cooperation programmes." For research question 2, findings portrayed that the majority of respondents generally agreed (75.6%) that innovation/knowledge clusters have significant relations with transformative learning in higher education, with a cutoff mean 2.9 and with a standard deviation of 2.1, which is above a normal cutoff mean of 2.5. Innovation knowledge clusters have significant contributions towards building a transformative learning capability in Cameroon's higher education.

Relationship between transformative digital governance and transformative learning

Table 5 describes respondents' perceptions on transformative digital governance in higher education in Cameroon. In the seven construction items to

Table 4. Questionnaire Responses - Transformative Digital Governance

N/I	Statements	$\bar{X}$	SD
1	There is availability up-to-date and quality digital infrastructures in your institutions	2.98	2.20
2	There is effective steering of electronic management systems in the internal management processes	2.47	1.53
3	Your institution fosters data analytics for informed digital decision making	2.76	1.90
4	There are facilities for content personalisation and mobility	3.03	2.30
5	There is online dashboard/ or portal for institutional change management	2.80	1.96
6	There is a digital framework for transparency and accountability in institutional management performance	2.93	2.15
7	There exist digital collaboration and engagement in soliciting feedback, ideas and suggestions for the best institutional management performance	2.84	2.02
	Sum total	**2.83**	**1.87**

(Strongly Disagreed=1, Disagreed=2, Agreed=3, strongly Agreed=4)

measure transformative digital governance, six of the seven items have means above 2.5 which is a normal distribution. In the first item, 275 (74.3%) of the respondents generally agreed that there is availability up-to-date and quality digital infrastructures in their institutions. The second item shows that 187 (50.5%) of the respondents generally agreed with the statement that "There is effective steering of electronic management systems in the internal management processes." For the third item, 218 (64.3%) of the respondents generally agreed with the view that their institution fosters data analytics for informed digital decision making. The fourth item, 213 (80.3%) of the respondents agreed that there are facilities for content personalisation and mobility. In the fifth item, 253 (68.4%) of the respondents generally agreed with the view there is online dashboard/ or portal for institutional change management. The sixth item shows that 288 (87.8%) of the respondents agreed on the opinion that There is a digital framework for transparency and accountability in institutional management performance. in the seventh item, 276 (74.6%) of the respondents generally agreed that there exist digital collaboration and engagement in soliciting feedback, ideas and suggestions for the best institutional management performance. Drawn from the results of the research question three, the majority

Table 5. Questionnaire Responses - Transformative Learning Capabilities

N/I	Statements	$\bar{X}$	SD
1	There is higher need for open access in knowledge sharing process	3.17	2.51
2	Continuous curriculum development and innovation is requirement in knowledge transfer	2.90	2.10
3	Project-based and experiential learning approaches foster knowledge creation	2.74	1.88
4	Problem- solving and strategic thinking competences promote the development of products	2.79	1.95
5	Knowledge resources mobilisation enhance efficiency in knowledge development and transfers	2.12	1.12
6	Strategic monitoring and evaluation ensure quality and incremental innovation	3.01	2.30
7	The creation of effective communities of practices facilitates knowledge transfers	3.13	2.45
	Sum total	**2.84**	**2.04**

(Strongly Disagreed=1, Disagreed=2, Agreed=3, strongly Agreed=4)

of the respondents generally agreed at an overall percentage of 71.4% that transformative digital governance has a significant relationship with transformative learning in Cameroon higher education with a cut off mean 2.8 with standard deviation 1.87 which is above a normal cut off mean 2.5. Transformative digital governance has significant contribution in building transformative learning capabilities sin higher education.

Table 5 presents respondents' views on transformative learning capabilities in Cameroon higher education. Based on the items designed to measure this variable, all the 7 items have a mean which is above the normal cutoff mean of 2.5. This implies that the respondents generally agreed on the importance of transformative learning in Cameroon's higher education in the Fourth Industrial Revolution. In the first item, 298 (81.2%) of the respondents generally agreed that there is a higher need for an open knowledge sharing process. The second item shows 286 (77.3%) of the respondents generally agreed with the statement that "Continuous curriculum development and innovation is a requirement in knowledge transfer." For the third item, 260 (70.3%) of the respondents generally agreed with the view that project-based and experiential learning approaches foster knowledge creation. The fourth item, 253 (68.5%) of the respondents agreed that problem-solving and strategic thinking competences promote the development of products. In the fifth item, 168 (61.6%) of the respondents generally agreed with the view that knowledge resources mobilisation enhances efficiency in knowledge development and transfers. The sixth item shows that 310 (83.7%) of the respondents agreed on the opinion that strategic monitoring and evaluation ensure quality and incremental innovation. In the seventh item, 315 (85.2%) of the respondents generally agreed that the creation of effective communities of practice facilitate knowledge transfer. The findings of the of the dependent variable shows that, the respondents generally agreed at an overall percentage of 75.4%. More so, all the items designed to measure transformative learning in Cameroon's higher education with a cutoff mean of 2.8 with a standard deviation of 2.04, which is above a normal cutoff mean of 2.5. This implies that higher education stakeholders should foster transformative learning capabilities in higher education.

Hypotheses Testing

H01: There is a significant relationship between digital technological knowledge networks and transformative learning in Cameroon's higher education.

H02: There is a significant relationship between innovation/knowledge clusters and transformative learning in Cameroon's higher education.

H03: There is a significant relationship between transformative digital governance and transformative learning in Cameroon's higher education.

Table 6 shows a significant correlation between digital technological networks and transformative learning capabilities in higher education in Cameroon. ($r=0.597$, $p = 0.00$, $\alpha = 0.005$). The correlation coefficient signifies that a unit increase of digital technological networks influences transformative education capabilities at 59.7%. Therefore, the Spearman's rank correlation coefficient suggests that an improvement in digital technological knowledge networks will lead to an exceptional increase of transformative education capability in Cameroon's higher education. Institutional managers should strive to promote the development of digital technological networks by means of boosting transformation in learning.

Table 6 also shows the correlation between innovation/knowledge clusters and transformative education

Table 6. Correlation Between Variables

Spearman's rho Correlations (ρ)

		Transformative learning capabilities	Digital technological knowledge networks
Transformative learning capabilities	ρ	1.000	.597**
	Sig. (2-tailed)	-	.000
Digital technological knowledge	ρ	.597**	1.000
	Sig. (2-tailed)	.000	-

		Transformative learning capabilities	Innovation/ knowledge clusters
Transformative learning capabilities	ρ	1.000	.558**
	Sig. (2-tailed)	-	.000
Innovation/ knowledge clusters	ρ	.558**	1.000
	Sig. (2-tailed)	.000	-

		Transformative learning capabilities	Transformative digital governance
Transformative learning capabilities	ρ	1.000	.713**
	Sig. (2-tailed)	-	.000
Transformative digital governance	ρ	.713**	1.000
	Sig. (2-tailed)	.000	-

*** Correlation is significant at the 0.01 level (2-tailed); N=370*

capabilities in higher education in Cameroon. (r=0.558, p=0.00, α =0.005). This implies that there is statistically significant relationship between innovation/knowledge clusters and transformative learning in Cameroon's higher education. The spearman correlation coefficient signifies that innovation/knowledge clusters impact transformative learning capability in Cameroon's higher education correlated at 55.8%. Therefore, the Spearman's rank correlation coefficient indicates that an incremental unit of development in innovation knowledge clusters should yield a corresponding increase in the transformative education in capabilities in Cameroon's higher education.

The third block in Table 6 shows the correlation between transformative digital governance and transformative education (r=0.713, p=0.00, α =0.005). There is a statistically significant correlation between transformative digital governance and transformative learning in Cameroon's higher education. The correlation coefficient means that transformative digital governance has an influence on transformative learning capability in education at 71.3%. Therefore, the Spearman's rank correlation coefficient reveals that the effective implementation of transformative digital governance may lead to an extraordinary impact on transformative education capabilities in Cameroon's higher education.

Discussion

Digital Technological Knowledge Networks

Digital technological knowledge networks have an important role in Cameroon's higher education in knowledge transformation and economic growth. The findings of the study revealed at the level of descriptive statistics that the respondents generally agreed at 84.7% on the different measurements of technological knowledge networks (Reirchart, 2019). These findings were shown to corroborate Sivasankaran and Karthikeyan (2021). This signifies that the promotion of digital collaboration and knowledge networking ecosystems, open access to digital knowledge sharing opportunities, talent development, continuous or digital lifelong learning programmes, institutional promotion of the development of regional digital knowledge ecosystems, and an attractive environment for digital investment are indispensable in the sustainability of an institutional technological knowledge network and transformative learning capabilities in higher education in Cameroon (Sivasankaran & Karthikeyan, 2021). Also, the inferential statistics revealed that digital technological knowledge networks have a significant relationship with transformative learning in Cameroon's higher education with a predictive coefficient of 59.7%. Our study corroborates with Akan (2020) which focused on developing hyper-local innovation ecosystems (Yan, Wang, Yan, & Zhai, 2020). Findings demonstrate that higher education in the regionalisation and decentralisation processes work with regional and local authorities in developing a robust and completive innovation ecosystem. Findings also show that digital technological knowledge networks in the innovation ecosystem will facilitate value creation (Cai, Ma, & Chen, 2022). Therefore, higher education has a transformative potential in the emerging Fourth Industrial Revolution.

Innovation Clusters

Innovation/knowledge clusters in higher education stimulate entrepreneurial initiative and build a robust innovation ecosystem. From our findings, innovation and knowledge clusters have a significant relationship with transformative education capabilities in

Cameroon's higher education. This relationship affects transformative learning capabilities at 55.8%. Clusters and incubators are the building blocks of a national and regional innovation ecosystem. Higher education institutions are motors that drive these ecosystems through innovation production and dissemination (Reirchart, 2019). These results show the positive effect of innovation clusters on knowledge and competences development (Yan, Wang, Yan, & Zhai, 2020). Therefore, entrepreneurship and start-up ecosystems, emerging technological-based ventures, accessibility to funding and mentoring innovative research, knowledge brokers and accelerators within the innovation clusters, concentration of knowledge and expertise within clusters and industrial-relevant skills, competences and the stimulation of local economic growth through research and cooperation are indispensable indications of innovation clusters in the micro-meso-macro innovation ecosystems. These findings are supported by Bocket et al, 2020.

To further confirm these innovation ecosystem benchmarking indicators, the descriptive statistics show that 75.6% of respondents generally agreed that innovation/knowledge clusters have a significant relationship with transformative learning in higher education in Cameroon, which is above a normal cutoff mean. Innovation knowledge clusters have significant contributions towards building a transformative learning capability in Cameroon's higher education (Sivasankaran & Karthikeyan, 2021). Knowledge and innovative cluster promote knowledge and technological transfer (Bocket et al, 2020).

Transformative Digital Governance

The integration and sustainable appropriation of transformative digital governance strategies is central to transformative education capabilities in the Fourth Industrial Revolution in Cameroon's higher education. The findings of our study reveal that transformative digital governance has a predictive coefficient of 71.3%. These results implied that, availability of up-to-date and quality digital infrastructures, effective steering of electronic management systems, internal management processes, data analytics for informed digital decision making, content personalisation and mobility, online dashboard or a portal for institutional change management, a digital framework for transparency and accountability in institutional management performance and digital collaboration, and engagement in soliciting feedback, ideas and suggestions for the best institutional management performance are key digital governance assessment methodology indicator(Vlesov, 2021). The development and provision of digital infrastructures in an institution of higher education improve efficiency and cost-effectiveness in the institutional resource-based management. Moreso, the respondents generally agreed at an overall descriptive score of 71.4% that digital transformative digital governance has a significant relationship with transformative learning capabilities in higher education. Transformative digital governance strategies will foster tremendous transformative learning capabilities in higher education (Lotz-Sisitka1 et al, 2015). Digital governance indicators in higher education are primordial in shaping research development, pedagogical innovation, knowledge flows, and institutional steering for quality assurance and community outreach (Brito, 2018)

Conclusions

This paper evaluated the relationship between transformative development in the Fourth Industrial Revolution and transformative education capabilities in Cameroon's higher education as a means of fostering technological development and knowledge transfer for the strategic innovation ecosystem approach. At a more in-depth level, the paper focused on digital technological networks, innovation/knowledge clusters, transformative digital governance, and transformative education capabilities. The strategic innovation ecosystem theory demonstrated that higher education is a major stakeholder in the leading national and regional innovation ecosystems through decentralisation and regionalisation in Cameroon's higher education (Reirchart, 2019). The promotion of digital collaboration and knowledge networking ecosystems in the community and at inter-university levels fosters ecosystem development, open access to digital knowledge sharing opportunities just as talent development creates transformative communities of practice, and continuous or digital lifelong learning programmes. These also foster entrepreneurship and start-up ecosystems, emerging technological-based ventures, and accessibility to funding and mentoring innovative research.

Knowledge brokers and accelerators are innovation opportunities that build students' communities and create a competitive knowledge environment, as well as promote excellence in research and development. Further, they offer developing data analytics tools for informed digital decision making, harnessing content-personalisation and mobility frameworks. Also crucial

are an appropriation of online dashboard/or portal for institutional change management, a digital framework for transparency and accountability in institutional management performance pragmatic digital approach to transformative education. We therefore conclude that higher education knowledge and innovation practices from an exosystemic approach have indispensable contributions to transformative education in Cameroon's higher education. Consequently, institutions of higher education must develop transformative digital governance, technological knowledge, and benchmarking frameworks to ensure continuous improvement, sustainability, competitiveness, visibility in knowledge production, and commercialisation in Cameroon's higher education (Njebakal, & Teneng, 2017).

Recommendations

Policies makers and institutional administrators should consider concentrating investments on technological infrastructures that pay attention to the realities of the emerging Fourth Industrial estate while equipping human resources with digital capabilities through knowledge networks and innovation clusters that create a competitive leverage for universities in the global knowledge society. Also, providing students with up-to-date digital tools resources which are fundamental to the formation of the responsive human capital is a crucial component. That said, effectiveness, efficiency, transparency, and equity of institutional governance also depend on the appropriation and crystallisation of digital technology into a university management system. This digitalised infrastructure will facilitate data analytics, which could greatly contribute to informed decision-making in higher education. Institutional administrators must continuously improve their knowledge infrastructures and network ecosystems for a transformative education.

New Perspective

This study focuses on technological knowledge networks, innovation and knowledge clusters, transformative digital governance in higher education in the emerging Fourth-Industrial Revolution. A future study has the possibility of extending the research to Artificial Intelligence (AI) and its implications in transformative education in Africa or in Cameroon's higher education.

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