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THE AFRICAN JOURNAL OF INFORMATION AND COMMUNICATION (AJIC)

ISSUE 27, 2021



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## Issue 27, 2021

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# ARTICLES



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# Problematic Internet Use (PIU) Among Adolescents during COVID-19 Lockdown: A Study of High School Students in Ibadan, Nigeria

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## Abstract
Problematic internet use (PIU) has generally been strongly associated with depression and attention deficit hyperactivity disorder, especially among adolescents, with resulting consequences for their health. This study explores the pattern of internet use, and the prevalence of PIU before and during the COVID-19 lockdown, as well as the causes, effects, and potential mitigation measures in respect of PIU during the lockdown, among high school students in Ibadan, Nigeria. A structured questionnaire, including a 20-question internet addiction test (IAT), was administered during the COVID-19 lockdown to 440 adolescents enrolled in high schools. Of these adolescents, 7.7% appeared from their responses to have had PIU before the COVID-19 lockdown period. However, 64.3% of respondents appeared from their responses to have had PIU during the COVID-19 lockdown period. The main reasons for the increased PIU were boredom, loneliness, idleness, pleasure gained from internet use, physical isolation, and the need for information and communication. The effects of PIU reported among the adolescents included reduced family intimacy, poor academic performance, loss of concentration, as well as internet abuse and risky sexual behaviour. To mitigate PIU among high school students, parental monitoring of adolescents, and their internet access and use, should be promoted. In addition, programmes should be organised by the media and academic institutions to keep adolescents engaged in productive tasks.

## Keywords
problematic internet use (PIU), internet addiction test (IAT), adolescents, high school students, COVID-19, lockdown, Ibadan, Nigeria



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**Declaration**
The authors declare that they have no conflicts of interest.

**Authors' contributions**
OSI, AAA, and AMA conceptualised the study; OSI and AAA analysed the data; AAA wrote the first draft of the article; OSI and AMA reviewed and provided input on the draft; and all authors approved the final draft.

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## 1. Introduction

The outbreak of novel coronavirus disease (COVID-19), first documented in Wuhan, China in late 2019, was declared a public health emergency by the World Health Organisation in March 2020 (WHO, n.d.; Ilesanmi et al., 2021). As of 10 April 2021, COVID-19 had spread across 213 countries, with 135,945,439 confirmed cases and nearly 3 million deaths recorded globally (Afolabi & Ilesanmi, 2021; Worldometer, n.d.). In Africa, recorded COVID-19 cases and fatalities were highest in South Africa, Morocco, Tunisia, Ethiopia, Egypt, Libya, and Nigeria (Worldometer, n.d.). As of 10 April 2021, Nigeria had documented 163,736 confirmed COVID-19 cases and 2,060 deaths (Worldometer, n.d.). The COVID-19 lockdown period increased the use of computers and the internet as indispensable tools for accessing information and enhancing relationships (Donohue & Miller, 2020). Due to workplace closures, the internet has also been increasingly adopted as a viable means of economic





activity and job retention. Online meetings, the virtual scheduling of religious activities, and online classes became routine during the lockdown period (Donohue & Miller, 2020).

The internet is a technological tool which supports the growth of children and adolescents, and enhances research, intuition, problem solving skills, development of life skills, and critical thinking abilities (Cakmak & Gul, 2018). However, when used in an uncontrolled, purposeless, and excessive manner, it can negatively influence the development of positive and protective habits (Cakmak & Gul, 2018; Park et al., 2018). Problematic internet use (PIU) has been defined as a condition where an individual uses the internet excessively and cannot withdraw from the internet. The occurrence of PIU during the COVID-19 lockdown has been recognised in the literature (Király et al., 2020).

The occurrence of PIU could occur at any stage of life; however, adolescents are at the highest risk for its occurrence (Cakmak & Gul, 2018). Adolescents are particularly vulnerable to PIU because of the rapid mental, emotional, and social developments occurring during this phase of life (Yang & Tung, 2007; Ceyhan, 2008). Due to their quest for knowledge during this developmental period, adolescents are more attracted than any other age group to technological tools (Cakmak & Gul, 2018). It has also been suggested that adolescents adopt internet usage as a means of substituting the challenges faced in real life with the euphoria obtained from the virtual world (Brown, 2006). PIU has generally been strongly associated with reduced sleeping time, the tendency to postpone sleep, insomnia, increased alertness, excessive tiredness, and depression (Brown, 2006; Park et al., 2018). The failure to address the possible effects of PIU and to suggest mitigating factors could result in impaired cognitive capacity among adolescents with a resulting decline in their productivity in later years. This could pose great threats to the overall safety and productivity of Nigeria and the entire world.

To the best of our knowledge, no research has been conducted regarding PIU among adolescents in Nigeria during the COVID-19 lockdown. According to the Nigeria Demographic Health Survey, 15.6% of adolescents aged 15 to 19 years use the internet; most of them reside in urban settings (NPC & ICF, 2019). Research on the causes and effects of PIU is important to the development of further guidelines regarding PIU and its management while coping during a lockdown. This study therefore aimed to assess the pattern of internet use, and the prevalence of PIU before and during the COVID-19 lockdown, as well as the causes, effects, and potential mitigation measures for PIU during the COVID-19 lockdown among high school students in the Nigerian city of Ibadan.



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## 2. Research design

***Study sample***

The research took place during COVID-19 lockdown—between 27 July and 7 August 2020—in Ibadan, the capital of Oyo State. The study population consisted of adolescents in selected communities in the city. A minimum sample size of 460 was estimated for this study, using the Leshlie Kish formula for cross-sectional studies. (We used an estimated prevalence of 50%, a precision value of 5% due to the unavailability of sample size calculation in existing PIU literature, and a 20% non-response rate.)

All eligible adolescents aged 10 to 18 years who provided consent were included in the study. A two-stage sampling technique was used to enrol respondents. In the first stage, a simple random sampling method was used to select four of the 11 local government areas (LGAs) in Ibadan: Ibadan South-East, Ibadan South-West, Ibadan North, and Ibadan North-East. In the second stage, we selected a political ward from each of the four selected LGAs, again using a simple random sampling technique. In each of the four selected wards, a centre location was identified, and a bottle was rotated once on a map to determine the areas to be targeted in seeking interviewees. From the areas corresponding to the direction of the bottle tip, all eligible adolescents were included in the study. First, each adolescent was approached in their household and asked if they were enrolled in high school before the COVID-19 lockdown. All adolescents who provided positive responses about their school enrolment, and who were confirmed to be users of the internet, were then informed about the purpose of the study. (All those who were not enrolled in high school before the lockdown were excluded.) Respondents were informed that they had the right to withdraw from the study at any time. All participants were assured that all information obtained would remain confidential. Eligible but unwilling adolescents were excluded.

Consent was obtained from each participating adolescent, and from a parent or an adult who could make decisions for the adolescent in the absence of a parent. Of the 460 eligible participants approached, we obtained permission and consent for 440 adolescents, thus yielding a response rate of 95%. No harm was inflicted on participants as a result of their participation in this study.

***Data collection instrument***

A structured, interviewer-administered questionnaire was used for data collection (see questionnaire in Appendix). The questionnaire covered the following:

- sociodemographic characteristics of the respondents and their parents (closed-ended questions);
- pattern of internet use (closed-ended questions);
- causes, effects, and factors associated with PIU during COVID-19 lockdown (open-ended questions);





- strategies to mitigate PIU during COVID-19 lockdown (open-ended questions); and
- an internet addiction test (IAT), which generated a PIU scale (see Appendix).

The IAT is a 20-question tool, developed by Young (see Young & Rogers, 2009). The IAT has been validated in literature as a standard tool for assessing PIU and internet addiction, including among adolescents and young adults in Nigeria (Oshodi et al., 2012). A shift in paradigm has informed a trend towards focusing on PIU rather than internet addiction. Internet addiction describes uncontrolled engagement in online activities that offer no benefit to the user. PIU, meanwhile, allows for the reality that an online activity may ordinarily provide benefits to the user, but its excessive use can result in negative consequences. To date, there is no consensus on a tool to measure PIU; hence, the IAT is still being used to assess PIU.

Using the IAT tool, 20 questions were asked on elements associated with PIU, both before and during the COVID-19 lockdown. These included questions such as the frequency of staying online longer than intended, the frequency of neglecting household chores to spend more time online, the frequency of sleep loss due to late night log-ins, the frequency of hiding the length of time spent online, the frequency of feeling depressed or moody while offline, and the frequency of a decline in school grades or work performance. In addition to these, we asked questions about the frequency of being secretive about the online activity being engaged in, the frequency of prioritising email checks, the frequency of anticipating the next online schedule, the frequency of receiving complaints from others due to the time spent online, and the frequency of saying "just a minute more" when online. Other questions were asked about the frequency of preferring the internet to family intimacy, the failure to reduce time spent online, and the frequency of snapping or yelling when offline. A slight modification in the IAT was made to capture two different periods: before the COVID-19 lockdown, and during the lockdown.

***Data collection***

Data were collected by trained research assistants (RAs) who had all obtained at least a Bachelor's degree. The RAs were trained on data collection for two days, on 25 and 26 July 2020. The questionnaire was pre-tested among adolescents in a community that was not selected for this study. After this pre-test, a few questions were modified.

Ethical approval for this study was obtained from the Oyo State Ministry of Health Ethical Review Committee, with reference number AD/13/479/1779[A].

***Data analysis***

Data analysis was done using SPSS version 23. Mean and standard deviation were used to summarise quantitative continuous variables such as age, while frequencies and percentages were used to summarise categorical variables such as age group.



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The pattern of internet use, the number of hours of daily internet access, the average time spent online per day, and the age of onset of internet use were computed using mean and standard deviation. Other details, such as the reasons for going online and the activities engaged in during the immediate past 24 hours, were also computed using frequency tables. Open-ended questions were asked about the causes of PIU, the effects of PIU, and strategies to reduce PIU. Closely related responses were grouped together when analysing the responses to these questions. Bivariate analysis was conducted using the Chi-square test, the t-test, and Pearson correlation. Pearson correlation was used to determine the strength of association between time spent online per day with sociodemographic and other internet use variables. Among the relationships of interest were the sociodemographic determinants of PIU before and during the COVID-19 lockdown, and associations between time spent online per day and sociodemographic characteristics. Statistically significant variables using Chi-square tests were used for the logistic regression model. The level of statistical significance was $p<0.05$.

To determine the prevalence of PIU, IAT scores for each of the 20 questions in the IAT were computed using the frequency of occurrence of each symptom of PIU. A score of "0" was assigned for "not applicable", "1" for "rarely", "2" for "occasionally", "3" for "frequently", "4" for "often", and "5" for "always". Thus, the maximum IAT score for each of the two periods—the pre-lockdown period and the lockdown period—was 100 points across. Cumulative IAT scores ranging between 20 and 49 points were treated as evidence of "complete ability to control/limit one's level of internet use". Cumulative scores between 50 and 70 points were treated as suggestive of "occasional PIU" (i.e., occasional inability to control/limit one's level of internet use). Cumulative IAT scores greater than 70 points were seen as suggesting "significant PIU" (i.e., significant inability to control/limit one's level of internet use).

## 3. Findings

***Respondents' sociodemographic characteristics***

A total of 440 respondents were interviewed, with a mean age of 14.15 ± 1.99 years. Of the respondents, 217 (49.3%) were males, 218 (49.5%) had attained junior high school, and 262 (59.5%) had three or fewer siblings. Other sociodemographic characteristics are as shown in Table 1.





**Table 1: Sociodemographic characteristics of surveyed adolescents**

| Variable | Frequency | % |
|---|---|---|
| **Age group (years)** | | |
| 10-12 | 88 | 20 |
| 13-15 | 238 | 54.1 |
| 16-18 | 114 | 25.9 |
| **Sex** | | |
| Male | 217 | 49.3 |
| Female | 223 | 50.7 |
| **Current enrolment level** | | |
| Junior high school | 218 | 49.5 |
| Senior high school | 222 | 50.5 |
| **Mother's age group (years)** | | |
| Less than 45 | 184 | 41.8 |
| 45 and above | 256 | 58.2 |
| **Father's age group (years)** | | |
| Less than 45 | 62 | 14.1 |
| 45 and above | 378 | 85.9 |
| **Father's education level** | | |
| Primary school or below | 36 | 8.2 |
| High school or above | 404 | 91.8 |
| **Mother's education level** | | |
| Primary school or below | 74 | 16.8 |
| High school or above | 366 | 83.2 |
| **Person lived with** | | |
| Parent | 389 | 88.4 |
| Guardian | 51 | 11.6 |
| **Number of siblings** | | |
| Three or fewer | 262 | 59.5 |
| Four or more | 178 | 40.5 |



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***Pattern of internet use***

Smartphones were the most owned device, owned by 369 respondents (98.1%). Smartphones were also the most used internet access device, used by 368 respondents (97.9%), and the most common point of internet access was the smartphone, cited by 347 respondents (92.3%). The most frequently cited reason for going online during the lockdown was socialising, cited by 331 respondents (88%), and the most used social networking platforms were Facebook (used by 359 respondents (95.5%)) and WhatsApp (used by 338 respondents (89.9%)). More than a half of respondents (64.2%) used the internet daily (see Table 2).

**Table 2: Pattern of internet use**

| Characteristics of internet use | Frequency | % |
|---|---|---|
| **Devices currently owned*** | | |
| Smartphone | 369 | 98.1 |
| Gaming device | 76 | 20.2 |
| Tablet | 26 | 6.9 |
| Laptop | 11 | 2.9 |
| Desktop computer | 3 | 0.8 |
| **Devices used for internet access*** | | |
| Smartphone | 368 | 97.9 |
| Gaming device | 45 | 12 |
| Tablet | 25 | 6.6 |
| Laptop | 10 | 2.7 |
| Desktop computer | 4 | 1.1 |
| **Internet points of access*** | | |
| Personal smartphone | 347 | 92.3 |
| Home | 37 | 9.8 |
| Paid hotspots | 5 | 1.3 |
| School | 3 | 0.8 |
| Free public hotspots | 2 | 0.5 |
| **Reasons for going online*** | | |
| Socialising | 331 | 88 |
| Communication | 266 | 70.7 |
| School assignment | 227 | 60.4 |
| Information research | 119 | 31.6 |
| **Internet social networking tools used*** | | |
| Facebook | 359 | 95.5 |
| WhatsApp | 338 | 89.9 |
| Snapchat | 40 | 10.6 |
| Twitter | 40 | 10.6 |
| Instagram | 28 | 7.4 |
| Eskimi | 1 | 0.3 |
| **Daily internet use** | | |
| Yes | 79 | 64.2 |
| No | 44 | 35.8 |

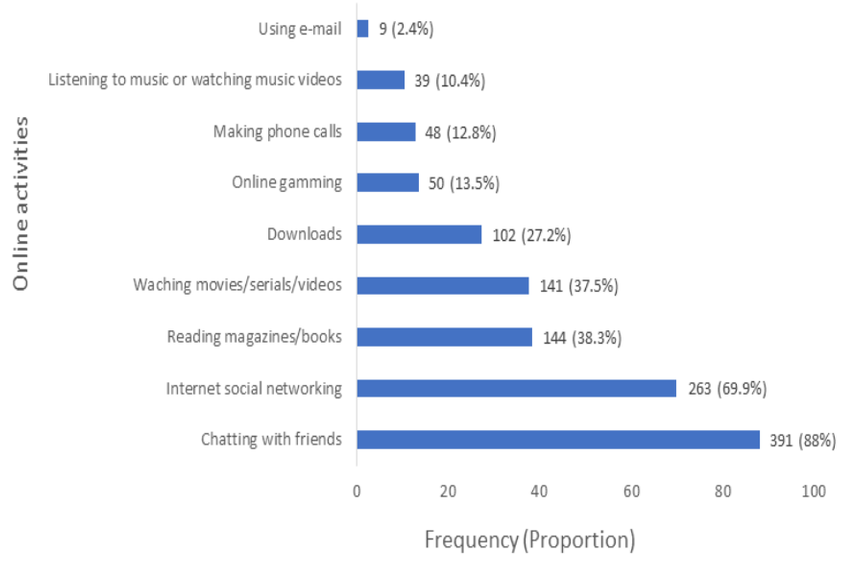
* = Multiple responses allowed





As seen in Figure 1, 391 respondents (88%) had, in the past 24 hours, engaged in chatting with friends, while 263 (69.9%) had engaged in internet social networking. Reading magazines and books was also cited by 144 (38.3%), while watching movies, serials and videos was cited by 141 individuals (37.5%).

**Figure 1: Online activities during the preceding 24 hours (during lockdown)**



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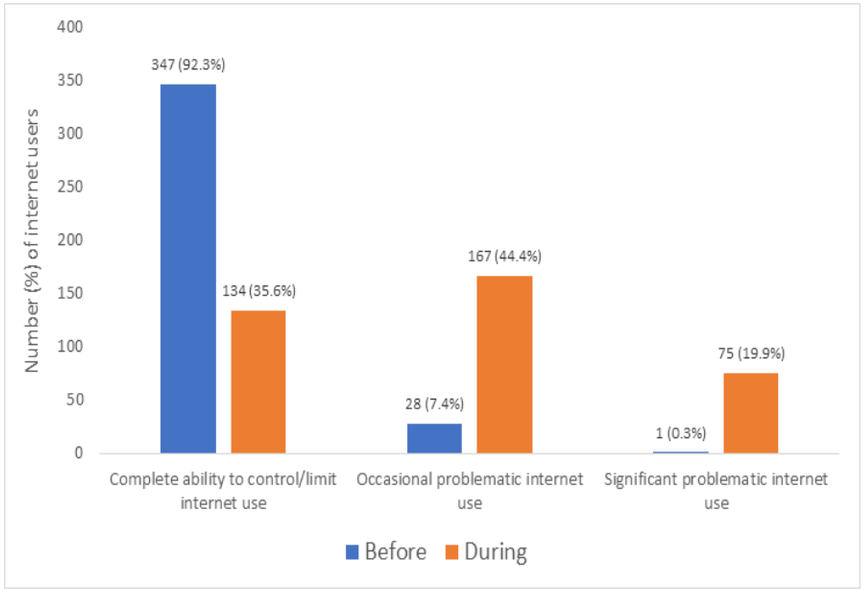
***Pattern of PIU before and during the lockdown***

As seen in Figure 2, the IAT test scores at the time of the survey suggest that 347 respondents (92.3%) believed they had the complete ability to control their internet use (defined as cumulative IAT scores from 0 to 49 points) during the pre-lockdown period. In contrast, only 134 (35.6%) felt they had the complete ability to control their level of use during lockdown. Before the lockdown, only 28 respondents (7.4%) had occasional PIU (defined as cumulative IAT scores ranging between 50 and 70 points). This figure rose during lockdown to 167 respondents (44.4%) having occasional PIU. Only one respondent (0.3%) had significant PIU (defined as cumulative IAT scores greater than 70 points) before the COVID-19 lockdown. This number rose during the lockdown to 75 respondents (19.9%) with significant PIU (Figure 2).

Aggregating the findings of occasional and significant PIU, 29 respondents (7.7%) appeared from their responses to have had PIU before the COVID-19 lockdown, while 242 (64.3%) appeared from their responses to have had PIU during the lockdown. The mean score of PIU before the lockdown was 30.15±14.13, while the mean score of PIU during the lockdown was 54.49±18.89 (t = -44.183, p = 0.001).

**Figure 2: PIU incidence before and during lockdown**








***PIU causes, effects and mitigation during the lockdown***

As seen in Table 3, 142 adolescents (32.3%) cited loneliness or physical isolation as the causes of PIU during the lockdown period. Other causes of PIU stated included poor discipline as cited by 99 (22.5%), and socialising, communication, and pleasure derived from online activities, as cited by 66 (15%). In terms of the effects of PIU, 118 (26.8%) mentioned reduced family intimacy, and 102 (23.2%) noted poor academic performance, and loss of concentration. In addition, 95 adolescents (21.6%) stated that PIU could result in internet abuse or risky sexual behaviour. When asked about the ways in which PIU could be mitigated, 286 respondents (65%) suggested awareness-raising among, and/or monitoring of, adolescents; 136 (30.9%) suggested ending the school closures; and 18 (4.1%) suggested that adolescents should be engaged in more productive tasks.

**Table 3: PIU causes, effects and mitigations during the COVID-19 lockdown**

| Dimension | Frequency | % |
|---|---|---|
| **Causes of PIU** | | |
| Loneliness, physical isolation | 142 | 32.3 |
| Poor discipline | 99 | 22.5 |
| Socialising, communication, pleasure from online activities | 66 | 15 |
| Boredom | 60 | 13.6 |
| Parental neglect | 41 | 9.3 |
| Laziness, idleness | 32 | 7.3 |
| **Effects of PIU** | | |
| Reduced family intimacy | 118 | 26.8 |
| Poor academic performance, loss of concentration | 102 | 23.2 |
| Internet abuse, risky sexual behaviour | 95 | 21.6 |
| Tiredness, loss of sleep, headaches, reduced eye functioning | 74 | 16.8 |
| Neglecting household chores | 51 | 11.6 |
| **Suggestions of ways to mitigate PIU** | | |
| Awareness-raising, monitoring | 286 | 65 |
| Suspension of school closures | 136 | 30.9 |
| Engagement of adolescents in more productive tasks | 18 | 4.1 |



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***Correlations between sociodemographic variables and PIU***

Table 4 shows the correlations between sociodemographic variables and PIU before and during the COVID-19 lockdown. In the pre-lockdown period, it was found that 13.4% of the adolescents aged 16 to 18 years had occasional or significant PIU (p = 0.019), compared to only 5.9% of the 13- to 15-year-olds and 2.3% of the 10- to 12-year-olds. During the lockdown, it was found that 86.6% of adolescents aged 16 to 18 had occasional or significant PIU (p = < 0.001), compared to 61.8% of the 13- to 15-year-olds and 20.5% of the 10- to 12-year-olds. This suggests that older adolescents are more likely than younger adolescents to develop PIU in both non-lockdown and lockdown periods. In turn, 13- to 15-year-olds appear to be less susceptible to PIU than 16- to 18-year-olds, and more susceptible than 10- to 12-year-olds. Table 4 also shows a similar difference in PIU susceptibility between senior high school and junior high school students, with the senior high school students more susceptible during both the pre-lockdown and lockdown periods. In respect of gender differences, Table 4 shows that the male respondents were more susceptible to PIU than the female respondents, both pre-lockdown and during lockdown.

**Table 4: Correlations between sociodemographic variables and PIU**

| **Variables** | **PIU pre-lockdown** | | **PIU during lockdown** | |
|---|---|---|---|---|
| | **Present** | **Absent** | **Present** | **Absent** |
| | **n (%)** | **n (%)** | **n (%)** | **n (%)** |
| **Age group (years)** | | | | |
| 10-12 | 1 (2.3) | 43 (97.7) | 9 (20.5) | 35 (79.5) |
| 13-15 | 13 (5.9) | 207 (94.1) | 136 (61.8) | 84 (38.2) |
| 16-18 | 15 (13.4) | 97 (86.6) | 97 (86.6) | 15 (13.4) |
| | $\chi^2$ = 7.912, p = **0.019** | | $\chi^2$ = 61.765, p = < **0.001** | |
| **Sex** | | | | |
| Male | 20 (10.9) | 163 (89.1) | 123 (67.2) | 60 (32.8) |
| Female | 9 (4.7) | 184 (95.3) | 119 (61.7) | 74 (38.3) |
| | $\chi^2$ = 5.181, p = **0.023** | | $\chi^2$ = 1.264, p = 0.261 | |
| **Current enrolment level** | | | | |
| Junior high school | 6 (3.8) | 154 (96.2) | 67 (41.9) | 93 (58.1) |
| Senior high school | 23 (10.6) | 193 (89.4) | 175 (81.0) | 14 (19.0) |
| | $\chi^2$ = 6.945, p = **0.013** | | $\chi^2$ = 61.399, p = <**0.0001** | |
| **Father's age group (years)** | | | | |
| Less than 45 | 3 (6.4) | 44 (93.6) | 24 (51.1) | 23 (48.9) |
| 45 and above | 26 (7.9) | 303 (92.1) | 218 (66.3) | 111 (33.7) |
| | $\chi^2$ = 0.133, p = 0.715 | | $\chi^2$ = 4.141, p = **0.042** | |
| **Mother's age group (years)** | | | | |
| Less than 45 | 8 (5.3) | 143 (94.7) | 83 (55.0) | 68 (45.0) |
| 45 and above | 21 (9.3) | 204 (90.7) | 159 (70.7) | 66 (29.3) |
| | $\chi^2$ = 2.067, p = 0.151 | | $\chi^2$ = 9.710, p = **0.002** | |
| **Father's education level** | | | | |
| Primary school or below | 3 (11.1) | 24 (88.9) | 19 (70.4) | 8 (29.6) |
| High school or above | 28 (7.4) | 323 (92.6) | 223 (63.9) | 126 (36.1) |
| | $\chi^2$ = 0.472, p = 0.492 | | $\chi^2$ = 0.458, p = 0.499 | |
| **Mother's education level** | | | | |
| Primary school or below | 6 (10.9) | 41 (89.1) | 38 (68.1) | 17 (30.9) |
| High school or above | 23 (7.2) | 298 (92.8) | 204 (63.6) | 117 (36.4) |
| | $\chi^2$ = 0.925, p = 0.336 | | $\chi^2$ = 0.628, p = 0.428 | |
| **Person lived with** | | | | |
| Parent | 27 (8.0) | 309 (92.0) | 219 (65.2) | 117 (34.8) |
| Guardian | 2 (5.0) | 38 (95.0) | 23 (57.5) | 17 (42.5) |
| | $\chi^2$ =0.463, p = 0.496 | | $\chi^2$ = 0.919, p = **0.038** | |
| **Number of siblings** | | | | |
| Three or fewer | 11 (5.0) | 210 (95.0) | 129 (58.4) | 92 (41.6) |
| Four or more | 18 (11.6) | 137 (88.4) | 113 (72.9) | 42 (37.1) |
| | $\chi^2$ = 5.636, p = **0.018** | | $\chi^2$ = 8.388, p = **0.004** | |

Notes: $\chi^2$ = Chi-square test; p-values in **bold** indicate finding is statistically significant (p < 0.05)

Table 5 shows that the male respondents were, before the lockdown, twice as likely as female adolescents to develop PIU (adjusted odds ratio (AOR) = 2.308; 95% confidence interval (CI) = 1.009–5.281). During the lockdown, however, no statistically significant difference was found between males and females in respect of PIU. The table also shows that, before the lockdown, the respondents aged 16 to 18 years were







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twice as likely as those aged 10 to 12 years (AOR = 2.159; 95% CI = 0.202–23.064) to develop PIU, and that, during the lockdown, they were seven times more likely than 10- to 12-year-olds to develop PIU (AOR = 7.093; 95% CI = 2.393–21.023). In respect of school level, the adolescents in senior high school were found to be twice as likely as junior high school students to exhibit PIU before the lockdown (AOR = 2.142; 95% CI = 1.009–5.281), and three times as likely during the lockdown (AOR = 3.228; 95% CI = 1.822–5.719).

**Table 5: Sociodemographic determinants of PIU**

| Determinants of PIU pre-lockdown | Unstandardised regression coefficient | adjusted odds ratio (AOR) | 95% confidence interval (CI) for AOR | | p-value |
|---|---|---|---|---|---|
| | | | Lower | Upper | |
| **Age group (years)** | | | | | |
| 10-12 | 0.770 | 2.159 | 0.202 | 23.064 | 0.524 |
| 13-15 | 0.365 | 1.440 | 0.579 | 3.579 | 0.432 |
| 16-18 | | 1 | | | |
| **Sex** | | | | | |
| Male | 0.836 | 2.308 | 1.009 | 5.281 | **0.048** |
| Female | | 1 | | | |
| **Current enrolment level** | | | | | |
| Junior high school | 0.762 | 2.142 | 0.696 | 6.592 | 0.184 |
| Senior high school | | 1 | | | |
| **Number of siblings** | | | | | |
| Three or fewer | 0.753 | 2.123 | 0.935 | 4.821 | 0.072 |
| Four or more | | 1 | | | |





| Determinants of PIU during lockdown | Unstandardised regression coefficient | adjusted odds ratio (AOR) | 95% confidence interval (CI) for AOR | | p-value |
|---|---|---|---|---|---|
| | | | Lower | Upper | |
| **Age group (years)** | | | | | |
| 10-12 | 1.959 | 7.093 | 2.393 | 21.023 | **<0.001** |
| 13-15 | 0.671 | 1.956 | 0.966 | 3.961 | 0.062 |
| 16-18 | | 1 | | | |
| **Current enrolment level** | | | | | |
| Junior high school | 1.172 | 3.228 | 1.822 | 5.719 | **<0.001** |
| Senior high school | | 1 | | | |
| **Number of siblings** | | | | | |
| Three or fewer | 0.457 | 1.579 | 0.916 | 2.723 | 0.100 |
| Four or more | | 1 | | | |
| **Father's age (years)** | | | | | |
| <45 | -0.258 | 0.773 | 0.354 | 1.687 | 0.517 |
| ≥45 | | 1 | | | |
| **Mother's age (years)** | | | | | |
| <45 | 0.136 | 1.145 | 0.656 | 1.998 | 0.633 |
| ≥45 | | 1 | | | |
| **Person lived with** | | | | | |
| Parent | -0.325 | 0.723 | 0.336 | 1.553 | 0.405 |
| Guardian | | 1 | | | |

Note: p-values in **bold** indicate finding is statistically significant (p < 0.05)



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Table 6 shows the correlations between time spent online per day (during the lockdown) and sociodemographic and other internet use variables. It was found that for every unit increase in age, there was a corresponding increase in daily time spent online. Also, an increase in the years in formal education increased the daily time spent online.

**Table 6: Correlation of time spent online per day with sociodemographic and other internet use variables**

| Variable | r | p-value* |
|---|---|---|
| Age | 0.277 | **< 0.001** |
| Current enrolment level | 0.168 | **0.001** |
| Number of siblings | 0.116 | 0.025 |
| Father's age | 0.127 | **0.014** |
| Mother's age | 0.092 | 0.075 |
| Hours of daily internet access | 0.593 | **< 0.001** |
| Age of onset of internet use | 0.036 | 0.587 |

Note: p-values in **bold** indicate finding is statistically significant ($p < 0.05$)

## 4. Analysis, conclusions and recommendations

We found that a complete ability to control/limit one's level of internet use (i.e., an absence of PIU) existed among many adolescents before the COVID-19 lockdown period. The reasons for this could be traced to their active engagement in academic and extramural activities while schools were open. However, during the lockdown, fewer adolescents maintained the complete ability to control/limit their level of internet use, and a rise in the prevalence of PIU during the lockdown period was identified. Thus, the compulsory stay-at-home conditions during the lockdown appear to have increased the risk of PIU among adolescents.

We also noted that an increase in the number of years spent in formal education increases the development of PIU among adolescents. This reveals a higher likelihood for the development of PIU among persons with more years of formal education compared to those with fewer years. However, we noted that adolescents aged 10 to 12 years were two times more likely to develop PIU compared to those aged 16 to 18 years in the period before the COVID-19 lockdown. During the COVID-19 lockdown, on the other hand, adolescents within this same age group (10 to 12 years) were seven times more likely to develop PIU. This may be the result of parents providing internet-enabled devices to their children to enhance their mental development.





We identified the following reasons for PIU among adolescents during the COVID-19 lockdown: boredom, loneliness, idleness, pleasure gained from internet use, peer pressure, poor discipline, parental neglect, physical isolation, and the need for information and communication. This corroborates with findings that when faced with undesirable conditions, many adolescents use the internet as a remedy or strategy for easing the burden of boredom, loneliness, and physical isolation (Brown, 2006). Although this adaptive strategy presents emotional and physical challenges, the internet provides immediate but temporary relief from life's worries (Cakmak & Gul, 2018).

An implication of our findings is that a lack of physical social relationships could lead to the development or worsening of PIU. Many academic institutions have opted for e-learning or home-based schooling due to the imposed lockdown on schools (Donohue & Miller, 2020). This need for access to e-learning has contributed to increasing adolescents' use of the internet beyond the two hours of daily use as recommended by the Australian government (Hoare et al., 2016). This is because most academic programmes last for about three hours every day, with each session lasting about an hour. Undisciplined use of the internet can result, which can expose adolescents to X-rated sites or other platforms which are not age appropriate (Tahiroğlu et al., 2008; Hoare et al., 2016). Thus, more frequent use of the internet, regardless of whether it is under the guise of e-learning or communication or seeking information, can put adolescents at greater risk for PIU.

The suggestions provided by the respondents about ways of mitigating PIU among adolescents included educating adolescents about the threats that PIU can pose to their present and future lifestyle. Parental monitoring of internet use was also cited as a means by which internet use could be kept at more appropriate levels among adolescents. Parental monitoring does not necessary imply excessive parental intervention in internet use, but implies the regulation of internet use for adolescents. The controlled use of the internet has been associated with the development of positive and protective habits that can ensure that adolescents become responsible adults in the future (Cakmak & Gul, 2018; Park et al., 2018).

Suspension of the school closures was also, quite reasonably, stated as a potential mitigating factor for PIU among adolescents. However, a precise public health approach is needed for the resumption of school activities (Donohue & Miller, 2020). Adolescent engagement in more productive tasks could also contribute to the prevention of PIU during the COVID-19 lockdown. These tasks could include practical music, vocational, or writing skills. This finding therefore clarifies that PIU can be prevented if its prevention is seen as a responsibility of both adolescents and their parents/guardians.



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In respect of the limitations of our study, it should be noted that, because this study was not conducted at the early stage of the COVID-19 outbreak in Nigeria, our findings could have been limited by recall bias. Also, the nature of this study could have concealed important knowledge that would have been obtained using a longitudinal study design.

It is our recommendation that healthy internet use interventions should commence with children at an early age, to strengthen the positive use of the internet during adolescence. Parents should regulate adolescents' access to the internet. Also, health education sessions on the risks of developing PIU through excessive internet usage should be communicated during health campaigns and should be broadcast on the media. In addition, further research needs to be conducted on the effects of PIU on adolescents' mental and psychological health.

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## Appendix: Questionnaire

| Sociodemographic characteristics | | | |
|---|---|---|---|
| **1. Age (last birthday):** | **2. Sex:** | 1. M | 2. F |
| **3. Highest class attained:** | | | |
| **4. Who do you live with?** | 1. Parent | 2. Guardian | 3. Others (specify): |
| **5. Father's highest educational qualification:** | | | |
| **6. Mother's highest educational qualification:** | | | |
| **7. Father's occupation:** | | | |
| **8. Mother's occupation**: | | | |
| **9. Family type** | 1. Nuclear | 2. Extended | |
| **10. Number of siblings:** | | | |
| **11. Father's age:** | | | |
| **12. Mother's age:** | | | |
| **Pattern of internet use** | | | |
| **13. Which of these devices do you currently own?** 1. Smartphone 2. Desktop 3. Laptop 4. Tablet 5. Gaming device | | | |
| **14. How many hours per day do you have internet access?** | | | |
| **15. Time spent online per day (specify):** | | | |
| **16. Age of onset of internet use (specify):** | | | |
| **17. Frequency of internet use** 1. Less than once a week 2. 1-3 times a week 3. 4-6 times a week 4. Daily | | | |
| **18. Device used for internet access** 1. Smartphone 2. Desktop 3. Laptop 4. Tablet 5. Gaming device | | | |
| **19. Internet point of access** 1. Home 2. School 3. Free public hotspots 4. Paid hotspots 5. Personal phone | | | |
| **20. Reason(s) for going online** 1. Communication 2. Socialization 3. School assignment 4. Information research 5. Others (specify): | | | |
| **21. What have you done online in the past 24 hours?** 1. Watching movies/serials/videos 2. Downloads 3. Reading magazines/books 4. Listening/watching music 5. Online gaming 6. Chatting with friends 7. Using e-mails 8. Making phone calls 9. Internet social networking | | | |
| **22. Parent's awareness of internet use** 1. None 2. Good 3. Very good | | | |
| **23. Used internet social networking type** 1. Facebook 2. WhatsApp 3. Instagram 4. Snapchat 5. Twitter 6. Eskimi | | | |
| **24. Do you perceive you have problematic internet use?** 1. Yes 2. No | | | |
| **25. What are the causes of problematic internet use among high school during the COVID-19 lockdown?** | | | |
| **26. What are the likely effects of problematic internet use on high school during the COVID-19 lockdown?** | | | |
| **27. What are the factors associated with increased internet use among high school during the COVID-19 lockdown?** | | | |





| **28. What can you suggest should be done to reduce problematic internet use among high school students during the COVID-19 lockdown period?** |
|---|

| **29. Internet Addiction Test** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Key:** 0: does not apply; 1: rarely; 2: occasionally; 3: frequently; 4: often; 5: always | | | | | | | | |
| | | **Score** | | | | | | |
| | **Questions** | **0** | **1** | **2** | **3** | **4** | **5** |
| 1. | a. How often did you stay online longer than you intended before the lockdown? | | | | | | |
| | b. How often did you stay online longer than you intended during the lockdown? | | | | | | |
| 2. | a. How often did you neglect household chores to spend more time online before the lockdown?<br>b. How often do you neglect household chores to spend more time online during the lockdown? | | | | | | |
| 3. | a. How often did you lose sleep due to late night log-ins before the lockdown? | | | | | | |
| | b. How often do you lose sleep due to late night log-ins during the lockdown? | | | | | | |
| 4. | a. Before the lockdown, how often did you try to hide how long you've been online? | | | | | | |
| | b. During the lockdown, how often do you try to hide how long you've been online | | | | | | |
| 5. | a. Before the lockdown, how often did you feel depressed, moody, or nervous when you're offline, which goes away when you're back online? | | | | | | |
| | b. During the lockdown, how often do you feel depressed, moody, or nervous when you're offline, which goes away when you're back online? | | | | | | |
| 6. | a. Before the lockdown, how often did your school grades or work suffer because of the amount of time you spend online? | | | | | | |
| | b. During the lockdown, how often do your school grades or work suffer because of the amount of time you spend online? | | | | | | |
| 7. | a. Before the lockdown, how often did your job performance or productivity suffer because of the internet? | | | | | | |
| | b. During the lockdown, how often does your job performance or productivity suffer because of the internet? | | | | | | |
| 8. | a. Before the lockdown, how often did you become defensive or secretive when anyone asks you what you do online? | | | | | | |
| | b. During the lockdown, how often do you become defensive or secretive when anyone asks you what you do online? | | | | | | |
| 9. | a. Before the lockdown, how often did you check your e-mail before something else that you need to do? | | | | | | |
| | b. During the lockdown, how often do you check your e-mail before something else that you need to do? | | | | | | |



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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 10. | a. Before the lockdown, how often did you find yourself anticipating when you will go online again? | | | | | | |
| | b. During the lockdown, how often do you find yourself anticipating when you will go online again? | | | | | | |
| 11. | a. Before the lockdown, how often did others in your life complain to you about the amount of time you spend online? | | | | | | |
| | b. During the lockdown, how often do others in your life complain to you about the amount of time you spend online? | | | | | | |
| 12. | a. Before the lockdown, how often did you find yourself saying "just a few minutes more" when online? | | | | | | |
| | b. During the lockdown, how often do you find yourself saying "just a few minutes more" when online? | | | | | | |
| 13. | a. Before the lockdown, how often did you try to cut down the amount of time you spend online and fail? | | | | | | |
| | b. During the lockdown, how often do you try to cut down the amount of time you spend online and fail? | | | | | | |
| 14. | a. Before the lockdown, how often did you prefer the excitement of the internet to intimacy with your family? | | | | | | |
| | b. During the lockdown, how often do you prefer the excitement of the internet to intimacy with your family? | | | | | | |
| 15. | a. Before the lockdown, how often did you form new relationships with fellow online users? | | | | | | |
| | b. During the lockdown, how often do you form new relationships with fellow online users? | | | | | | |
| 16. | a. Before the lockdown, how often did you block out disturbing thoughts about your life with soothing thoughts of the internet? | | | | | | |
| | b. During the lockdown, how often do you block out disturbing thoughts about your life with soothing thoughts of the internet? | | | | | | |
| 17 | a. Before the lockdown, how often did you fear that life without the internet would be boring, empty, and joyless? | | | | | | |
| | b. During the lockdown, how often do you fear that life without the internet would be boring, empty, and joyless? | | | | | | |
| 18. | a. Before the lockdown, how often did you snap, yell, or act annoyed if someone bothers you while you are online? | | | | | | |
| | b. During the lockdown, how often do you snap, yell, or act annoyed if someone bothers you while you are online? | | | | | | |
| 19. | a. Before the lockdown, how often did you feel preoccupied with the internet when offline, or fantasize about being online? | | | | | | |
| | b. During the lockdown, how often do you feel preoccupied with the internet when offline, or fantasize about being online? | | | | | | |
| 20. | a. Before the lockdown, how often did you choose to spend more time online over going out with others? | | | | | | |
| | b. During the lockdown, how often do you choose to spend more time online over going out with others? | | | | | | |



# Indigenous Knowledge and Vocational Education: Marginalisation of Traditional Medicinal Treatments in Rwandan TVET Animal Health Courses

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## Abstract
This study explores Rwandan ethno-veterinary knowledge and the degree to which this knowledge is reflected in the country's technical and vocational education and training (TVET) instruction. The knowledge considered is the Indigenous medicinal knowledge used by rural Rwandan livestock farmers to treat their cattle. Through interviews with farmers, TVET graduates and TVET teachers, and an examination of the current TVET Animal Health curriculum, the research identifies a neglect of Indigenous knowledge in the curriculum, despite the fact that local farmers use numerous Indigenous medicinal innovations to treat their animals. The focus of the Rwanda's TVET Animal Health curriculum is on Western-origin modern veterinary practices. The authors argue that this leaves Rwandan TVET Animal Health graduates unprepared for optimal engagement with rural farmers and with the full range of potential treatments.

## Keywords
livestock farming, cattle, animal health, Indigenous knowledge, ethno-veterinary medicine, medicinal herbs, technical and vocational education and training (TVET), Rwanda



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## 1. Introduction

Often dismissed as fetish, retrogressive, superstitious, and of no scientific validity, Africa's Indigenous knowledge systems were mostly ridiculed by the colonial administrations. There was little critical consciousness of the implications of the imposition of an alien episteme on local communities possessing their own sophisticated Indigenous knowledge systems. The end of colonial rule in Sub-Saharan Africa did not generate a meaningful departure from reliance on Western knowledge systems, and the colonial state of affairs largely persists in many African countries in respect of the treatment of Indigenous knowledge in official, formal education curricula. Meanwhile, in other parts of the world—for example, in China, India, and Japan—tremendous progress has been made in the recognition of traditional knowledge in





the fields of governance, medicine, architecture, social organisation, technology, agriculture, and conflict resolution.

In this study, we explore Rwandan farmers' use of Indigenous knowledge to treat ailments in cattle, and the degree to which this ethno-veterinary medical knowledge is reflected in the country's technical and vocational education and training (TVET) instruction in Animal Health. Through interviews with farmers, TVET graduates and TVET teachers, and an examination of the current TVET Animal Health curriculum, the study identifies a stark contrast between the large body of Indigenous knowledge being used by Rwandan rural livestock farmers and the near-complete absence of representation of this knowledge in the country's TVET system.

## 2. Research design

Rwanda was judged to be an appropriate context for this case study because of its majority agrarian population and that population's centuries of Indigenous knowledge, particularly the agricultural and ethno-veterinary knowledge held and curated by traditional pastoral farmers. We conducted the study via qualitative means, with data collected in two forms: semi-structured interviews, guided by an interview protocol, with rural livestock farmers, TVET Animal Health teachers, and TVET graduates; and scrutiny of the curriculum content for the Rwandan TVET Animal Health qualifications (WDA, n.d.).

Eighteen interviews were conducted, with:

- six experienced livestock farmers (three female, three male), aged between 62 and 84, who had been keeping livestock for between 17 and 50 years;
- four less-experienced, younger livestock farmers (all male), aged between 27 and 34, who had been keeping livestock for between five and 10 years;
- three TVET Animal Health teachers (males), with teaching experience of two, three, and nine years, respectively, and two of whom were involved in TVET Animal Health curriculum development; and
- five TVET Animal Health graduates (males) now working in rural communities (three as veterinary pharmacists, two as veterinary clinicians), all in their positions for between three and six years.

The interviews were conducted in two locations:

- Mpenge cell, Muhoza sector, Musanze District, Northern Province; and
- Remera cell, Kiyumba sector, Muhanga District, Southern Province.

Purposive sampling was used to identify the farmers, TVET teachers, and TVET graduates interviewed in the two districts. The interview questionnaire was developed in English and translated into Kinyarwanda. The interviews were conducted in Kinyarwanda, and the responses were translated and transcribed into English for the data analysis. Each interview took about 30 minutes to complete.



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## 3. Research context

***Indigenous knowledge, education, colonialism, and African agriculture***

Our definition of Indigenous knowledge takes account of elements of definitions of Indigenous knowledge and its synonyms or constructs (such as, notably, traditional knowledge and local knowledge) in law (WIPO IGC, 2019) and in the extant literature (Oguamanam, 2006; Kiggundu, 2007; Bruchac, 2014). We use the term to reference multiple, open-ended, and complex sites of lived experiences through which non-Western Indigenous peoples and local communities engage with phenomena by way of language, practices, innovations, and ways of life, including stewardship (and co-stewardship with other life and non-life forces) for sustainable living; ecological and environmental cohesion; and spiritual, cultural, social, and economic harmony.

The theoretical underpinnings of Indigenous knowledge systems in general, and the place of Indigenous knowledge in education curriculum development, are still evolving. However, if education is generally accepted as a process through which individuals are able to acquire knowledge for specific goals that will be beneficial to themselves and society, then for education to successfully fulfil its objectives in any locale, an acknowledgement and incorporation of the pre-existing knowledge of its host community in curricula is needed. In several classic works on education, Dewey is specific about the place of community in successful learning. For Dewey, one of the aims of learning should be to work with communities in inculcating their banks of knowledge into younger generations (Dewey, 1959).

***Indigenous knowledge and education***

In the 1962 book *The Structure of the Scientific Revolution*, Kuhn opines that reference to "knowledge" as "universal" is in fact a reference to Western scientific knowledge, which, in turn, calls into question all other forms of knowledge and assumes that they are either irrelevant or sub-par (Kuhn, 1962). The idea that knowledge generated in the West should be wholly embraced by other regions is instrumental in the West's continued domination of the rest of the globe. So-called "Western culture", according to Oguamanam (2006, p. 19), is "a local tradition, which has been spread worldwide through intellectual colonization" .

For a curriculum to produce learners who are aware of the opportunities and challenges within their immediate environment, its contents must reflect the real life and lived experiences of learners. White (1983) notes that no curriculum, educational programme, or policy should be analysed outside of its ideological, political, or environmental foundations. Educational curricula are inherently and directly connected to societal dynamics and power; therefore, whether intentionally or inadvertently, more emphasis is often placed on some knowledge form or system of knowledge over others. What is included, highlighted, downplayed, or excluded will grant or deny power to a segment of the population (White, 1983). In *Pedagogy of the Oppressed*,





Freire maintains that it is critical that curricula in any educational setting are representative of "situations familiar to the individuals whose thematics are being examined, so that they can easily recognize the situations (and thus their own relation to them)" (Freire, 1968, p. 107). Educators who aim to produce learners who can create innovations grounded in Indigenous knowledge must focus attention on how their curriculum either affirms the knowledge forms, values, and ideals of the students' cultural milieu, or ignores, de-emphasises, and even ridicules it (McLaren, 2003). A core challenge then lies in integrating locally generated content, instructional strategies, and techniques in the curriculum design (Trifonas, 2003).

***Indigenous knowledge, education, and colonialism***

Van Niekerk (2004) makes a case for the contextualisation of all curricula in order to reflect societal dynamics. Such contextualisation often requires the re-assessment of curricula, especially in formerly colonised territories (Danmole, 2011). According to UNESCO, "there is an urgent need to enhance the intergenerational transmission of indigenous knowledge, as a complement to mainstream education" (UNESCO, n.d.). Accordingly, UNESCO promotes efforts "to bring indigenous language and knowledge into school curricula and to move learning back into the community, thus reaffirming the status of elders as knowledge holders" (UNESCO, n.d.).

National education systems in most parts of Africa have their origins in colonialism. Curricula were copied verbatim from the education systems of colonial authorities, without thought being given to the Africans' cultural practices, Indigenous epistemologies, ontologies, and pedagogies. In the few instances where Africa's Indigenous knowledge found its way into colonial era curricula, it was often included in order to ridicule it, deride it, or cast it in a negative light, while holding up Western knowledge as the ideal. Empowerment, creativity, and innovation did not play a role in the design of academic programmes in colonial Africa (Freire, 1968; Nhalevilo, 2013; Owuor, 2007). Had they been considered, Africa's epistemologies would have been at the forefront, since their aim is to build confidence in learners and a sense of respect for their environments and lived realities.

The colonial governments' Victorian-era norms for male and female roles likewise influenced the structure of education in the colonised territories (Ezeanya-Esiobu, 2019). Despite the fact that across much of the continent, African women worked alongside their husbands, the colonisers established all-male schools and hired mostly men to work in government offices and establishments. For women, domestic management and training schools were established to orient them towards skills in, for example, "sewing, dressmaking, baking, cooking", decoration, and general home and housekeeping skills (Oguamanam, 2019, p. 16).

The end of colonial rule did not result in significant changes in curricula across much of Sub-Saharan Africa, since post-colonial governments remained dependent



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on the colonial authorities for education funding. Beyond that, many educated Africans whose task it was to educate the younger generation were beholden to the West and looked derogatorily upon Indigenous knowledge (Msila, 2016). For the most part, Western-based education continued to thrive across Africa, decades after the end of colonial rule (Gumbo, 2016). In a few instances of deviations from this norm, such as in Kenya, the government recognised the need to incorporate Indigenous knowledge into curricula. However, the government abandoned the idea due to the lack of manpower and technical know-how needed to adequately conceptualise and aggregate the Indigenous knowledge of the many ethnicities that make up that country (Owuor, 2007).

### *African agriculture*

Across Africa, pastoralists have for generations successfully employed Indigenous medicinal knowledge in rearing livestock. Such ethno-veterinary medical knowledge abounds on the continent, especially in rural areas. However, practitioners of this knowledge are scarcely recognised. Much of the agricultural production in Africa happens at the smallholder level (Kamara et al., 2019). A report released by the Alliance for a Green Revolution in Africa (AGRA) concludes that smallholder farmers "will be vital to the continent's long-awaited green revolution" (AGRA, 2019). In terms of sustainability and conservation, smallholder farmers use predominantly natural or biodegradable pesticides, which are less toxic to the body and the environment than the conventional pesticides used in industrial agriculture (Barucha, 2019). Studies have established that "many of these small farmers are increasingly using innovative ways of reducing greenhouse gas emissions and adapting to climate change" (Barucha, 2019).

Goal 2 of the UN Sustainable Development Goals (SDGs) is the eradication of hunger. To achieve that goal, the UN targets an increase, of no less than 200%, in agricultural productivity for smallholder farmers (UN, 2020). There is an expectation of an increase by the same percentage in the income of vulnerable populations who engage in smallholder agriculture, such as women, pastoralists, and fishing communities. A commitment to working with smallholder farmers inevitably places Indigenous knowledge of agriculture at the core of discussions of the SDGs (IISD, 2020). In a report, *Realizing the Future We Want for All*, the UN System Task Team on the Post-2015 UN Development Agenda noted the significance of Indigenous knowledge in the sustainability discourse, by observing that "[t]raditional and indigenous knowledge, adaptation and coping strategies can be major assets for local response strategies" (UN, 2012, p. 28).

Indigenous knowledge of animal health is essentially an organic-friendly endeavour (Chander et al., 2011). Organic farming supports the use of local or native breeds since they are "less susceptible to stress and disease, and so the need for allopathic medicines and antibiotics is much lower." Therefore, "indigenous technical knowledge, available in poorer and developing countries, may provide an effective substitute for veterinary care" (Kumar et al., 2006, quoted in Chander et al., 2011, p. 977). According to a 2008 UN report on a study that explored the relationship between organic agriculture and food security in Africa, the study findings "support the argument that organic agriculture can be more conducive to food security in Africa than most conventional production systems, and that it is more likely to be sustainable in the long term" (UNCTAD & UNEP, 2008, p. iii).

### *Rwandan livestock farming and Indigenous treatments*

Rwanda's livestock sector contributes roughly 16% of the country's GDP (Mazimpaka, 2017). The Rwandan Government has initiated the Girinka (One Cow per Poor Family) Programme, promoting the rearing of cattle to increase wealth and productivity (USAID Rwanda, 2016). Cattle are integral to Rwandan culture, with the Inyambo breed traditionally used in royal ceremonies. It is an established practice to give a cow as a gesture of friendship and goodwill. Cows are also gifted as dowry, and can be offered as a sacrifice to the gods (Hirwa et al., 2017a). Due to the embeddedness of cattle in Rwandan culture, maintaining their health is a central aspect of Indigenous knowledge that is handed down from one generation to the next.

Cattle breeds reared in Rwanda can be divided into three categories: Indigenous, imported, and cross breeds. A study conducted in Nyagatare District, Eastern Province, found that 67.03% of cattle in the district were Indigenous breeds, 28.37% were cross breeds, and 4.6% were imported breeds (Mazimpaka, 2017).

**Figure 1: Imported-breed cattle, Musanze District**



Photo source: Vedaste Ndungutse





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Imported breeds were introduced in Rwanda due to the low milk production of Indigenous breeds. However, these imported breeds are very susceptible to disease, and thus the government encourages cross-breeding between imported and local Indigenous breeds (Mazimpaka, 2017). The government also promotes the rearing of fully Indigenous breeds, due to their resilience to disease (Hirwa et al., 2017a). Indigenous cattle also have better heat tolerance, and adapt more easily to low quality food and limited quantity of feeds (Hirwa et al., 2017a). Indigenous breeds are also more resilient to tsetse flies, whose attack is often fatal for foreign breeds (Hirwa et al., 2017a; Mazimpaka, 2017).

Approximately 40% of cattle in Rwanda are fed via open grazing, with the rest fed via semi-grazing, which is a hybrid between open grazing and zero-grazing (where all feeds are transported to pens to feed animals) (USAID Rwanda, 2016). The Rwandan Government encourages zero-grazing, due to a shortage of land and in order to prevent the land degradation caused by open grazing (USAID Rwanda, 2016). Research conducted in Nyagatare District reported that 23.3% of cattle are being fed through zero-grazing (Mazimpaka, 2017).

More than 600 Rwandan Indigenous plant species are used as herbs in cosmetics, agriculture, food and beverage production, traditional medicine, and construction (Rwanda Environment Management Authority, 2019). In the areas surrounding Buhanga Forest in the Northern Province—specifically in Bikara Cell, Nkotsi Sector, Musanze District—around 45 herbs belonging to 28 families have been identified as useful in Indigenous medicine (Runyambo et al., 2016). In Buhanga Forest, six plant species have been identified that are traditionally used in treating cattle diseases, while another three species have been identified as being used for the traditional treatment of both cattle and human diseases (Runyambo et al., 2016).

Traditionally, Rwanda's pastoralists prepare medicine in the form of juice by pounding or crushing plant parts with wood or stone. Water is then typically used to dilute the juice (Runyambo et al., 2016). In Rwanda's Indigenous veterinary medical practice, medicine is administered through oral application 84% of the time, through external application on the skin 8% of the time, through the ears 5% of the time, and as an anal application 3% of the time, depending on the infected part of the animal and the type of disease (Runyambo et al., 2016).

At the same time, veterinary doctors providing modern treatments are located all over the country, and thus most livestock holders in Rwanda, if they have the resources to pay for the service, have ready access to a veterinary doctor to take care of their sick animals.

The Government of Rwanda recognises the value of Indigenous knowledge. There is a public policy on traditional human medicine, and a forum of about 3,000 traditional healers operating all over the country with government-sponsored training (Rwanda Environment Management Authority, 2019). Rwanda has signed the Nagoya[1] and Swakopmund[2] Protocols and the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) for the use and protection of Indigenous knowledge, including farmers' practices (Rwanda Environment Management Authority, 2019).

***Rwandan TVET provision***

TVET was introduced in the Rwandan education system following a 2009 national audit that indicated a 60% shortage of skilled people in the country (Kiberu et al., 2009). The number of Vocational Training Centres (VTCs) grew from 61 in 2010 to 116 in 2012, resulting in a roughly 50% increase in TVET enrolment (Ministry of Education, 2013). In 2013, for every 10 students attending TVET schools, eight were from rural areas, compared to 2005, when there were only four rural-origin students for every 10 TVET learners (Ministry of Education, 2013).

The policy establishing TVET is aligned with, among others, Rwanda's Science, Technology, and Innovation (STI) Policy and its National Employment Policy (Ministry of Education, 2008a). The training offered under TVET aims to respond to the labour market in the country and in the broader East African region (Ministry of Education, 2008b). In 2009, the government established the Workforce Development Authority (WDA), responsible for coordinating TVET via the identification of subjects to be taught; the development of curricula; the training of teachers; the provision of examinations; and the certification, accreditation, regulation, and inspection of TVET institutions (Ministry of Education, 2013).

In its curriculum development work, the WDA considers the labour market needs of the private sector and potential employers, who are included in curriculum development meetings. Emphasis is placed on hands-on skills, with more hours allocated to practical activities than to theoretical learning. In order to be part of the TVET curriculum development process, a TVET teacher must possess knowledge and skills in the subject matter being developed; knowledge and skills in information and communication technologies (ICTs); and a minimum of three years of teaching experience built around learner-centred, competence-based curricula.

## 4. Findings on livestock farmers' use of Indigenous treatments

Of the six experienced livestock farmers interviewed, most stated that they learned livestock farming from their parents, with one specifying that he also acquired knowledge from other livestock farmers. All four of the younger, less-experienced

1 Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity.
2 Swakopmund Protocol on the Protection of Traditional Knowledge and Expressions of Folklore.





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livestock farmers interviewed said they learned livestock farming from their parents and grandparents.

When asked if they have used traditional cures to treat sick animals, all six of the experienced farmers, and three of the four less-experienced farmers, said they have done so, and gave numerous examples (Table 1). The experienced farmers were found to have far more knowledge of the Indigenous treatments than the younger farmers.

**Table 1: Indigenous treatments of cattle, as identified by farmer interviewees**

| Ailment | Symptoms | Treatments, and medicinal substances used |
|---|---|---|
| *rutandara*, or *intandara* | retention of fluids in the mouth of the cow<br><br>increased temperature, unstable limbs, immobility, refusal to graze | • A blood vessel located on the neck of the cow is cut and allowed to bleed (a process known as *irago* in Kinyarwanda).<br>• Leaves of traditional *Colocasia* are pounded, mixed with water, and administered orally to the animal.<br>• The *Tetradenia riparia (Umuravumba)* plant is administered orally (dosage depends on the animal's age).<br>• The *Umusange* (*Entada abyssinica*) plant is mixed with a *Colocasia* plant called *Iteke* and administered orally.<br>• The animal is beaten using *Acanthus pubescens (Amatovu)*, a plant with thorns (a remedy known to be especially effective and allowing for speedy recovery of the sick animal). |
| *Ikibagarira*, or *inka igira umuriro mwinshi* | fever caused by ticks | • The *Ikibomwe* plant is administered orally to the animal (a remedy said to not be very effective, with many cows dying even after receiving the treatment).<br>• A hot knife is used to burn the Ganglion cysts, caused by fever, under the ears. |
| *gufuma* | retained placenta: inability to release placenta and afterbirth from the uterus after delivery | One of these two treatments is implemented to induce release if a cow's placenta and afterbirth are not released within six hours of giving birth (if not treated, a retained placenta can cause complications, include heavy bleeding and infection, which can be detrimental):<br>• The *Phyllanthus nummulariifolius (Umuhanurankuba)* or *Umuhoko* (*Phytolacca dodecandra)* plant is pounded, mixed with water, and administered orally.<br>• The *Umuyobora* and *Umubogora* herbs are pounded, mixed with water, and administered orally.<br><br>As a preventive measure, animals are given the pounded leaves of *Umuhoko* or *Ikawa* mixed in water orally, minutes after delivery, in order to speed up the process of placenta and afterbirth discharge. |
| *Akanyaga* | general body pain, lethargy, loss of hair on skin | • Approximately 3 to 4 litres of blood are bled from the cow via the process known as *irago* (see treatment of *rutandara* above). Then animal hair is used to stop the bleeding, while *umwumano* (milk from a cow in gestation) is poured over the hair to bind the hair to the incision.<br>• Another treatment, mentioned by a single farmer among the experienced male farmers, is to collect human bodily fluids, after sexual intercourse, on a towel, and then rub the fluids on the body of the animal (in order to prevent the disease from progressing to the hair-loss stage). |
| *Uruhiga* or *amashyuyo* | fever, causing disruption of feeding and loss of weight | • The cow is bled via the *irago* process (see treatment of *rutandara* above), and then taken to a place where there is plentiful feed and encouraged to eat to its satisfaction. |
| *Ibyashi* | fungal infection between the hooves | • Faecal matter of a hen in incubation (*amatoto y'inkoko irariye*) is rubbed on the infected area.<br>• Cow butter (*amavutay'inka*) is heated and melted on the infected area.<br>• Black "charcoal" from a disused radio battery is rubbed on the infected area. |
| *Ifumbi* | mastitis: pus and blood coming from teats | • The herbs *Mitragyne rubrostipulosa (Umuzibaziba)*, *Umunkamba, Umukuzanyana*, *Umutanga*, and *n' imizi y'umutarishonga* are administered orally. |
| *Ubutaka* | fever, difficulty in breathing | • The *Umusange* and *Magaru* herbs, and a banana species called *Intokatoki*, are mixed together and administered orally. (During the treatment, the cow is not provided with bedding, i.e., is not given organic materials such as straw and sawdust usually put in the pen to support the animal when at rest.) |
| *impiswi* | diarrhoea | • The *Umuhati, Umuzingangore* and *Idoma* herbs (and sometimes also the *Umunaba* plant) are administered orally.<br>• *Englerina schubotziana/solanaceae/solanum sp (Umutobotobo utagiraamahwa)* (without the thorns) is administered orally. |
| *Amata acika* | production of sedimented, non-homogenised milk | • The *Magaru, Umureterezaho, Umuzigangore* herbs, and *Englerina schubotziana/solanaceae/solanum sp (Umutobotobo utagiraamahwa)* (without the thorns) are administered orally. |
| *Inkubasi* | increased temperature in feet and legs, with liquids dripping from the mouth and nose (usually occurs in early months of gestation) | • *Umusange* herbs are administered orally. |
| *Umuzimire* | blood in faeces | • *Umuzigangore* herbs are administered orally. |







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**Figure 2: Cow treated for mastitis**



**Researcher with cow that has been cured of *ifumbi* (mastitis) with medicinal herbs, Musanze District**
Photo source: Vedaste Ndungutse

All the farmers, both experienced and less-experienced, unanimously agreed that Indigenous treatments are still effective for animal disease treatment. Another farmer indicated that he is no longer using Indigenous methods to treat his animals because, in his experience, the necessary herbs have become difficult to find. One farmer, who presently keeps only imported cows (also called "exotic" cows by farmers), pointed out that Indigenous medicine tends to be practised mostly on Indigenous cows, especially in rural areas. However, at the same time, he confirmed that for diseases such as *rutandara* and *akanyaga*, he still uses traditional methods, even for his imported cows.

All the farmers were of the view that remedies based on Indigenous knowledge are much more cost-effective than their Western counterparts. Despite the availability of government subsidies and generous livestock insurance programmes, many of the farmers still find the cost of Western-method treatments for their cattle to be beyond their means. In the words of one respondent farmer:

> Modern medicine is very expensive. [The] traditional one is cheaper, and with 2,000 Rwandan francs [approx. USD2.20], an animal can be treated with Indigenous methods since plants used are obtained locally.

According to another farmer:

> Modern medicine is very effective. Animals are treated after consultation to be sure of the disease to be treated. However, it is very expensive. Indigenous medicine is cheaper. In some cases, you offer one bottle of local banana wine to a traditional healer after he has healed the animal.





All respondent farmers were generally of the view that modern veterinary medicine is superior in most respects to Indigenous medicine. There was consensus that modern veterinary medicine excels in diagnoses and in the precise prescription of a remedy to treat identified disease, while traditional veterinary medicine lacks this kind of diagnostic precision. With Indigenous treatments, the dosage regimes and treatment strategies are not precise. Sometimes several different herbs are given to the animals without knowing exactly which one is most effective. The lack of precision can sometimes result in animal fatalities.

The respondents identified some modern veterinary medicinal remedies or practices for which there are no Indigenous alternatives or equivalents, including the procedures of artificial insemination and Caesarean section. At the same time, one farmer pointed out that some diseases, such as *akanyaga* and *rutandara*, are best treated with Indigenous medicine. This farmer did, however, agree that some ailments are more efficiently treated with modern medicine, citing the example of *ikibagarira*:

> Traditionally, we did not know the cause of *ikibagarira*. It was in 1980 that we were trained on its cause, where they told us that it is caused by ticks. Since then, modern medicine has been used mostly in the treatment of *ikibagarira* very well.

It is widely felt that foreign-breed cows should be treated using only modern medicine, while Indigenous cattle (and cross breeds) can be treated using both Indigenous and modern remedies. One of the interviewees noted that fewer and fewer farmers are using Indigenous treatments—in part because of the many new diseases that have come to Rwanda with the introduction of foreign cattle breeds. Another reason given for the decline in the use of Indigenous treatment methods is the government mandate that a veterinary doctor is to be called whenever a cow is sick.

One farmer was of the view that Indigenous and modern medicines are complementary, although he added that modern medicine is superior. Some of the farmers reported that for most ailments suffered by their livestock, they first commence treatment using Indigenous treatment methods, with a veterinary doctor sought only when traditional cures fail or where no traditional cure is known.

## 5. Findings on TVET Animal Health instruction

### *Curriculum content*

In our review of the curriculum documents for Rwanda's TVET Animal Health certificate and diploma programmes, we found that there is no Indigenous knowledge content (WDA, n.d.). The curricula could easily be applicable to any European or North American country. And although Kinyarwanda is the language most easily understood by many TVET students and teachers, none of the curriculum content is in Kinyarwanda. There is no indication that students serviced by the curriculum are



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going to apply their trades in locations where longstanding Indigenous knowledge and Indigenous animal health practices are present. There is, in fact, no mention of the Rwandan context in the curriculum.

***Farmers' views***

Most of the farmers interviewed were found to be in favour of the idea of incorporating Indigenous knowledge into the TVET Animal Health curriculum. The most prevalent view was that the TVET courses should teach students how to use local herbs in treating animal diseases and how to effectively combine them with modern veterinary medicine. There was also a widely held view that including Indigenous knowledge in the curriculum would allow useful animal health Indigenous knowledge to spread all over the country, rather than being, in some cases, localised within districts.

Only two farmers had opinions that diverged strongly from the others. One believed that including Indigenous knowledge in the TVET curriculum should be for the purpose of cultural preservation only, and that students should be taught to conduct all treatments using modern medicine. The other was of the opinion that modern medicine had effectively replaced its Indigenous counterpart, and that, accordingly, teaching Indigenous knowledge at TVET schools would amount to teaching "backwardness". Thus, in his view, there is no need to include Indigenous knowledge in the TVET Animal Health curriculum.

***Graduates' views***

All five of the TVET Animal Health graduates interviewed said they are aware of the value that traditional livestock farmers attach to Indigenous animal health treatments. They also confirmed that they were not taught any form of Indigenous animal health knowledge during their TVET studies. Four of the five graduates interviewed did not consider the curriculum's exclusion of Indigenous knowledge to be problematic. According to one of these four respondents, "it is not necessary to add Indigenous knowledge in TVET curriculum. We have veterinary doctors who are trained, and their knowledge is enough." According to another of the four respondents not concerned with the absence of Indigenous knowledge in the curriculum, "modern medicine is more trustable, and we advise livestock farmers to use it rather than [the] Indigenous one".

In the view of these four respondents, such knowledge is only fit to be passed on orally from generation to generation, since it is "archaic" and was only used prior to the advent of modern veterinary medicine. One of the four expressed his conviction that, by every standard, modern veterinary medicine is superior to Indigenous medicine, and that any contrary belief is only upheld in some rural areas: "[These] few remote areas are behind in development. Therefore, the adoption of modern vet medicine is slow." Another stated that livestock farmers often try to convince him that Indigenous knowledge is superior to modern knowledge in the treatment of certain diseases, but his response is always to advise them to rely only on modern medicine. One of the four was of the view that Indigenous treatments can have severe side-effects, especially for foreign breeds that do not tolerate traditional medicine, and can even lead to livestock death.

The one respondent with a differing perspective was of the view that Indigenous medicine is as important as modern medicine, because in many cases animals can be treated and healed through its application. Thus, in this respondent's opinion, teaching Indigenous ethno-veterinary knowledge in TVET schools is necessary to equip students with all the available skills required for livestock management.

All five of the TVET graduates interviewed listed the disadvantages of Indigenous animal medicine when compared to Western approaches, including the concern that, with Indigenous medicine, inaccurate diagnoses result in high rates of fatality, and the concern that there is a lack of standardisation of dosages. With modern veterinary health care, they pointed out, diagnosis is much more precise, and the administration of medicine follows scientifically established dosages. One graduate now working as a vet practitioner observed that—unfortunately, in his view—the low cost of Indigenous medicine, compared to paying for the services of trained vets, has a countervailing effect on the patronage of animal clinics and formal veterinary medical practices.

***Teachers' views***

All three TVET Animal Health teachers interviewed were aware of the existence and use of Indigenous knowledge in animal health in Rwanda. However, they all said that they consider modern medicine to be far more efficacious than Indigenous medicine, on the grounds that livestock farmers who use Indigenous cures also need modern medicine, while others use only modern cures and do not need Indigenous medicine.

Two of the teachers said they have never incorporated Indigenous knowledge into their teaching or encouraged its discussion in class. According to one,

> Indigenous knowledge is allowed [as] it is a localised knowledge. It varies from one area to another. There is no regulation restricting people to teach it. Myself, I do not teach Indigenous knowledge because I do not know it. I only teach modern medicine.

The second teacher who does not incorporate Indigenous knowledge into his teaching said he believes that teaching such knowledge is not appropriate, and not allowed in the classroom, since it is not relevant, as "TVET is about teaching students modern medicine which is up to date." According to these two teachers, the TVET





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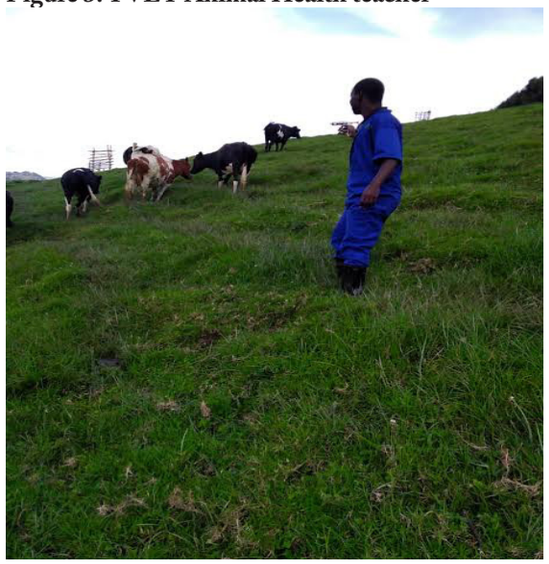
students are not interested in Indigenous knowledge, as they come to school to learn about modern medicine.

**Figure 3: TVET Animal Health teacher**



**TVET teacher with grazing cattle, Muhanga District**
Photo source: Vedaste Ndunguste

The third teacher interviewed, however, was of the view that Rwanda's Indigenous ethno-veterinary knowledge can assist TVET Animal Health students when they graduate and go into the field. This is so, he said, because in his understanding some ailments are treatable only by Indigenous methods, with no available treatment in modern veterinary medicine. He added that, given the percentage of Indigenous cattle in Rwanda, it is important to ensure that Indigenous knowledge of animal husbandry is not marginalised. If incorporated into the TVET Animal Health curriculum, Indigenous treatments would complement modern medicine. The teacher also stated that, even though it is not part of the curriculum, he sometimes includes Indigenous knowledge in his teaching. For instance, he sometimes references the practice of treating animals with charcoal, the practice of treating animals with cow butter (*amavutay'inka*), and the process known as *kwina*, in which Indigenous medicine is administered to the animal anally through a piece of local bamboo straw, usually as a treatment for constipation. He does this because, in his view, many students are interested in knowing about Indigenous treatments.

The two teachers who had participated in developing the TVET Animal Health curriculum confirmed that Rwanda's Indigenous knowledge is not considered during curriculum development. One of the two said this lack of inclusion of Indigenous





practices contrasted with government support for Indigenous knowledge in other sectors. He pointed to the example of the certification given by the government, through the Ministry of Health, to Indigenous knowledge practitioners of human medicine.

## 6. Analysis, conclusions and recommendations

It is clear in the findings of this study that Indigenous knowledge of cattle treatments is both held and used by rural livestock farmers in Rwanda and, at the same time, that such knowledge is not being supported by the country's TVET Animal Health curriculum. The livestock farmers interviewed hold nuanced views about the interfaces between Indigenous and modern Western treatments for their cattle. The farmers, both experienced and less-experienced, know about the Indigenous techniques, and all but one of the farmers has used them on their cattle, either directly or with the assistance of traditional animal health practitioners. A key advantage of Indigenous medicine cited by the farmers is its cost-effectiveness, with the use of modern treatments, via modern veterinary clinics, being prohibitively expensive and thus only used as a last resort or for ailments not treatable using traditional means. The farmers do, at the same time, acknowledge the greater precision and predictability of modern veterinary treatments, and the greater efficacy of modern treatments for foreign breeds of cattle (with Indigenous breeds and cross breeds seen as compatible with effective treatment by both Indigenous and modern methods).

Meanwhile, in TVET Animal Health education, the Indigenous medicinal knowledge known and practised by rural livestock farmers is not provided for in any meaningful way. The TVET Animal Health curriculum covers none of the Indigenous knowledge detailed by the farmers in the research interviews. Moreover, four of the five TVET Animal Health graduates interviewed, and two of the three TVET Animal Health teachers interviewed, see absolutely no value in making Indigenous animal health treatments part of TVET instruction—and even the one graduate and one teacher who see some value in making TVET learners aware of such knowledge do not see the need for it to be part of the formal curriculum. The TVET graduates, who in their work as vets and animal pharmacists interact with rural livestock farmers, are not equipped with the knowledge necessary to optimally interact with these farmers.

To be relevant to the continent's overall advancement, Africa's education curricula need to incorporate the continent's Indigenous knowledge and practices across numerous fields and sectors (Msila, 2016). In the planning and development of curricula, knowledge that is Indigenous to learners' locales must be infused generously, with the aim of such knowledge being appropriate human-centred development. As seen in the passage quoted earlier in this article from UNESCO, there is global recognition among education policymakers of the "urgent need to enhance the



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intergenerational transmission of indigenous knowledge" and "to bring indigenous language and knowledge into school curricula" (UNESCO, n.d.).

Rwandan policymakers need to pursue several elements if they wish to build Indigenous knowledge into the country's TVET Animal Health curriculum. At the foundation is a need for research into Rwandan Indigenous animal health knowledge, and the widespread dissemination of these research findings. Research is also needed into ways of improving Indigenous animal health practices in Rwanda, as the farmer respondents noted that lack of precision in dosages, and uncertainty about which herbs work for which disease, hinder the effectiveness of Indigenous treatments. Western medicine, which many respondents in this study consider to be much more efficacious, is itself evolutionary, refined through centuries of research and development in order to attain the legitimacy and trust currently ascribed to it. Accordingly, there is a need to prioritise the establishment of research laboratories dedicated to indigenous Rwandan animal health by the nation's Ministry of Education, and specifically the Ministry's Directorate for Science, Technology and Research (DSTR).

Another important element is teacher training. Before the TVET Animal Health curriculum can be transformed, teachers must be educated about using Indigenous knowledge for Africa's advancement. Such training can be located within the larger UN SDGs framework, with appreciation of Indigenous knowledge presented as a prerequisite for sustainable development. That exercise should aim to foster appreciation of cultural diversity across all sectors, not only agriculture.

Another crucial element is the preservation and expansion of Rwanda's biodiversity. As noted by one of the farmer interviewees in this study, some of the herbs used to effectively treat certain diseases in animals are no longer available in abundance. One way in which Rwandan biodiversity relevant to Indigenous animal health care could be preserved is through the creation of herbal nurseries at TVET schools, where efforts could be made to cultivate known local herbs that are used in, inter alia, animal health maintenance. Such herbaria or farms could be maintained by TVET students and teachers, in cooperation with community-based Indigenous knowledge practitioners.

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# Supervised Machine Learning for Predicting SMME Sales: An Evaluation of Three Algorithms

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**Abstract**
The emergence of machine learning algorithms presents the opportunity for a variety of stakeholders to perform advanced predictive analytics and to make informed decisions. However, to date there have been few studies in developing countries that evaluate the performance of such algorithms—with the result that pertinent stakeholders lack an informed basis for selecting appropriate techniques for modelling tasks. This study aims to address this gap by evaluating the performance of three machine learning techniques: ordinary least squares (OLS), least absolute shrinkage and selection operator (LASSO), and artificial neural networks (ANNs). These techniques are evaluated in respect of their ability to perform predictive modelling of the sales performance of small, medium and micro enterprises (SMMEs) engaged in manufacturing. The evaluation finds that the ANNs algorithm's performance is far superior to that of the other two techniques, OLS and LASSO, in predicting the SMMEs' sales performance.

**Keywords**
supervised machine learning, algorithms, sales predictive modelling, ordinary least squares (OLS), least absolute shrinkage and selection operator (LASSO), artificial neural networks (ANNs), small, medium and micro enterprises (SMMEs)

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## 1. Introduction

Today's organisations, both small and large, handle increasingly large amounts of data, and the amounts are expected to continue to grow exponentially (Cheriyan et al., 2018; Ndikum, 2020). Ndikum (2020) notes that human beings generate and store in excess of 2.5 quintillion bytes of data daily. Inevitably, the availability of such huge amounts of data has provided an impetus for organisations to harness efficient and flexible methods to conduct predictive analytics and inform data-driven future plans (Bajari et al., 2015; Leo et al., 2019; Obaid et al., 2018).

Machine learning techniques are attracting the interest of numerous stakeholders, including private-sector entities seeking the means to intelligently exploit their data to aid decision-making and enhance their competitive advantage in the market (Dod & Sharma, 2010; Krishna et al., 2017; Tsoumakas, 2019). Kolkman and Van Witteloostuijn (2019) explain that machine learning enables businesses to perform advanced predictive modelling to an extent not possible with traditional statistical techniques (Leo et al., 2019; Van Liebergen, 2017). Machine learning has been widely embraced for a variety of purposes, including financial modelling, health and safety analysis, medical diagnosis, and fraud detection (Crane-Droesch, 2017; Enkono & Suresh, 2020; Gholizadeh et al., 2018; Mohammed et al., 2016). Machine learning techniques have also been embraced for predicting market demand and consumer behaviour (Bajari et al., 2015; Sekban, 2019; Tsoumakas, 2019; Venishetty, 2019). The power of machine learning has attracted significant interest from numerous players, including business owners, data scientists, and econometricians (Bajari et al., 2015; Sekban, 2019; Venishetty, 2019).

Sales predictions are one of the most important elements of business operations, including for small-sized firms seeking to sustainably increase sales in order to enhance their chances of survival (Sekban, 2019; Venishetty, 2019). The rise of advanced data analytics techniques provides SMMEs with opportunities to conduct sales performance predictive modelling (Krishna et al., 2017; Tsoumakas, 2019). However, despite their significant contribution to predictive analytics, machine learning techniques have not yet been fully exploited in small enterprises' research and practice. The existing literature provides very few studies on SMMEs' use of machine learning in developed countries or in developing countries such as South Africa (Bauer, 2020; Haataja, 2016; Kolkman & Van Witteloostuijn, 2019; Te, 2018).

In respect of machine learning algorithms, Ryll and Seidens (2019) note that the extant literature lacks an evaluation of the various algorithms' effectiveness. The result is that stakeholders are likely to arbitrarily select an algorithm, without any scientific basis for their choice. Identification of the best-performing predictive techniques for particular settings and purposes would provide stakeholders with bases for deciding which to use.





To address this gap in the South African context, our study evaluated the performance of three supervised machine learning algorithms that can be used to conduct sales predictive modelling: OLS, LASSO, and ANNs. The algorithms' ability to predict SMME sales performance was evaluated using a panel dataset of manufacturing SMMEs in South Africa's KwaZulu-Natal (KZN) Province.

## 2. Machine learning

According to Ryll and Seidens (2019), the concept of machine learning, despite its growing popularity, remains ill-defined in extant literature. The authors define it as a process through which a system interacts with its environment in such a way that the system's structure changes and, owing to structural alterations, the interaction process changes as well. Shalev-Shwartz and Ben-David (2014) assert that machine learning is the detection of meaningful data patterns by algorithms in an automated way, essentially indicating that machine learning techniques endow programs with the ability to "learn" and adjust accordingly. This conception aligns with that of Goodfellow et al. (2016), who define machine learning as the ability of artificial intelligence (AI) systems to acquire knowledge by gleaning patterns from raw datasets. Lantz (2019) conceives machine learning as being concerned with techniques that process and transform data into actionable intelligence. Mohammed et al. (2016) describes machine learning as the enablement of machines to learn without explicit programming.

A key advantage of various machine learning techniques like ANNs is that they are non-parametric, i.e., they do not require features in the dataset to be normally distributed, as do some classical statistical modelling approaches (Kolkman & Van Witteloostuijn, 2019; Van Liebergen, 2017). This flexibility allows algorithms to learn, adapt, and in the process uncover subtle insights in data (Leo et al., 2019).

Research has shown that organisations which adopt machine learning algorithms for predictive modelling will benefit in many ways, including more effective strategic planning, resource optimisation, risk management, and inevitably enhanced competitive advantage (Cheriyan et al., 2018; Kolkman & Van Witteloostuijn, 2019; Leo et al., 2019). Krishna et al. (2017) have found that algorithms can be used to accelerate business performance and achieve long-term goals. One of the main areas in which machine learning techniques have been used is in sales performance predictive modelling (Sekban, 2019; Tsoumakas, 2019; Venishetty, 2019). This is because sales directly impact enterprise survival and long-term growth (Bauer, 2020; Sekban, 2019).

### *Supervised machine learning*

Machine learning techniques can be of either a supervised or unsupervised nature. *Unsupervised* techniques are used when dealing with unlabelled datasets (Mohammed et al., 2016; Venishetty, 2019). In unsupervised learning, the interest is more in the structure of the dataset as it is analysed, without specifying a response variable to predict (Aziz & Dowling, 2019; Mohammed et al., 2016; Van Liebergen, 2017).



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*Supervised* techniques are used when features in the dataset are labelled and the target variable is known and specified (Ryll & Seidens, 2019; Venishetty, 2019). In this study, the techniques used fall under the supervised paradigm.

Under the supervised machine learning paradigm, tasks are grouped into either classification or regression (Venishetty, 2019). *Classification* can be used, for instance, to predict (in this case) whether an SMME will grow (1) or not grow (0) in the next year, and this type of task is commonly termed a binary classification. On the other hand, *regression* tasks involve the prediction of a continuous variable, like (in this case) the prediction of an SMME's sales.

To ensure enhanced model performance, the common practice is to conduct *data partitioning*, i.e., dividing the data into two separate parts, commonly known as the *training* and *test* datasets (Bauer, 2020). *Training* data, which is labelled and thus "seen", is used for model-building, and the *test* data, which is unlabelled and thus "unseen", is used for model validation or testing (Mohammed et al., 2016; Te, 2018). This partitioning allows algorithms fitting well on training data to be checked to make sure they are not "overfitting" when applied to the test data (Mohammed et al., 2016). (Some algorithms might fare well on the training (seen) data but poorly on the test (unseen) data, and this is known as overfitting.) The training dataset is made up of input vector $X$ and output vector $Y$, both of which have labelled features. In the training phase, algorithms learn to approximate a function to produce $\hat{Y}$ which is also denoted $\hat{f}(X)$. Thus, through using different algorithms, as per Equation (1) below, a mapping function from $X$ to $Y$ is learned.

$$Y = f(X) + \varepsilon \qquad (1)$$

Based on Equation (1), $\varepsilon$ is the error term independent of the explanatory variables, and despite the performance of the mapping function this error cannot be reduced.

***Supervised machine learning tools***

Choosing an appropriate algorithm for any given task is not a trifling decision but an important one, because the results from the selected technique will influence and guide decision-making. As argued by Venishetty (2019), there is no "one-size-fits-all" machine learning technique for every problem and thus there is a need to evaluate and identify an appropriate algorithm for a given task. Various machine learning techniques have been used to solve regression problems such as sales modelling. OLS, LASSO, and ANNs are among the most extensively used algorithms for such learning tasks (Casella et al., 2017; Lantz, 2019; Melkumova & Shatskikh, 2017; Shalev-Shwartz & Ben-David, 2014).





*Ordinary least squares (OLS)*

The OLS technique, which is also generally referred to as the linear regression technique, is valued mainly for its ability to learn efficiently. It has been found to provide linear predictors that are not only intuitive and easily interpretable, but also perform reasonably well in fitting data in different natural learning problems (Casella et al., 2017; Shalev-Shwartz & Ben-David, 2014). This form of predictive technique is normally used in traditional statistical modelling when ascertaining causal relationships between response variables and dependent variables (Aziz & Dowling, 2019). In essence, this technique attempts to choose the slope and the intercept that minimise the sum of the squared errors—or, as described by Lantz (2019), to minimise the distance between the predicted and the actual target variable.

Expressed in mathematical terms, the goal of OLS regression modelling is to minimise the error ($e$), also known as the sum of squared residuals, which is the difference between predicted value $\hat{y}$ and the actual value $y$ as per Equation (2):

$$\sum (y_i - \hat{y}_i)^2 = \sum e_i^2 \qquad (2)$$

As can be noted in Equation (2), in order to eliminate negative values, the error values are squared and summed across all data points.

Key shortcomings with OLS are its linearity assumption between the response and predictor variables and its inability to deal with collinearity (Kolkman & Van Witteloostuijn, 2019; Van Liebergen, 2017). Nonetheless, OLS is one of the most popular techniques in academic research. Kolkman and Van Witteloostuijn (2019) describe OLS as the empirical "workhorse" in academia. The algorithm was included in this study as the traditional benchmark so as to enable cross-method comparisons with the two other algorithms evaluated.

*Least absolute shrinkage and selection operator (LASSO)*

The LASSO method is mainly used to achieve simultaneous parameter estimation and model selection in regression analysis (Muthukrishnan & Rohini, 2016). This algorithm zero weights covariates with low explanatory power and allows one to work with an interpretable parsimonious model (Aziz & Dowling, 2019; Leo et al., 2019; Melkumova & Shatskikh, 2017). Casella et al. (2017) find that the LASSO technique performs better than OLS, and another related technique called ridge regression, in predictive analytics. The LASSO technique shares similarities with OLS, save that, unlike the latter, LASSO employs the $\ell_1$ penalty function. In essence,



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LASSO is a simple OLS technique with feature selection and regularisation embedded in it. Following Muthukrishnan and Rohini (2016), we defined our LASSO estimates as per Equation (3) below:

$$\hat{\beta} = \arg\min_{\beta} \left\{ \frac{1}{2} \sum_{i=1}^{N} \left( y_i - \beta_0 - \sum_{j=1}^{p} x_{ij} \beta_0 \right)^2 + \lambda \sum_{j=1}^{p} |\beta_j| \right\} \qquad (3)$$

Based on Equation (3), $\lambda \geq 0$ is a tuning parameter, and when $\lambda = 0$ the penalty has no effect and LASSO will produce similar estimates to those of least squares. However, $\lambda \rightarrow \infty$, $\ell_1$ forces some of the coefficient estimates to zero, thereby performing forward-looking variable selection. LASSO effectively deals with the problem of collinearity among predictors by selecting only one and shrinking other variables to zero, thereby producing stable and accurate predictions (Casella et al., 2017; Muthukrishnan & Rohini, 2016).

*Artificial neural networks (ANNs)*

ANN algorithms are inspired by the structure of the internal functioning of the human brain and nervous system (Shalev-Shwartz & Ben-David, 2014). The technique aims to solve problems by mimicking the human brain, through learning from past experiences and then making use of those learnings as a basis for making future decisions. This technique differs from traditional statistical techniques in that it is non-parametric, i.e., it makes no presumptions on the data distribution (Youn & Gu, 2010). ANN algorithms have become popular for implementing machine learning (Krishna et al., 2017) owing to their ability to yield an effective learning paradigm that produces excellent performance on various learning tasks (Shalev-Shwartz & Ben-David, 2014). The neural network is a network of connected nodes, and for each node, inputs are summed before being linearly transformed. Equation (4) presents an ANN mathematically:

$$o = \sum_{i=1}^{n} w_i x_i + b \qquad (4)$$

Where $x_i$ is the $i$th input to the ANN node, $w_i$ the $i$th input weight, $n$ the number of inputs, $b$ the bias term and $o$ the node output.

The motivations for the adoption of this technique include its flexibility—in increasingly complex data structures—in addressing outliers, missing data, multicollinearity, and nonlinearities (Gepp & Kumar, 2012; Merkel et al., 2018). The advantage of ANN algorithms lies in their versatility, as they can be applied to virtually any learning task,





be it regression, classification, or even unsupervised learning tasks (Leo et al., 2019; Youn & Gu, 2010). The class of ANN we used in this study is the multilayer perceptron (MLP), which is also referred to as a multilayer feedforward network (Lantz, 2019).

***Existing comparative findings on the three tools***

Findings reported in the existing literature shown that, generally, in terms of predictive performance across different fields, ANN algorithms perform better than OLS. Nghiep and Al (2001) find that compared to the OLS technique, ANNs performed better in predicting residential property value. This finding is in line with the Farahani et al. (2016) study, which evaluates the performance of ANNs and OLS techniques to predict car sales and finds ANNs superior. Ahangar et al. (2010) establish the superior performance of ANNs compared to OLS in predicting the stock price of listed companies. Croda et al. (2019) establish that ANNs have a very high predictive accuracy compared to traditional statistical techniques in sales forecasting, even when presented with a small dataset. Accordingly, alternative methods aiming to improve OLS, such as the LASSO technique as per Equation (3), have been established (Casella et al., 2017; Tibshirani, 2011).

Ratnasena et al. (2021) find that compared to ANNs, the LASSO technique more accurately predicts the condition of tapes in sampled US cultural heritage institutions. Das et al. (2018) find that LASSO performs better than both ANNs and (as expected) OLS in predicting rice yields in India. Castelli et al. (2020) find that LASSO is more accurate than ANNs in predicting online property trends in Bulgaria. Utilising European Environmental Agency air pollution data, Chen et al. (2019) find that both LASSO and OLS have superior predictive performance compared to the ANNs in predicting the annual average concentration of fine particle and nitrogen dioxide across Europe.

Strandberg and Låås (2019), using data on Swedish companies, find that ANNs perform significantly better than LASSO in predicting sales performance.

Droomer and Bekker (2020), utilising a large database of US online grocery stores, find that ANNs outperform other modern and complex algorithms like XGBoost in predicting customers' purchasing behaviour. Croda et al. (2019), using a small Mexican chemicals wholesaler dataset, establish that ANNs produce highly accurate sales predictions. Wang et al. (2019) demonstrate the high accuracy of ANNs in predicting the annual sales of Taiwanese manufacturing enterprises. Penpece and Elma (2014) show that ANNs produce sales predictions that are close to the actual data of Turkish retail stores.



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## 3. Study design and methodology

The study used R version 3.6.3, an open source software developed by the R Development Core Team (2019).

### *Dataset preparation*

The three-year longitudinal dataset, containing information on 191 manufacturing SMMEs in KwaZulu-Natal Province for the years 2015 to 2017, was accessed from McFah Consultancy, a Durban-based company focusing on business and tax advisory services for SMMEs. The majority of the SMMEs (61%) in the dataset were from eThekwini Metropolitan Municipality (greater Durban), followed by King Cetshwayo District (11%), uThukela District (10%), uMgungundlovu District (7%), iLembe District (3%), Amajuba District (3%), Ugu District (2%), Zululand District (2%), uMzinyathi District (1%) and uMkhanyakude District (1%). There were no SMMEs from Harry Gwala District. The data had the following features: sales, owner's gender, enterprise location, owner's year of birth, total assets value, permanent employees, temporary employees, digital marketing medium use, website use, enterprise registration type, and registration year. Three macroeconomic variables were also included in the dataset: gross domestic product (GDP) and unemployment statistics from Statistics South Africa (2018), and the purchasing managers' index (PMI) from the Bureau for Economic Research (n.d.).

*Target variable*

Since the interest, for this study, was in evaluating the predictive potency of OLS, LASSO, and ANNs with respect to enterprise performance, it was important to define the target variable based on the dataset. In line with previous studies, enterprise performance was proxied by sales (Buyinza, 2011; Panda, 2015; Phillipson et al., 2019), which we coded as LogSales.

*Independent variables*

Total assets were coded as LogTA, total number of permanent workers as Pemp, number of temporary workers as Temp, and labour productivity, which was measured by sales per employee, was coded as Prod. The SMME owner's gender—proxied by 1 for male and 0 for female—was coded as Gen. The SMME owner's age, which was measured as the difference between the panel dataset period (2015 to 2017) and year of birth, was coded as EntAge. Having a website—proxied by 1 for enterprises with a website and 0 for those without—was coded as Web. The company's age, which was coded as CoAge, was measured as the difference between the panel data period and





the year of registration. The SMME's registration type, which was the legal structure of the participating enterprises, was defined by 1 for limited liability registered enterprises and 0 for other, and this variable was coded as Reg. For digital marketing, coded as DigMkt, the dummy variable 1 was used for those using one or more of three digital marketing platforms (Facebook, Twitter, and Instagram) and 0 for those not using any of these platforms. SMME location, coded as Loc, was proxied by 1 for those based in eThekwini Metropolitan Municipality and 0 for those located in district municipalities.

Three additional polynomial features were constructed to assess the nonlinear effects of these variables on enterprise performance. These were the owner's age squared (EntAge2), the SMME's age squared (CoAge2), and temporary workers squared (Temp2).

Finally, three external variables were used: the national annual economic growth rate, coded as GDP; the national unemployment rate, coded as Unemp; and the purchasing managers' index, coded as PMI, calculated as the average annual PMI rate for each of the three years between 2015 and 2017. Exploratory analysis showed that the dataset was not stationery; to address this, we followed Curran-Everett (2018) by log transforming all continuous variables (i.e., sales, total assets, permanent workers, temporary workers, productivity, owners' ages, and SMMEs' ages). Consequently, the transformation stabilised the variance of all continuous variables.

### *Hypothesis-testing*

Model-building was done after conducting hypotheses tests to establish variables with an impact on sales performance. Hypothesis testing is an important step in model building, as this enables the identification of key factors which impact the target variable (Punam et al., 2018). The benefit of this step is that the data features selected for training the algorithm are those that best explains sales performance, and irrelevant features, which tend to adversely impact model accuracy due to data redundancy, are removed. Furthermore, a model built using important variables tends to minimise the challenge of overfitting, the model training time is significantly reduced, and overall, the model performs better when applied to real world problems (Venishetty, 2019). An in-depth literature review was thus conducted, and Table 1 provides the 13 hypotheses that were derived for empirical investigation to identify features with a significant effect on SMMEs' sales performance that were then used for model-building.



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**Table 1: Hypotheses**

| Hypothesis | Supporting literature |
|---|---|
| H1: Entrepreneur's gender has a significant effect on enterprise performance | (Amran, 2011; Bardasi et al., 2011; Essel et al., 2019) |
| H2: Entrepreneur's age has a significant nonlinear effect on enterprise performance | (Amran, 2011; De Kok et al., 2010; Kaunda, 2013) |
| H3: Labour productivity has a significant effect on enterprise performance | (Bellone et al., 2008; Bigsten & Gebreeyesus, 2007; Esteve-Pérez & Mañez-Castillejo, 2006) |
| H4: Permanent employees have a significant effect on enterprise performance | (Clinebell & Clinebell, 2007; Pauka, 2015; Thorsteinson, 2003) |
| H5: Temporary employees have a significant nonlinear effect on enterprise performance | (Chadwick & Flinchbaugh, 2016; Pauka, 2015; Roca-Puig et al., 2012;) |
| H6: Total assets have a significant effect on enterprise performance | (Al-Ani, 2013; Gupta et al., 2013; Maggina & Tsaklanganos, 2012) |
| H7: SMME's age has a significant nonlinear effect on enterprise performance | (Coad et al., 2018; Loderer & Waelchli, 2010; Rijkers et al., 2010) |
| H8: Limited liability registration type has a significant effect on enterprise performance | (Adegbite et al., 2007; Muriithi, 2017; Small Business Project, 2014;) |
| H9: Usage of digital media platforms significantly impacts enterprise performance | (Camilleri, 2018; Jobs & Gilfoil, 2014; Parsons, 2013) |
| H10: Website usage has a significant effect on enterprise performance | (Jobs & Gilfoil, 2014; Meroño-Cerdan & Soto-Acosta, 2005; Parsons, 2013) |
| H11: National unemployment rate has a significant effect on enterprise performance | (Halicioglu & Yolac, 2015; Huggins et al., 2017) |
| H12: GDP growth rate has a significant effect on enterprise performance | (Egbunike & Okerekeoti, 2018; Klapper & Richmond, 2011; Motoki & Gutierrez, 2015) |
| H13: PMI has a significant effect on enterprise performance | (Harris, 1991; Koenig, 2002) |

Note: Based on the consulted literature, three of the variables—entrepreneur's age, temporary workers and SMME's age—were each expected to have a nonlinear effect on performance. This suggests that over time, unlike the other 10 variables, each of these three was expected to have a turning point, i.e., a point when the variable switches from having a negative effect to having a positive effect (or vice versa) on firm performance.

To empirically test the above hypotheses, the random effects within between (REWB) panel data modelling technique (Bell et al., 2019) was used. The distinct advantage of REWB over other techniques, such as fixed effects or random effects, is that the former simultaneously captures both micro and macro associations of the independent variables on the target variable (Bell & Jones, 2015; Bell et al., 2019).

The hypotheses-testing step was important as it enabled us to identify drivers with a significant impact on the target variable, and to drop those without any material effect (Punam et al., 2018; Cheriyan et al., 2018). Eventually a total of 11 variables (including three polynomial features) were found to have a significant impact on enterprise sales performance:

- Prod, Pemp, Temp, Temp2, LogTA, CoAge and Unemp at 1% significance level;
- CoAge2 and DigMkt at 5% significance level; and
- EntAge and EntAge2 at 10% significance level.

These identified variables were then used in building the machine learning models for OLS, LASSO, and ANNs, which were then evaluated to establish which one has the superior sales predictive accuracy.

***Data partitioning, sales performance modelling, evaluation***

The next step was the dataset partitioning, which, as discussed above, is one of the critical elements in machine learning. For this study, following a related study (Delen et al., 2013), a 70:30 split ratio was used to generate the training and test datasets. Using these two datasets, three sales performance predictive models—one each for OLS, LASSO, and ANNs—were built and evaluated.

## 4. Findings and analysis

Figure 1 provides graphical representations of the predictive performance of each of the three algorithms—OLS, LASSO, and ANNs—on the test dataset. (The OLS algorithm was fit using the plm function in R. The LASSO algorithm was fit using the glmnet function in R, and 10-fold cross validation was performed to identify the optimal tuning parameter λ. The neuralnet function in R was used to fit the ANN algorithm, and the model with 2 neurons provided the best output and thus was used for further computations on the test dataset.)

The comparison shows that the OLS and LASSO algorithms' predictive performances are highly similar, and neither fits the data nearly as well as the ANN algorithm, which performs extremely well. Thus, the visualisations indicate that the ANN algorithm provides a more accurate sales predictions than do the other two algorithms.







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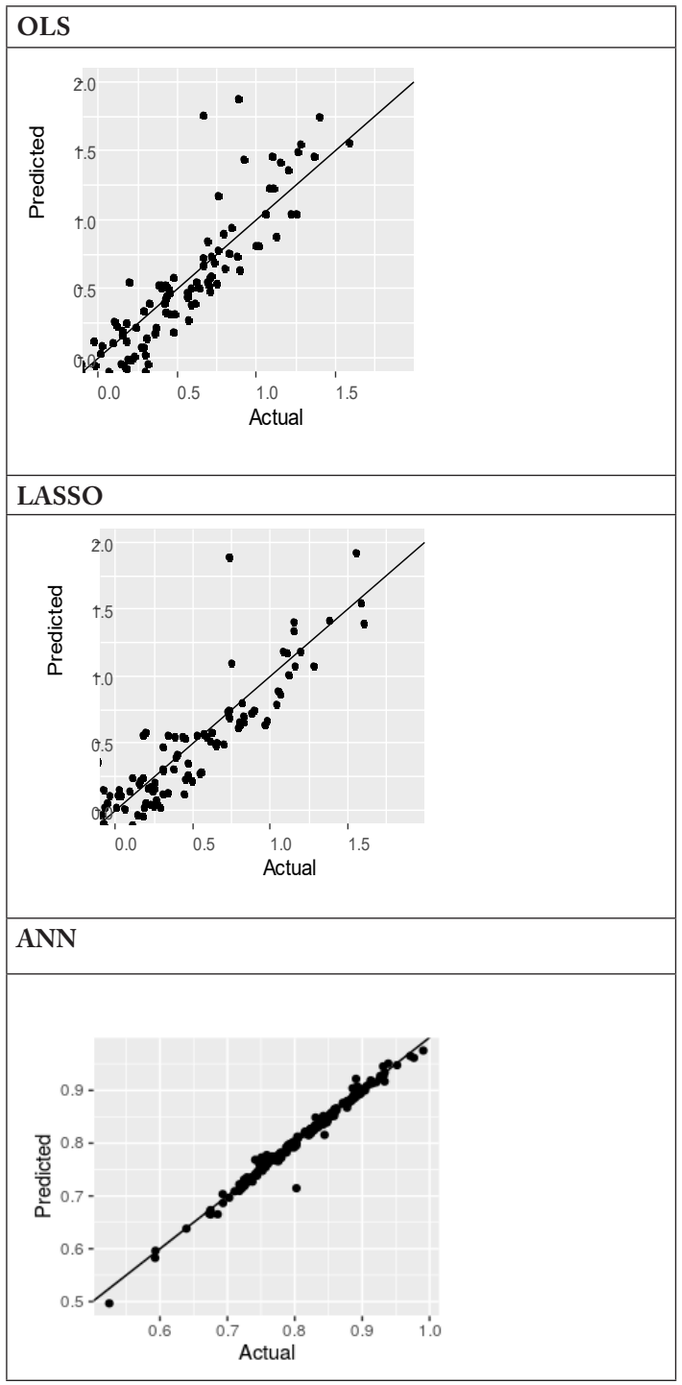
**Figure 1: Graphical representations of predictive performance**








We also more formally evaluated each technique's predictive performance using five established model evaluation metrics: mean squared error (MSE), root mean squared error (RMSE), mean absolute error (MAE), mean absolute scaled error (MASE), and median absolute error (MDAE) (Casella et al., 2017; Hyndman & Koehler, 2006; Kolkman & Van Witteloostuijn, 2019; Muthukrishnan & Rohini, 2016; Punam et al., 2018; Tsoumakas, 2019). For each of the assessment metrics, the lower the value the better the algorithm's performance in predicting SMMEs' sales. The formal evaluation of the predictive models is presented in Table 2.

**Table 2: Formal evaluation of predictive performance**

| | MSE | RMSE | MAE | MASE | MDAE |
|---|---|---|---|---|---|
| **OLS** | 1.085967 | 1.042097 | 0.4517873 | 0.6902265 | 0.2088684 |
| **LASSO** | 0.08130493 | 0.2851402 | 0.1868477 | 0.2065746 | 0.1474003 |
| **ANN** | 0.000259 | 0.01611 | 0.0120 | 0.1389323 | 0.0072478 |

The assessment, as per Table 2, above shows that the ANN algorithm clearly outperforms other machine learning algorithms, as shown by the very low MSE, RMSE, MAE, MASE, and MADE values compared to the other two algorithms. The worst performing, as was expected, was OLS, with LASSO compared to the former showing some improvement on all the assessment metrics. Based on the assessment above and graphical analysis as per Figure 2, the ANN algorithm was thus selected as the best performing machine learning algorithm for sales predictive modelling.

Further to the evaluation of the predictive models, we also computed variable importance for each algorithm, as per Figure 3. From the graphical presentations it was clear across the three models that, generally, productivity and permanent workers are the two most important variables that positively influence SMMEs' sales performance. However, in respect of those variables which negatively influence sales performance, the results were mixed.



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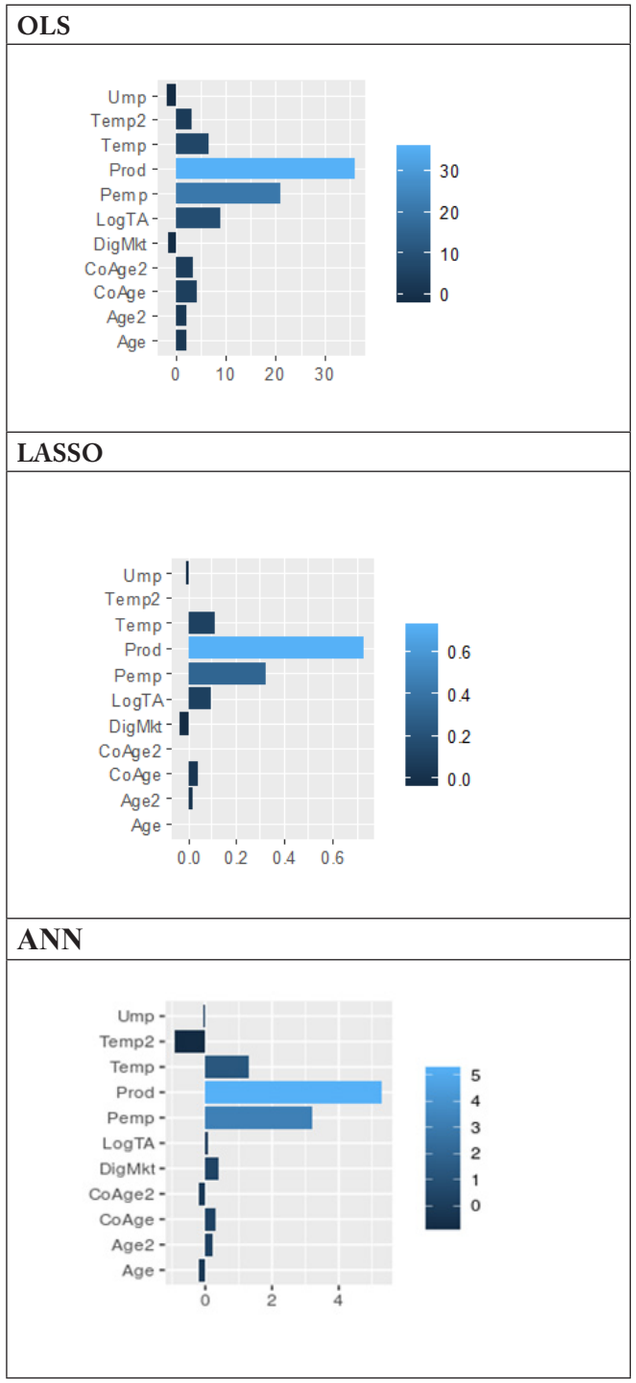
**Figure 3: Variable importance**








The ANN technique identified the excessive utilisation of temporary workers (Temp2) as negatively impacting on sales, while OLS indicated the opposite and LASSO showed no impact. Another feature which generated conflicting importance ratings was digital marketing, with OLS and LASSO highlighting it as having a negative impact on sales performance, while the ANN algorithm indicated that it had a positive effect.

The mixed findings show the importance of selecting the proper technique based on an objective criterion such as predictive accuracy. In this case, SMME owners would benefit most from exploiting ANN algorithms.

## 5. Conclusion and recommendations

The assessment found that the ANN approach was far superior to the other two machine learning approaches across all the assessment metrics, with the LASSO technique coming a distant second. The superior performance of the ANN algorithm, despite the inclusion of non-linear factors, shows the algorithm's versatility in identifying and incorporating functional relationships among variables in its predictive modelling process. This is in line with the assertion by Youn and Gu (2010) that, owing to their less restrictive assumptions when engaging with the dataset, ANNs tend to provide more accurate and reliable predictions than other algorithms.

More specifically, and in line with the other existing literature to date, this study provides stakeholders in the SMME sector with a basis for selecting ANNs to conduct sales predictive modelling and to inform strategic decision-making that can drive sustainable SMME growth. It is recommended that governments and other pertinent stakeholders develop and make available sales predictive applications powered by ANNs to manufacturing SMMEs in order to assist them in conducting predictions and developing data-driven plans. It is also recommended that future studies utilise larger datasets, covering periods longer than three years, to evaluate ANNs, and to compare ANNs' predictive performance with that of other complex techniques such as deep learning and support vector machines.

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# A Taxonomy to Understand Scaling of Innovation by African Enterprises

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**Abstract**
Grounded in empirical research findings and key statements in the literature, this article proposes a four-part taxonomy for mapping African knowledge-based enterprises' efforts to achieve scale. The taxonomy, adapted from the framework proposed by Uvin et al. (2000), is comprised of scaling *by expanding coverage*; *by broadening activities*; *by changing behaviour*; and *by building sustainability*. The article sets out the framework and provides examples of the four scaling dimensions from empirical research conducted in Egypt, Tunisia, Morocco, Ghana, Nigeria, Ethiopia, Uganda, Kenya, Botswana, and South Africa.

**Keywords**
scaling, innovation, enterprises, Africa, definitions, taxonomies, scaling up, scaling out, scaling down, scaling in, expanding coverage, broadening activities, behaviour change, sustainability

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## 1. Introduction

There is general agreement in African innovation ecosystems—among policymakers, private-sector players, non-profit entities, researchers, academics, and others—that a successful innovation is one that can "scale" or "scale up". However, not enough attention is given to what scaling actually entails, and what it looks like when it is happening, on the ground in African innovation settings. For example, there is a marked difference between the process of taking a new commercial business to market and the process of increasing the effectiveness of a health information campaign. Yet both involve, at least to some extent, scaling of an innovation. The aim of this article is to set out a taxonomy of scaling that captures the realities of not only the two examples just cited, but also of the myriad other ways in which African innovators are seeking, and achieving scale.

We and our colleagues in the Open African Innovation Research partnership (Open AIR) have undertaken numerous case studies looking at the practices and perspectives of collaborative innovators in African settings—including these innovators' approaches to achieving scale and their views on the forms that scaling can take. We have also worked to conduct an extensive review of literature on scaling. In this article, we present a taxonomy of four scaling dimensions—*expanding coverage*; *broadening activities*; *changing behaviour*; and *building sustainability*—that revealed themselves during the course of the exploration of the literature and of the case study findings.[1]

## 2. Literature relevant to innovation-scaling in African settings

### *Definitions*

Efforts to define scaling are prominent in the literature in the fields of health, education, agriculture, information and communication technology (ICT), social innovation, business and management, microfinance, and development work by non-governmental organisations (NGOs). In the health sector, scaling-up is a frequently used term, particularly in examinations of global health matters (see Johns & Torres, 2005; Simmons & Shiffman, 2007; Simmons et al., 2007; Uvin, 1995). According to Simmons et al. (2007), scaling-up can be defined as an "effort to magnify the impact of health service innovations successfully tested in pilot or experimental projects so as to benefit more people and to foster policy and programme development on a lasting basis" (Simmons & Shiffman, 2007, p. 1).

In the context of education and its role in development, DeJong and UNESCO (2014, p. 21) define scaling-up as "the process […] of expanding the scale of activities with the ultimate objective of increasing the numbers of people reached and the *impact* on the problem at hand". In the literature relating to scaling-up in agriculture, one of the most influential definitions is that published in 2000 by the International Institute of Rural Reconstruction (IIRR). The IIRR definition states that to scale up is to bring "more quality benefits to more people over a wider geographical area more quickly, more equitably and more lastingly" (IIRR, 2000, p. iv). Wigboldus et al. (2016, p. 2), writing in the context of agricultural research and innovation, find that scaling is typically cast in terms of "the extent to which outputs and outcomes in the form of novel technologies and practices can lead to wider benefits".

In their volume focused on scaling of impact from social innovations grounded in scientific research, McLean and Gargani (2019) offer this definition: "Scaling impact is a coordinated effort to achieve a collection of impacts at optimal scale that occurs if it is both morally justified and warranted by the dynamic evaluation of evidence" (2019, p. 9). In the literature on NGOs' programme delivery and sustainability, Uvin's (1995) approach—focused on scaling's quantitative, functional, political and organizational dimensions—is widely cited.

1 For a more detailed account of the literature review, the development of the taxonomy, and the mapping of empirical research findings against the taxonomy, see Open AIR (2020).





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In the field of information and communication technology for development (ICT4D), Foster and Heeks (2013) focus on scaling in the context of ICT innovation at the base of the pyramid (BoP). They remind us that "[w]e know little about the dynamics of scaling, about the particular impact of the BoP context, or about the changing relation between scaling strategy, the process of scaling, and the nature of innovation within that context" (2013, p. 4).

***Scaling up, out, down, in***

Uvin et al. (2000) and others propose that scaling is typically both "up" and "out", i.e., both vertical and horizontal. But there are nuances in how researchers delineate these dimensions. Vertical integration (scaling-*up*), according to Uvin et al. (2000, p. 1411), occurs "when organizations add upstream or downstream activities that complement their original program, seeking to better control the environment and ensure sustainability of impact." Meanwhile, horizontal integration (scaling-out), for Uvin et al. (2000, p. 1411), "consists of an expansion in the number and diversity of the activities undertaken [and] is often done upon request by beneficiaries or donors". Duggan et al. (2013), drawing on CGIAR (1999), define scaling-up as "institutional in nature" and involving "other sectors/stakeholder groups in the process of expansion", and scaling-*out* as "geographical spread to cover more people and communities [that] involves expansion within the same sector or stakeholder group across geographical boundaries" (2013, p. 159).

For Gündel et al. (2001), vertical scaling (scaling-*up*) involves "institutional" expansion to other sectors or stakeholders, e.g., "from grassroots organisations to policymakers, donors, development institutions and international investors", while horizontal scaling [scaling-*out*] is "geographical" expansion "to more people and communities within the same sector or stakeholder group" (2001, p. 1). According to Wigboldus et al. (2016), scaling-*up* is "something similar to increasing (e.g., in terms of numbers, speed, size)", while scaling-*out* "often relates to expanding, such as geographically spreading the use of a particular technology" (2016, p. 2). Critchley (1999, drawing on Scarborough et al. (1997)), conceives of scaling-up as "expanding", and scaling-out as "influencing other organisations" (1999, p. 270). In our analysis, while it is important to recognise that both vertical and horizontal dimensions are typically present in scaling, it is less important to strictly distinguish between the elements that are headed *up* and those that are headed *out*—because typically elements of both will be present, intermingled.

Duggan et al. (2013), drawing on CGIAR (1999), propose the additional notions of "scaling down", which they characterise as "increasing participation by decentralization of accountabilities and responsibilities" and "scaling in", which they say is "values and culture based" (2013, p. 159).





***Principles, processes, stages***

McLean and Gargani (2019) argue that in order to ensure that scaling occurs in a manner that serves the "public good", it must be guided by observance of four principles: justification, optimal scale, coordination, and dynamic evaluation. DeJong and UNESCO (2014) propose the following key principles: scaling-up within existing systems and policies; local ownership and leadership; grounding in evaluated pilot programmes; and ensuring sustainability and adaptability of the project beyond its funding timeline.

Writing in the agricultural context, Wambugu et al. (2001, p. 489) propose a community-based approach to scaling-up that requires: building "partnerships with a range of stakeholders"; ensuring appropriateness of practice, and farmers' interest in it; assisting local communities "to be effective in mobilising local and external resources"; and ensuring "effective participation of farmer groups and other stakeholders in testing, disseminating, monitoring, and evaluating the practice".

Earl et al. (2001), in setting out their "outcome mapping" approach to monitoring and evaluating of development projects, point to the fact that "[w]hen large-scale change—or impact—manifests itself, it is often the product of a confluence of events over which no single agency has control or can realistically claim full credit" (Earl et al., 2001, p. xi). Accordingly, Earl et al. (2001) advise that development initiatives seeking sustainability focus on contributing, along with other actors, to "outcomes". They define outcomes as "changes in the behaviour, relationships, activities, or actions of the people, groups, and organizations with whom a program works"(Earl et al., 2001, p. 1). They also speak of "boundary partners", which they define as the "individuals, groups, and organizations with whom the program interacts directly and with whom the program anticipates opportunities for influence" (Earl et al., 2001, p. 1).

In a similar vein, Duggan et al. (2013, p. 159), in speaking of the importance to scaling of involving "other stakeholders/sectors", write that this kind of scaling is "institutional in nature [and] involves other sectors/stakeholder groups in the process of expansion—from the level of grassroots organizations to policymakers, donors, development institutions and investors at international levels". Duggan et al. (2013, p. 153) also point to the transformative power of the internet as "a significant enabler of scale".

Additionally, Duggan et al. (2013) draw a link between the scaling dynamics of the internet and the internet's role in supporting development of "communities of practice" (2013, p. 154). The concept of communities of practice can be found deployed in literature across a wide range of disciplines, as evidenced by the Koliba and Gadja (2009) review of community-of-practice literature. A key developer of the community-of-practice concept is Wenger, and Wenger et al. (2002) write that "[c]



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ommunities of practice are groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis" (2002, p. 4). Communities of practice have a strong scaling dynamic, as their vitality depends to a large extent on their growth through drawing in additional participants, via online and/or offline outreach and interactions.

Foster and Heeks (2013) see scaling-up as "a four-stage process of exploratory, incremental then aggressive growth, followed by (attempted) standardisation" (2013, p. 2). They also set out the importance of using a BoP approach in the process of scaling-up, and of using scaling-up processes that are locally owned. Gündel et al. (2001) conceive of scaling-up of innovations as a two-pronged process, comprising identification of appropriate strategies for acceleration, and providing a framework to guide the acceleration. Gillespie (2004) emphasises the importance of local ownership, local support, and sustainability in successful scaling-up, finding that there is a "need for donors and supporters […], including governments, to think of the *process* beyond the project, and of transformation or transition rather than exit" (2004, p. ii, italics in original).

## 3. The proposed taxonomy

As explained in the introduction to this article, the taxonomy proposed in this article is grounded in both the relevant literature *and* empirical research findings. Table 1 below lists the empirical case studies, conducted in 10 African countries, whose findings inform the taxonomy.

**Table 1: Case studies with findings on African scaling modalities**

| Study country(ies) | Study | Researchers/authors | Publication year(s) |
|---|---|---|---|
| Egypt | Power relations, innovation, scaling, and knowledge governance at three Egyptian tech hubs: An initial exploration | ElHoussamy, Weheba, Rizk | 2020 |
| Egypt, Tunisia, Morocco | The maker movement across North Africa | ElHoussamy, Rizk | 2018, 2020 |
| Ghana | Skills development, knowledge and innovation at Suame Magazine, Kumasi | Adu-Gyamfi, Adjei | 2018 |
| Nigeria | Determinants of innovation capability in informal settings: The case of Nigeria's clustered ICT microenterprises | Jegede, O.O., Jegede, O. E. | 2018 |
| | The Nollywood phenomenon: Innovation, openness and technical opportunism in the modeling of successful African entrepreneurship | Oguamanam | 2018, 2020 |
| Ethiopia | Determinants of innovation in Ethiopian informal-sector micro and small enterprises (MSEs) | Belete | 2018a, 2018b |
| Uganda | ICTs in agricultural production and potential deployment in operationalising geographical indications in Uganda | Dagne, Oguamanam | 2018 |
| Kenya | Modes of innovation and enterprise development by Nairobi's mobile tech startups | Nzomo, Mwangi, Matu-Mureithi, Muchiri, Rutenberg | 2020a, 2020b |
| Botswana | MSMEs and open collaborative innovation in Botswana | Ama, Okurut | 2018 |
| South Africa, Kenya | 3D printing: Enabler of social entrepreneurship in Africa? The roles of FabLabs and low-cost 3D printers | Schonwetter, Van Wiele | 2018, 2020 |
| South Africa | Innovation entanglement at three South African tech hubs | Abrahams | 2020 |
| | Empowering rural women crafters in KwaZulu-Natal: The dynamics of intellectual property, traditional cultural expressions, innovation and social entrepreneurship | Oriakhogba | 2020 |
| | Complexities of social innovation and social entrepreneurship by two Indigenous organisations in rural South Africa | Rutert, Traynor | 2019 |
| | Institutionalisation and informal innovation in South African maker communities | Armstrong, De Beer. Kraemer-Mbula, Ellis | 2018 |
| | A scan of South Africa's maker movement | De Beer, Armstrong, Ellis Kraemer-Mbula | 2017 |
| | The maker movement in Gauteng Province, South Africa | Kraemer-Mbula, Armstrong | 2017 |
| | A data commons for food security | Baarbé, Blom, De Beer | 2017, 2019 |







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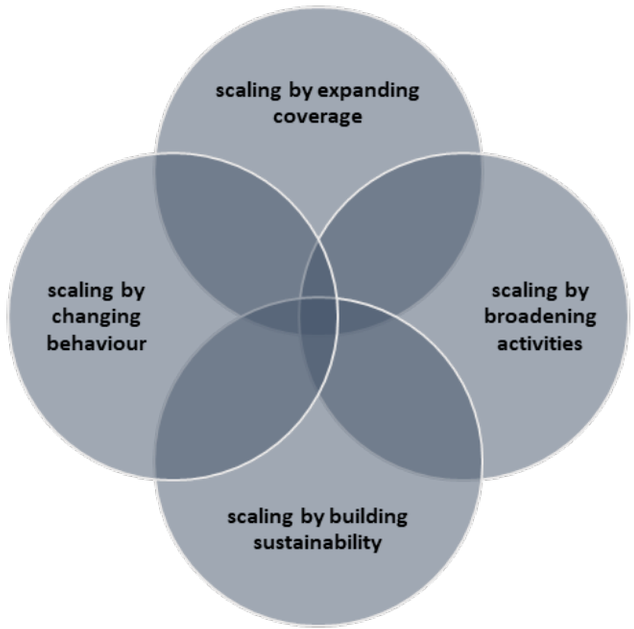
In reflecting on the findings from the above-listed studies, and on the statements in the literature as also cited above, we concluded that the aforementioned Uvin et al. (2000) four-part taxonomy of scaling—(1) expanding coverage and size, (2) increasing activities, (3) broadening indirect impact, and (4) enhancing organisational sustainability—is the framework in the existing literature that comes closest to describing the scaling modalities found on the ground in African innovation settings. Accordingly, the taxonomy we propose (see Figure 1) is grounded in the Uvin et al. (2000) taxonomy, with small modifications.

**Figure 1: Proposed scaling taxonomy (adapted from Uvin et al. (2000))**




Tables 2 through 5 below provide some of the key statements in the literature that inform the four parts of the taxonomy, including statements from Uvin et al. (2000).

**Table 2: Scaling by expanding coverage**

| | |
|---|---|
| Uvin et al. (2000, p. 1411) | "cover a larger number of beneficiaries, typically in a larger geographical area" |
| IIRR (2000, p. iv) | bring "more quality benefits to more people over a wider geographical area more quickly, more equitably and more lastingly" |
| DeJong and UNESCO (2014, p. 20) | "[expand] the scale of activities with the ultimate objective of increasing the numbers of people reached and the *impact* on the problem at hand" (italics in original) |
| Gündel et al. (2001, p. 1) | "geographical spread to more people and communities within the same sector or stakeholder group" |

**Table 3: Scaling by broadening activities**

| | |
|---|---|
| Uvin et al. (2000, p. 1411) | "expansion in the number and diversity of the activities undertaken" |
| Uvin et al. (2000, p. 1417) | "multiplication and mainstreaming through spinning off organisations, letting go of innovations, creating alternative knowledge, and influencing other social actors" |
| Duggan et al. (2013, p. 156) | "adapting an innovation successful in some local setting to effective usage in a wide range of contexts" |

**Table 4: Scaling by changing behaviour**

| | |
|---|---|
| Uvin et al. (2000, pp. 1411–1412) | "can occur through training, advocacy, knowledge creation, or advice. The targets can be other civil society organizations […] state agencies, from the central to the local level; and private for-profit businesses, such as banks, multinational corporations, etc." |
| Earl et al. (2001, p. 1) | "Outcomes are […] changes in the behaviour, relationships, activities, or actions of the people, groups, and organizations with whom a program works […] aimed at contributing to specific aspects of human and ecological well-being by providing partners with new tools, techniques, and resources to contribute to the development process"<br><br>"Boundary partners are those individuals, groups, and organizations with whom the program interacts directly and with whom the program anticipates opportunities for influence" |
| Duggan et al. (2013, p. 159) | "involves other sectors/stakeholder groups in the process of expansion—from the level of grassroots organizations to policymakers, donors, development institutions and investors at international levels" |
| McLean and Gargani (2019, p. 66) | "coordinate the actions of diverse actors with multiple agendas and perspectives in a way that balances private interests and the public good." |
| Uvin et al. (2000, p. 1418) | creation "of strategic and programmatic knowledge that can be spun off and/or integrated into the two mainstream sectors of society: governments and markets" |

**Table 5: Scaling by building sustainability**

| | |
|---|---|
| Uvin et al. (2000, p. 1412) | "Enhancing organizational sustainability" through "movement from the uncertainties of the entrepreneurial beginning […] to the long-term solidity of programmatic institutions." |
| Gundel et al. (2001. p. 1) | "creating sustained poverty alleviation and increasing local capacity for innovation" |





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| | |
|---|---|
| Duggan et al. (2013, p. 159, drawing on CGIAR (1999)) | "increasing participation by decentralization of accountabilities and responsibilities, particularly in breaking down big programmes into smaller programmes/projects" |
| Wenger et al. (2002, p. 4) | "Communities of practice are groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis" |
| Uvin et al. (2000, p. 1418) | "Impact, finally, is not only about the number of beneficiaries or even the specific policy changes won, but also about local capacity built, intersectoral contacts developed, norms of trust and cooperation strengthened, and democratic space and social diversity reinforced" |
| McLean and Gargani (2019, p. 63) | "*Optimal Scale* is the point at which the magnitude, variety, sustainability, and equity of impacts are balanced in a way that is endorsed." (italics in original) |

**4. Research findings that demonstrate the four scaling dimensions**

We now map research findings, from the studies listed above in Table 1, against the four scaling categories in the proposed taxonomy:

- scaling by expanding coverage
- scaling by broadening activities
- scaling by changing behaviour
- scaling by building sustainability

***Scaling by expanding coverage***

*Taking innovations (commercial and social) to market*

The notion of scaling by expanding coverage, when conceived narrowly, can refer simply to taking an innovation "to market" in a purely commercial sense. While the taxonomy proposed in this article actively seeks to avoid this kind of narrow focus, it cannot be denied that taking an innovation to market is indeed a marker of scaling. Research has found ample evidence of both product and process innovations being taken to market—via commercial enterprises or, even more often, social enterprises. For instance, the Oriakhogba (2020a, 2020b) case study of the Woza Moya craft collective in KwaZulu-Natal, South Africa, finds that the initiative had scaled from an original 15 Zulu women beadworkers to having more than 350 traditional crafters, almost all of them women, involved in several arts and crafts activities, including woodcarving, ceramics, sewing, basket-weaving, and beadwork. The study of maker collectives in South Africa's Gauteng Province (Kraemer-Mbula & Armstrong, 2017) also finds evidence of innovations being taken to market, including the RepRap Morgan 3D printer and the Robohand 3D-printed prosthetic (Kraemer-Mbula & Armstrong, 2017). Belete's (2018a, 2018b) study of footwear and textile MSEs operating in informal-sector clusters in the Ethiopian capital Addis Ababa finds evidence that the enterprises were able to make use of the clusters to engage in rapid market commercialisation of new products, i.e., of new designs. Perhaps the most dramatic example of scaling through taking innovations to market that has been studied to date is the case of Nigeria's Nollywood film industry. As Oguamanam (2018, 2020) illuminates, participants in Nollywood have developed innovative business models—grounded in low-cost production, locally-attractive narratives, and low-cost distribution—which have managed to scale across Nigeria, across the African continent, into the African diaspora outside the continent, and internationally to non-African consumers.

*Prototyping innovations (commercial and social)*

For innovation-based enterprises, the first step on the path towards scaling through expansion of coverage is typically a prototyping stage. Some may argue that this stage is a "pre-scaling" phase and should not be regarded as scaling, but the taxonomy we propose regards prototyping as integral to the scaling continuum. In the ElHoussamy and Rizk (2018, 2020) study of maker communities in North Africa (Egypt, Tunisia, Morocco), it is found that several of the interviewees regard their maker communities' primary role as being that of supporting innovators at the prototyping phase of enterprise development. In the aforementioned study of maker communities in Gauteng Province, South Africa (Kraemer-Mbula & Armstrong, 2017), a similar sentiment is identified—i.e., that maker communities should prioritise prototyping— among the majority of the maker community interviewees from the eight communities studied.

*Participating in ICT-enabled networks*

Research findings suggest that another important element of scaling for many innovative African enterprises is that which occurs via participation in ICT-enabled networks. Research in Uganda by Dagne and Oguamanam (2018) sheds light on how ICT use supports knowledge-sharing and market decision-making by smallholder farmers. Baarbé et al. (2017, 2019) find enterprise-scaling being supported by farmers' and fishers' contributing to pools of "open data" through mobile apps and internet platforms, e.g., contribution to datasets on agricultural inputs, weather conditions, and market prices. Another instance of ICT network-enabled scaling is that of Nigeria's aforementioned Nollywood film industry (Oguamanam, 2018, 2020), with Nollywood's current distribution models strongly relying on ICT networks (complemented by offline physical networks).

*Participating in informal-sector clusters*

Scaling through expanded coverage can also be enabled by participation in informal-sector clusters. The Jegede and Jegede (2018) study of Otigba computer village, an informal-sector cluster of ICT hardware enterprises in Lagos, finds that the cluster engenders a mix of both healthy competition and supportive, open cooperation among the enterprises. The enterprises participating in the cluster are able to expand





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their coverage through, among other things, access to new customers, new markets, and new suppliers of raw materials and inputs. The Belete (2018a, 2018b) study of two informal-sector clusters in the Ethiopian capital Addis Ababa—the Shiro Meda handloom-weaving cluster and the Merkato leather footwear manufacturing cluster—finds evidence of the enterprises increasing their market access through cluster participation. In Kumasi, Ghana, researchers Adu-Gyamfi and Adjei (2018) point to the remarkable scaling of Suame Magazine, the informal-sector metalworking and vehicle repair cluster, which has grown from roughly 50 artisans in the 1950s to a current estimate of approximately 200,000 people working in and around the cluster (Adu-Gyamfi & Adjei, 2018, with citations of Obeng, 2001; Powell, 1981).

*Participating in formal-sector tech hubs*

Participation in formal-sector tech hubs is another means through which innovative African enterprises are able to expand coverage as a means to achieve scale. Nzomo et al. (2020a, 2020b) look at the innovation dynamics of 25 Kenyan mobile tech startups, many of whom are interacting with tech hubs in Nairobi, and find that the enterprises' interactions with the hubs tend to generate increased coverage for the startups' innovations. The ElHoussamy et al. (2020) study of the views of leaders at three Egyptian tech hubs—Flat6Labs, AUC Venture Lab, and the Technology, Innovation and Entrepreneurship Center (TIEC)—finds that the hubs' hosted startups are able to expand coverage of their business models. The Abrahams (2020) study of innovation modalities at three South African tech hubs—Bandwidth Barn Khayelitsha and Workshop 17 in Cape Town, and Tshimologong Digital Innovation Precinct in Johannesburg—finds that startups' ability to scale through expanding coverage is generally enhanced by their participation in the hubs.

***Scaling by broadening activities***

*Engaging in product innovation*

The Belete (2018a, 2018b) study of handloom-weaving and leather footwear manufacturing enterprises in Addis Ababa's informal sector finds evidence that the enterprises in the two clusters studied are able to increase their capacity to develop new products (i.e., new designs). In their survey of the open collaborative innovation practices of 206 micro, small, and medium-sized enterprises (MSMEs) in Botswana, Ama and Okurut (2018) find that roughly half (51.3%) of the enterprises say they have scaled their businesses through "new products and services developed" (2018, p. 28).





*Engaging in process innovation*

In their study of the ICT hardware enterprises operating in the Otigba computer village in Lagos, Jegede and Jegede (2018) find process innovation to be central to the success of the enterprises: Oguamanam's (2018, 2020) study of the Nollywood film industry identifies clear instances of process innovations that have been successfully scaled by Nollywood entrepreneurs.

*Engaging in business-model innovation*

We regard "business models" as the models followed by social, commercial, or social-commercial hybrid enterprises in their efforts to achieve their objectives, balance their books, and/or turn a profit. The Armstrong et al. (2018) scan of South Africa's maker movement identifies several instances where maker communities are pursuing the broadening of activities through social-commercial hybrid business models. For example, the Kluyts MakerSpace in the town of Knysna, Western Cape Province, falls under a non-profit entity that is, in turn, linked to the for-profit Kluyts and Co. wood manufacturing (mostly furniture) factory, with both the makers and the factory working out of the same premises. Another study that reveals successful expansion in scope of activities through business-model innovation is Oguamanam's (2018, 2020) study of Nigeria's Nollywood film industry. Oguamanam explains how, when Nollywood started in the early 1990s, VHS cassette sellers, needing to find a way to sell excess stock, teamed up with creators of low-cost video dramas to produce content made available only on VHS (2018, 2020).

*Engaging in organisational-strategy innovation*

Innovations in organisational strategy are often made in support of scaling via expansion of the scope of activities. Indeed, the business-model examples outlined in the preceding sub-section all include elements of organisational strategy innovation. Another example emerges from the ElHoussamy and Rizk (2018, 2020) study of maker communities in North Africa. That study identifies organisational-strategy innovation in the work of Fab Lab Egypt, which "changed its role from being a makerspace that delivers workshops related to making, to more of a 'caretaker' role for other makerspaces in the country" (ElHoussamy & Rizk, 2018, pp. 11, 32). Another example of organisational-strategy innovation is seen in the Kraemer-Mbula and Armstrong (2017) study of maker communities in South Africa's Gauteng Province. That study identifies significant organisational-strategy innovation in the work of the Geekulcha maker community, which has only a small core team but is able to deliver a multitude of digital skills programmes through its myriad partnerships with South African government departments (at national, provincial, and municipal levels), foreign donors, international organisations, and private-sector IT firms.



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***Scaling by changing behaviour***

The taxonomy's conceptualisation of behaviour change is drawn from the Earl et al. (2001) outcome mapping framework detailed above, which sees developmental outcomes as being a function of "changes in the behaviour" of "boundary partners" (2001, p. 1).

*Collaborating with outside stakeholders*

The Jegede and Jegede (2018) study of the Otigba computer village in Lagos finds clear evidence of the cluster's hardware enterprises engaging in external collaborations of mutual benefit with enterprises outside the cluster, customers, and trade and industry associations. The Adu-Gyamfi and Adjei (2018) study of the Suame Magazine cluster in Kumasi, Ghana, finds a long history of collaboration between enterprises in the cluster and the Technology Consultancy Centre (TCC) at Kumasi's Kwame Nkrumah University of Science and Technology (KNUST). The Rutert and Traynor (2019) study of social innovation and social entrepreneurship by two Indigenous enterprises in rural South Africa—Vukuzenzele Medicinal Plant Nursery and Garden (Vukuzenzele Plant Nursery) and the Kukula Traditional Health Practitioners Association (Kukula Healers)—finds that both enterprises had a strong ethos of collaboration, and behaviour change, in their interactions with external stakeholders.

*Engaging in systemised outreach and inclusion*

Another key modality for enterprises seeking scaling through behaviour change is their engagement in outreach and inclusion activities. Some of the most prominent examples of systemised outreach and inclusion efforts are found in the work of South African maker communities (Armstrong et al., 2018; De Beer et al., 2017; Kraemer-Mbula & Armstrong, 2017). The aforementioned Kluyts MakerSpace, in the South African town of Knysna, seeks to provide low-cost workspaces and enterprise opportunities to local woodworkers who have been marginalised by the decline in the region's once-vibrant furniture-making sector. Workspace, in the town of Hout Bay near Cape Town, has a skills-building project called The Employable Nation (TEN), which targets unemployed youth living in Hout Bay's impoverished informal settlements. The I Make Makers Lab in Irene, next to Pretoria, uses its mobile maker unit to work with under-employed artisans and craftspeople in rural areas. KATO's Women in Tech Cape Town and Geekulcha's Raeketsetsa are both projects that actively promote and build participation by girls and women in making. And the Wits University Tshimologong MakerSpace (formerly called the DIZ MakerSpace) in Johannesburg, the Gauteng Provincial Government eKasi Labs, and the Sebokeng FabLab all collaborate with innovators from low-income communities (De Beer et al., 2017).





***Scaling by building sustainability***

The taxonomy's conception of *scaling by building sustainability* rests to a great extent on the assumption that the more sustainable an enterprise is, the greater its potential will be to engage in the taxonomy's other three kinds of scaling as covered in the preceding sub-sections.

*Participating in communities of practice*

ElHoussamy and Rizk (2018, 2020), in their study of the work of maker communities in North Africa, find that Fab Lab Egypt has developed a strong community of practice, as exemplified by its shift from delivery of services via a single makerspace to delivery of support to the entire network of Fab Labs in Egypt. ElHoussamy and Rizk also find that Alex Hackerspace in Alexandria is ensuring "close ties to the Egyptian maker community through co-hosting workshops and participating in events" (2018, p. 14), and that the majority of the makerspaces covered by the study are "engaged in activities that support upscaling and the ensuing sustainable knowledge-sharing processes" (2018, p. 32). In South African maker research, De Beer et al. (2017) find evidence of each individual maker collective taking steps to build a community of practice, as well as evidence of the makers building and participating in national, African continental, and international maker-oriented communities of practice—with ICT platforms allowing for community members to overcome barriers created by geographical remoteness.

*Developing human capital*

The Belete (2018a, 2018b) study of Ethiopian small enterprises finds in-house, on-the-job training to be integral to the enterprises' ability to scale up their operations. The Jegede and Jegede (2018) study of the Otigba ICT cluster in Lagos finds a link between informal MSEs' in-house training and annual turnover and, in turn, increased innovation capability. In their survey of Botswana small enterprises, Ama and Okurut (2018) find that 56.4% of the enterprises say they have scaled via an "increased number of skilled employees", and nearly half (48.7%) say they had scaled "through motivation of their staff" (2018, p. 28).

*Engaging in open, collaborative innovation*

While research has found open, collaborative innovation to be relevant to all four of the taxonomy's scaling categories, its strongest roles are likely here in the fourth category: scaling by building sustainability. The Baarbé et al. (2017, 2019) study of sharing of open data to support scaling of small-scale farming and fishing enterprises finds strong evidence of open, collaborative approaches, particularly in the case of the Abalobi fishing management mobile apps in South Africa, developed collaboratively by project leaders and small-enterprise fishers. Open collaboration is also found to be central to the sustainable scaling of enterprises in three aforementioned informal-sector clusters—the Otigba ICT hardware cluster in Lagos (Jegede & Jegede, 2018), the Suame Magazine informal-sector cluster in Kumasi, Ghana (Adu-Gyamfi &



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Adjei, 2018), and the Shiro Meda handloom-weaving cluster in Addis Ababa (Belete, 2018a, 2018b)—and in the Woza Moya craft enterprises project in KwaZulu-Natal, South Africa (Oriakhogba, 2020a, 2020b). Also, the studies of maker communities in South Africa, Egypt, Tunisia, and Morocco have found an ethos of open collaborative innovation to be a central motivation for individuals' participation in these communities, and thus a crucial driver of sustainability (see Armstrong et al., 2018; De Beer et al., 2017; ElHoussamy & Rizk, 2018, 2020; Kraemer-Mbula & Armstrong, 2017).

*Grounding innovations in social challenges and environmental management*

In their study of the use of 3D-printing by social entrepreneurs in South Africa and Kenya, Schonwetter and Van Wiele (2020) find that the entrepreneurs perceive scaling "as being linked to becoming (more) sustainable, and increasing the impact of their work and products" (2020, p. 18). In their case study of scaling of smallholder farming in Uganda, Dagne and Oguamanam (2018, p. 7) identify the importance of "paying attention to environmentally sustainable practices" as part of "scaling up agricultural economies". The Baarbé et al. research (2017, 2019) into the Abalobi mobile apps developed for and with South African fishers find environmental management goals to be interwoven with scaling goals. The two South African Indigenous enterprises studied by Rutert and Traynor (2019)—Vukuzenzele Plant Nursery and the Kukula Healers—are found to have forged strong links to livelihood development and responsible environmental stewardship in the impoverished, remote rural area where they are based.

*Establishing communal knowledge governance*

In their study of potential scaling of production and market access by Ugandan smallholder farmers,Dagne and Oguamanam (2018) find that one group of farmers, the vanilla growers of Uganda's Mukono District, could potentially increase the sustainability, through scaling, of their production and market share if they were to communally develop a geographical indication (GI), i.e., a trademark that promotes and protects the locally specific features of Mukono vanilla. In the Rutert and Traynor (2019) study, a key dimension of the Kukula Healers' success is found to lie in their development of a bio-cultural community protocol (BCP) to govern the medicinal plant-related traditional knowledge (TK) held by the organisation's members.

## 5. Conclusions

In conclusion, it must once again be stressed that the four scaling conceptions in the taxonomy proposed in this article are conceived as overlapping, i.e., one can expect to find more than one, and often all, of these four scaling elements present in the actions and objectives of a knowledge-based enterprise operating in an African innovation setting. It is for that reason that several studies are referenced numerous times in this article's mapping of research findings against the taxonomy.





In setting out these four overlapping conceptions of scaling, which we have found to be valuable for the mapping of research findings, it is our hope that we are providing a framework that can be useful to other researchers, and to policymakers, scholars, private-sector players, civil society actors and the actual African enterprises engaged in knowledge-based innovation in the continent's myriad and vibrant innovation settings.

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# Narrative Styles and Institutional Isomorphism in South African CEOs' Shareholder Letters

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**Abstract**
Among the most-read corporate documents are chief executive officers' (CEOs') shareholder letters. Using institutional isomorphism as lens, this study examines the extent to which the narrative styles used by South African CEOs in their shareholder letters are similar to the styles used by CEOs at leading international companies. The study also explores the degree to which impression management techniques are present in the South African CEOs' shareholder letters. The study uses DICTION software to conduct a narrative analysis of South African CEOs' shareholder letters for a single financial year, and compares the findings with those drawn from the Craig and Amernic (2018) study of the shareholder letters of CEOs from samples of international Fortune 500 and FTSE 100 companies. The study finds that *optimism* and *realism* are the two most-used narrative styles in South African CEOs' shareholder letters, and that these findings are markedly similar to those generated by the Craig and Amernic (2018) study of international companies. The study contributes to the understanding of normative institutional isomorphism in corporate reporting by providing empirical evidence that the narrative styles employed by CEOs of companies in a developing economy with high corporate governance standards conform to the same norms as those of CEOs of large international companies. The study also finds that the South African CEOs' dominant communication styles in the shareholder letters lend themselves to being tools of impression management.

**Keywords**
corporate communications, narrative styles, CEO shareholder letters, institutional isomorphism, South Africa

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## 1. Introduction

Until recently, the focus of most accounting research was on quantitative information disclosed by companies. However, there is now growing recognition of the importance of qualitative information that captures risks, opportunities, and organisational relationships that quantitative information alone cannot provide (Allee & DeAngelis, 2015; Arena et al., 2015; Bonsall & Miller, 2017; González et al., 2021; Laskin, 2018; Mmako, 2016; Mmako & Jansen van Rensburg, 2017). As a result of the separation of management and ownership in organisations, and the resulting information asymmetry, quality financial and non-financial communication is key to ensuring cohesion and shared understanding between management and stakeholders.

Companies are encouraged to communicate their actions and activities to stakeholders in a transparent way (SEC, 1998; IoDSA, 2009, 2016; JSE, 2013). According to the mimetic and normative institutional isomorphism theory, companies may at first mimic each other in their disclosure style, and then, over time, the disclosure practices become normalised or standardised with little thought given to them (DiMaggio & Powell, 1983). At the same time, communication styles can be used to influence reactions (Yuthas, Rogers & Dillard, 2002), manage expectations (Asay et al., 2018a; Laskin, 2018), and/or shape perceptions, according to impression management theory (Allee & DeAngelis, 2015). The scope for impression management is limited in quantitative corporate reporting (e.g., audited financial statements), but this scope widens considerably in qualitative reporting, where language can be used to shape investors' perceptions (Leung, Parker & Courtis, 2015; Smith & Taffler, 2000; Sydserff & Weetman, 2002).





Most studies of communication styles in corporate reports focus on companies located in the US, the UK, and other developed economies. This study looks at practices in South Africa, an emerging economy. Applying an institutional isomorphism lens, the study investigates the extent to which the narrative styles deployed by South African chief executive officers (CEOs) in their shareholder letters follow the communication styles of their counterparts, as studied by Craig and Amernic (2018), in Fortune 500 and FTSE 100 international companies. We also examine the extent to which South African CEOs' shareholder letters exhibit the use of impression management techniques. Among other things, this study seeks to answer the call by Allee and DeAngelis (2015) and Laskin (2018) for more research into the narrative styles used by companies in communicating their financial and non-financial results.

South Africa provides a valuable environment for investigation of communication styles in corporate reports, as it is one of the countries at the forefront of the worldwide development of corporate governance codes, with its King Commission developing and regularly updating codes that are integrated into Johannesburg Stock Exchange (JSE) Listings Requirements. According to the World Economic Forum's (WEF) 2019 Global Competitiveness Report, South Africa ranked 26th out of 141 countries for corporate governance, while the US ranked 31st and the UK 13th. The JSE Listings Requirements (JSE, 2019) specify that companies must follow the guidelines in the King IV Code on Corporate Governance (IoDSA, 2016), specifically concerning preparing concise integrated reports that use plain language. In respect of matters of potential institutional isomorphism, South Africa's common law legal system and history under British colonial rule allow for useful exploration of the extent to which its corporate practices exhibit similarities to those of companies with strong Anglo-American ties.

## 2. Literature review

### *Institutional isomorphism*

Corporate reporting has its earliest roots in agency theory (Jensen & Meckling, 1976), as the historical purpose of the financial report was to provide information about fiduciary responsibilities. Managers voluntarily disclose information in order to reduce information asymmetry between themselves and owners (shareholders) and to signal their competence and trustworthiness (Jensen & Meckling, 1976; Spence, 1973). Research has established that investor decision-making is significantly affected by what managers choose to say, as well as how they say it (González et al., 2019). This is seen in verbal (Allee & DeAngelis, 2015) and written communications (Breton, 2009). In addition to reducing information asymmetry, corporate reporting can also serve legitimising purposes. Companies engage in and report on certain activities, e.g., building schools in the community, in order to obtain approval from society and to retain access to resources (DiMaggio & Powell, 1983; Deephouse, 1996; Suchman, 1995). Observing this type of reporting by fellow companies can



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also lead to institutional isomorphism, because organisations in similar situations tend to make use of similar structures (De Villiers, Low & Samkin, 2014; Heugens & Lander, 2009).

DiMaggio and Powell (1983) identify three types of institutional isomorphism, namely, *coercive*, *mimetic*, and *normative*. In the corporate reporting context, *coercive isomorphism* occurs when outside pressures, such as those from regulators or stakeholders, force companies to disclose information in a specific way or with a particular emphasis (Areneke, Yusuf & Kimani, 2019). *Mimetic isomorphism* typically occurs when there is uncertainty around new reporting practices, which encourages companies to mimic early adopters (De Villiers et al., 2014). Mimetic isomorphism can also be observed when companies follow or mimic others' resistance to new reporting practices (Maroun & Van Zijl, 2016; Nel & Esterhuyse, 2019). *Normative isomorphism* results from companies starting to perceive a certain "way of doing" as the norm and implementing the specific disclosure style because of what they believe is normal or "how it has always been done", or when practices are performed by persons from the same profession or training (DiMaggio & Powell, 1983; Mizruchi & Fein, 1999; Suddaby & Viale, 2011).

An example of institutional isomorphism in the South African reporting context can be found in De Villiers and Alexander (2014), who report finding no meaningful differences between South African and Australian mining companies in the vast majority (29 out of 30) of the disclosure patterns in their corporate social responsibility reports—which is evidence of the normative isomorphism that De Villiers and Alexander attribute to the professionalisation of reporting based on common "templates". Furthermore, smaller South African mining companies were found to be disclosing the same amount of environmental information in their reports as were the larger South African mining companies (De Villiers & Alexander, 2014).

### *Impression management*

Impression management refers to narrative disclosures that are presented in a way that promotes the image that the company wants to portray (Breton, 2009; Geppert & Lawrence, 2008; Mmako, 2016). Impression management is connected to legitimacy theory, as legitimacy is achievable only if public impressions of a company's activities are positive (sometimes regardless of actual company performance). Companies can therefore mimic each other to ensure that they obtain legitimacy through disclosures, using impression management. As the need to obtain legitimacy through managing impressions becomes the norm, normative institutional isomorphism ensues. Corporate narrative reporting can therefore be used by companies to manage perceptions and thus maintain legitimacy (Ben-Amar & Belgacem, 2018; Bozzolan, Cho & Michelon, 2015; Martins et al., 2019; Melloni, Caglio & Perego, 2017).





Impression management theory holds that managers use reports to convey selective information and in a manner that benefits the organisation and themselves, even if not necessarily to the benefit of stakeholders (Allee & DeAngelis, 2015; Arena et al., 2015; Asay et al., 2018b; Bozzolan et al., 2015; Cho, Roberts & Patten, 2010; Martins et al., 2019; Leung et al., 2015; Sydserff & Weetman, 2002; Yuthas et al., 2002). As Cho et al. (2010, p. 432) state, "[…] the more firm performance differs from a desired benchmark, the more management is motivated to manage impressions, and the more likely it is that narrative disclosure will be affected by a self-serving bias."

This self-serving bias (Leung et al., 2015), expressed through impression management tactics in earnings press releases, is rewarded by, for example, equity shares (Arslan-Ayaydin, Boudt & Thewissen, 2016), which managers can receive if the company that they manage is thought to perform well. Managers also attempt to influence analysts when management issues earnings guidance (for next period's earnings target), and subsequently in press releases and conference calls with analysts, when actual results are announced and discussed in relation to prior guidance and targets (Washburn & Bromiley, 2014).

Yakis-Douglas et al. (2014) find that managers communicate more to manage market perceptions of merger and acquisition deal announcements, the successful outcome of which will reflect well on the manager. Older CEOs and those with a longer tenure at a company have been found to provide less forward-looking information and to be less optimistic in their quarterly earnings conference calls, indicating that security of tenure plays a role in the communication style of CEOs (Bochkay, Chychyla & Nanda, 2019). Another impression management tactic is obfuscation, where messages are manipulated or made overly complicated, and certain pieces of information are concealed or omitted through minimal narrative disclosure (Arena et al., 2015; Asay et al., 2018b; Ben-Amar & Belgacem, 2018; Bonsall & Miller, 2017; Cho et al., 2010; Goel et al., 2010; Leung et al., 2015; Melloni et al., 2017). This contrasts with calls by users for clear and concise disclosure stretching back as far as the 1960s (Lawrence, 2013). To this end, the US Securities and Exchange Commission (SEC) in 1998 published *A Plain English Handbook: How to Create Clear SEC Disclosure Documents*, asking companies to use clearly understandable language in their narrative disclosures (SEC, 1998). In South Africa, the Institute of Directors in Southern Africa has requested the same (IoDSA, 2009) from South African corporate report preparers as part of IoDSA's integrated reporting and governance reforms embedded in the various King Codes on Corporate Governance.

### *CEO shareholder letters as vehicles for impression management*

The individual CEO can frame the narrative that they want to convey to the readership (Dikolli et al., 2020; Mmako, 2016). The chosen narrative could have effects on the readers/shareholders, e.g., consistently using words in the letter that emphasise shareholder value, year after year, has been found to markedly reduce the chances



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of the CEO being dismissed (Shin & You, 2020). Asay et al. (2018a) find that use of personal pronouns and the presence of a picture of the CEO with the shareholder letter both affect investors' perceptions. Craig and Amernic (2018) call the shareholder letter "staged discourse", as it is written in the CEO's name, in contrast to much of the rest of the integrated annual report. Much thought goes into the shareholder letter, as it should reflect on the results obtained in the year under review and prospects for the future (Aerts & Yan, 2017; González et al., 2019). The letter is, therefore, an excellent source for determining the use of selective narrative styles. The findings of Asay et al. (2018a), Craig and Amernic (2018), Craig and Brennan (2012), Greiner et al. (2020), and Shin and You (2020) on narrative styles in CEOs' shareholder letters are consistent with impression management theory, i.e., they find that narrative styles are used strategically and that researchers can make certain observations from the language choices employed in these texts.

Most studies on CEO shareholder letters have been performed on companies listed in the US, the UK, and other developed economies. Very little research has been conducted using textual analysis of corporate reports in South Africa. Mmako (2016) and Mmako and Janse van Rensburg (2017) investigate, in CEO shareholder letters of the largest South African companies, the priority (order of presentation) given to certain disclosure items required by integrated reporting, but they do not analyse narrative styles per se. Du Toit (2017) examines readability issues (but not narrative style) in integrated annual reports in South Africa (i.e., not limited to shareholder letters, per se) and establishes that integrated reports that more closely comply with integrated reporting disclosure guidelines are also the reports that tend to use more complex language (thus reducing readability).

## 3. Research design and methodology

The study was guided by two research questions:

- RQ1: To what extent do the narrative styles of South African CEOs' shareholder letters, when compared with the narrative styles in the CEO shareholder letters of top international companies, reflect institutional isomorphism?
- RQ2: To what extent are the narrative styles present in South African CEOs' shareholder letters indicative of impression management techniques?

### *Source documents*

The South African source documents consisted of CEOs' shareholder letters enclosed in the 2018 integrated annual reports published online by all companies listed in the consumer goods sector and consumer services sector of the JSE's main board. These are the second and third largest industry sectors on the JSE. These integrated reports were the most recent that were available for download when the data was gathered during the course of June 2019. Two integrated reports had no CEO shareholder letters, and two of the companies had not yet made an integrated report available online. The final document count totalled 50 CEOs' shareholder letters with the average length being approximately 2,000 words. (See Appendix for a listing of the 50 companies, each company's industry, each CEO's name and gender, and the word count of each shareholder letter.) Since this was an exploratory study, we considered the sample size of 50 letters from JSE companies to be sufficient for a determination of narrative styles in South African corporate shareholder letters. The sample size was comparable to those used in the Laskin (2018) and Craig and Amernic (2018) studies.

In order to allow for a comparison between the South African shareholder letters and international ones, we drew on the data analysis conducted by Craig and Amernic (2018), who looked at the contents of CEOs' shareholder letters for 91 Fortune 500 companies and 77 FTSE 100 companies, i.e., a total of 168 CEOs' shareholder letters that we regarded as being good representations of the narrative styles of international companies' CEOs.

### *Narrative analysis*

This study made use of DICTION 7.1.3 software, with its corresponding 31 dictionaries of word lists. DICTION, as developed by Hart (2000), and improved by Hart and Carroll (2013), analyses text for specific linguistic tones or styles. The software classifies text into five master variables or styles—*certainty*, *optimism*, *activity*, *realism*, and *commonality*. First, frequencies (word counts as percentages of total words in the document) are determined for each dictionary. Individual dictionary frequencies are then added or subtracted to arrive at the count for each of the five master variables or styles. Each dictionary belongs to one style only (DICTION, n.d.). The output scores are standardised for each dictionary and for the five master variables/styles, enabling direct comparison with the output scores of other texts. We used this feature to answer RQ1, comparing output scores from our sample with those of the international sample analysed by Craig and Amernic (2018). Each of the 50 South African shareholder letters was manually extracted from its integrated report and processed through DICTION.

No textual analysis software is without limitations. Loughran and McDonald (2016), as well as Craig and Amernic (2018), note that some of the words in the DICTION word lists can be misinterpreted in the context of accounting or financial analysis. For example, they indicate that a word such as *necessary*, listed as a positive word in DICTION, can have a negative connotation in accounting or financial literature. However, we believe that sound classification of the vast majority of the words in the extensive DICTION word lists, and the way in which the master variables are constructed from the individual dictionaries, minimises the effect of *some* words being misclassified in accounting contexts. Furthermore, we take confidence from the fact that many researchers have relied on DICTION for narrative analyses of corporate







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communications (see, for example, Arena et al., 2015; Arslan-Ayaydin et al., 2016; Bozzolan et al., 2015; Craig & Brennan, 2012; Craig & Amernic, 2018; Dikolli et al., 2020; Greiner et al., 2020; Hassan, 2019; Laskin, 2018; Melloni, Caglio & Perego, 2017; Ober et al., 1999; Yuthas et al., 2002).

## 4. Findings and analysis

To address the first research question (RQ1), we generated our DICTION results across the 50 JSE (South African) documents and compared them to the results that Craig and Amernic (2018) generated from their analysis, also using DICTION, of their aforementioned two sets of CEO shareholder letters: 91 from Fortune 500 companies and 77 from FTSE 100 companies. Table 1 contains the descriptive statistics for the five DICTION master variables (narrative styles) for the 50 JSE shareholder letters, and also provides the mean values found by Craig and Amernic (2018) in their Fortune 500 and FTSE 100 samples.

Table 1 shows that the most prominent narrative style across all three samples is that of *optimism* with a mean score of 55.43 in the JSE sample and mean scores of 56.54 and 56.12 respectively in the Fortune and FTSE samples analysed by Craig and Amernic (2018). DICTION defines *optimism* as "[l]anguage endorsing some person, group, concept or event or highlighting their positive entailments" (DICTION, n.d.). As the purpose of the CEO's shareholder letter is to report on the achievements of the company's management during the past year, it is unsurprising that *optimism* emerges as the most dominant narrative style.

**Table 1: Descriptive statistics for the 5 DICTION master variables**

| | JSE (n = 50) | | | | Fortune 500 mean (n = 91) (Craig & Amernic, 2018) | FTSE 100 mean (n = 77) (Craig & Amernic, 2018) |
|---|---|---|---|---|---|---|
| | mean | minimum | maximum | std. deviation | | |
| optimism | 55.43 | 50.18 | 59.68 | 2.69 | 56.54 | 56.12 |
| realism | 52.67 | 48.93 | 56.59 | 2.10 | 54.84 | 54.38 |
| activity | 49.26 | 46.82 | 51.36 | 1.31 | 49.12 | 49.24 |
| commonality | 49.04 | 44.89 | 54.28 | 2.19 | 49.08 | 49.13 |
| certainty | 46.67 | 36.92 | 52.84 | 4.22 | 47.17 | 47.93 |





The second most popular narrative style identified in the JSE sample, as well as in the Fortune 500 and FTSE 100 samples analysed by Craig and Amernic (2018), is *realism*, with a mean score of 52.67 in the JSE shareholder letters and means of 54.84 and 54.38, respectively, in the Fortune 500 and FTSE 100 letters. DICTION (n.d.) describes *realism* as "[l]anguage describing tangible, immediate, recognizable matters that affect people's everyday lives". When a CEO reports, they are indicating, amongst other issues, how the activities of the company have affected its workers, the surrounding community, and other stakeholders. The activities and strategies of the company thus need to be explained in realistic, tangible ways. Although the focus of Craig and Amernic's (2018) study was on CEO hubris, they also conclude that *realism* as a narrative style is a hallmark of CEOs' shareholder letters.

The *activity* narrative style was found to have the third-highest mean in all three samples: 49.26 in the JSE sample, 49.12 in the Fortune 500 sample, and 49.24 in the FTSE 100 sample. *Activity* language is defined, in the DICTION software, as "[l]anguage featuring movement, change, the implementation of ideas and the avoidance of inertia" (DICTION, n.d.). This narrative style is to be expected in a CEO's shareholder letter, as the CEO is describing how past plans and strategies have been implemented. This style was found to have the lowest standard deviation of the five master variables in the JSE sample. An explanation for this low variation between CEOs could be that almost all CEOs can be expected to write about how previous plans were executed or adapted, as that is arguably core to what "management" entails.

*Commonality* as narrative style was found to rank fourth in the South African CEOs' letters and in the letters analysed by Craig and Amernic (2018). *Commonality* showed means of 49.04 in the JSE sample, 49.08 in the Fortune 500 sample, and 49.13 in the FTSE 100 sample. DICTION (n.d.) describes this narrative style as "[l]anguage highlighting the agreed-upon values of a group and rejecting idiosyncratic modes of engagement". It makes sense for CEOs to use this narrative style as they are trying to indicate how the company's strategy execution is achieving the company's shared vision and mission in the longer term. Furthermore, in terms of the agency relationship, the board is appointed by the shareholders and this could spur CEOs on to communicate how the management team's (agents) and her or his values align with those of the shareholders (principal).

The least-used narrative style in our sample and in the samples analysed by Craig and Amernic (2018) was found to be *certainty*. As seen in Table 1, the means that emerged were 46.67, 47.17 and 47.93, respectively. These scores are well below the fourth-ranked style. DICTION defines the *certainty* narrative style as "[l]anguage indicating resoluteness, inflexibility, and completeness and a tendency to speak ex-cathedra". When addressing shareholders in the shareholder letter, the CEO must be cognisant of the fact that realities on the ground may force plans to change, and that



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the company should be flexible. Furthermore, the CEO may be attuned to the reality that in many situations, decisions are taken with the best available information, which is not necessarily complete information. Fear of litigation can also dampen the CEO's use of *certainty* as a narrative style. This narrative style had the largest standard deviation. We assume that this was due to the variations in levels of risk specific to each company.

RQ1 asked to what extent a comparison of the narrative styles in South African and international CEOs' shareholder letters would reflect institutional isomorphism. The combined results from Table 1 lead us to conclude that the narrative styles applied by South African CEOs in their shareholder letters do not meaningfully differ from those of the international company CEOs' letters analysed by Craig and Amernic (2018). If one assumes that most CEOs of large, listed companies complete similar managerial training (e.g., MBA), the similarity in dominant communication styles could be attributable to normative isomorphism (DiMaggio & Powell, 1983). The fact that the standard of corporate governance in South Africa is judged to be on par with that of some of the world's strongest developed countries (WEF, 2019) contributes to the validity of the finding that normative isomorphism is at work, even when local institutional contexts might be different. Furthermore, the prevailing Anglo-American corporate culture amongst South African CEOs presumably reinforces normative isomorphism and thus contributes to the similarity between South African shareholder letters' narrative styles and the styles found in shareholder letters written by the CEOs of large international companies listed in the US and the UK. We reject mimetic isomorphism as an explanation as there is not a strong novelty aspect to writing a shareholder letter ("new" or "uncertain" conditions are required for mimetic isomorphism). Thousands of examples of shareholder letters are available on companies' websites and they are a standard feature of integrated annual reports.

RQ2 asked to what extent the narrative styles in South African CEOs' shareholder letters could be indicative of the use of impression management techniques. To answer this, we revert to how each of the master variables (styles) is computed in DICTION. The *optimism* score is a composite of positive words from which negative words relating to blame, hardship, and denial are deducted. A high net score for *optimism*, which emphasises praise and accomplishments, seems likely to be an indication of impression management in our sample companies. The CEO is potentially trying to win the favour of the shareholders who must vote at the next annual general meeting on their renewed contract and variable remuneration. DICTION's computation of *realism* similarly consists of positive scores for, amongst others, familiarity and human interest, from which scores for past concerns and complexity are deducted. A high *realism* score can also be interpreted as evidence of impression management, in the sense that the CEO is trying to establish rapport and putting a "human face" on the company. Alternatively, the CEO could be trying to win sympathy from the shareholders, despite the poor performance of the management team. In





answering the second research question, we therefore conclude that certain narrative styles employed by the CEOs of JSE-listed consumer goods and services companies in their shareholder letters can be understood as evidence of the use of impression management tactics. This should concern readers of shareholder letters and regulators, as excessive impression management can increase client risk and, in turn, audit fees (Dikolli et al., 2020; Greiner et al., 2020), resulting in increased monitoring costs for shareholders.

## 5. Conclusions

This study contributes to the body of literature on normative institutional isomorphism. Our findings indicate that the economic development status of a country does not necessarily mean that its CEOs will employ different narrative styles to those of the CEOs of large international companies based in much richer countries when communicating with shareholders. We propose that good corporate governance standards, cultural commonalities, and standardised business education contribute to normative isomorphism and limit heterogeneity in corporate narrative styles. It is also argued that the South African CEOs' dominant communication styles in the shareholder letters lend themselves to being tools of impression management.

The study also has limitations, with the limitations indicative of ample scope for future research. As an exploratory study, the scope was confined to companies in the consumer goods and consumer services industries, and to a single year of reporting. An investigation of the narrative styles of CEOs of South African companies in other industries would provide useful insights. Observing narrative styles over time would provide insight into the degree to which (if at all) narrative styles evolve as a company grows (or contracts). Textual analysis of additional corporate documents, such as complete integrated annual reports and/or sustainability reports, would also be of value.

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## Appendix: South African sample for the study

| Company name | CEO | CEO's gender | Industry | CEO letter's word count |
|---|---|---|---|---|
| ADvTECH Ltd. | Roy Douglas | Male | Consumer services | 2,141 |
| Anheuser-Busch InBev SA/NV | Carlos Brito | Male | Consumer goods | 2,407 |
| Astral Foods Ltd. | Chris Schutte | Male | Consumer goods | 5,413 |
| AVI Ltd. | Simon Crutchley | Male | Consumer goods | 2,806 |
| Bid Corporation Limited | Bernard Berson | Male | Consumer services | 3,385 |
| British American Tobacco plc | Nicandro Durante | Male | Consumer goods | 1,112 |
| Cashbuild Ltd. | Werner de Jager | Male | Consumer services | 1,117 |
| Clicks Ltd. | David Kneale | Male | Consumer services | 2,384 |
| Clover Industries Ltd. | Johann Vorster | Male | Consumer goods | 1,819 |
| Comair Ltd. | Erik Venter | Male | Consumer services | 4,062 |
| Combined Motor Holdings Ltd. | JD McIntosh | Male | Consumer services | 2,512 |
| Crookes Brothers Ltd. | Guy Clarke | Male | Consumer goods | 1,023 |
| Curro Ltd. | Andries Greyling | Male | Consumer services | 649 |
| Dischem Ltd. | Ivan Leon Saltzman | Male | Consumer services | 1,759 |
| Famous Brands Ltd. | Darren Hele | Male | Consumer services | 2,245 |
| HomeChoice Holdings Ltd. | Gregoire Lartigue | Male | Consumer services | 2,074 |
| Hosken Passenger Logistics and Rail Ltd. | Francois Meyer | Male | Consumer services | 906 |
| Italtile Ltd. | Jan Potgieter | Male | Consumer services | 3,481 |
| Kaap Agri Bedryf Ltd. | Sean Walsh | Male | Consumer services | 1,257 |
| Lewis Group Ltd. | Johan Enslin | Male | Consumer services | 1,065 |
| Libstar Holdings Ltd. | Andries van Rensburg | Male | Consumer goods | 2,349 |
| Massmart Holdings Ltd. | Guy Hayward | Male | Consumer services | 4,112 |
| Metair Investments Ltd. | Theo Loock | Male | Consumer goods | 1,902 |
| Mr Price Group Ltd. | Stuart Bird | Male | Consumer services | 698 |
| Naspers Ltd. | Bob van Dijk | Male | Consumer services | 1,851 |
| Northam Platinum Ltd. | Paul Dunne | Male | Consumer services | 1,675 |
| Oceana Group Ltd. | Imraan Soomra | Male | Consumer goods | 2,382 |
| Pepkor Holdings Ltd. | Leon Lourens | Male | Consumer services | 1,276 |
| Phumelela Gaming & Leisure Ltd. | John Stuart | Male | Consumer services | 1,844 |
| Pick n Pay Stores Ltd. | Richard Brasher | Male | Consumer services | 2,113 |
| Pioneer Foods Ltd. | Tertius Carstens | Male | Consumer goods | 1,651 |
| Premier Fishing and Brands Ltd. | Mogamat Samier Saban | Male | Consumer goods | 1,091 |
| Quantum Foods Ltd. | Hendrik Lourens | Male | Consumer goods | 2,115 |
| RCL Foods Ltd. | Miles Dally | Male | Consumer goods | 4,071 |
| Rex Trueform Group Ltd. | Catherine Radowsky | Female | Consumer services | 855 |
| Rhodes Food Group Ltd. | Bruce Henderson | Male | Consumer goods | 1,217 |
| Sea Harvest Group Ltd. | Felix Ratheb | Male | Consumer goods | 1,272 |
| Seardel Investment Corp. Ltd. | André van der Veen | Male | Consumer services | 867 |
| Shoprite Holdings Ltd. | Pieter Engelbrecht | Male | Consumer services | 1,034 |
| Spur Corporation Ltd. | Pierre van Tonder | Male | Consumer services | 2,811 |
| Stadio Holdings Ltd. | Chris van der Merwe | Male | Consumer services | 537 |
| Steinhoff International NV | Louis du Preez | Male | Consumer goods | 2,926 |
| Sun International Ltd. | Anthony Leeming | Male | Consumer services | 3,056 |
| Taste Holdings Ltd. | Tyrone Moodley | Male | Consumer services | 2,090 |
| The Foschini Group Ltd. | Doug Murray | Male | Consumer services | 2,002 |
| The Spar Group Ltd. | Graham O'Connor | Male | Consumer services | 1,931 |
| Tiger Brands Ltd. | Lawrence MacDougall | Male | Consumer goods | 2,096 |
| Truworths Ltd. | Michael Mark | Male | Consumer services | 2,290 |
| Tsogo Sun Ltd. | Jacques Booysen | Male | Consumer services | 2,477 |
| Vivo Energy plc | Christian Chammas | Male | Consumer services | 1,184 |
| Woolworths Holdings Ltd. | Ian Moir | Male | Consumer services | 2,388 |





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# Reviewing a Decade of Human–Computer Interaction for Development (HCI4D) Research, as One of Best's "Grand Challenges"

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**Abstract**
The human–computer interaction for development (HCI4D) field emerged at the intersection of the fields of information and communication technology for development (ICT4D) and human–computer interaction (HCI). In 2010, Michael Best nominated HCI4D as one of ICT4D's "grand challenges". This HCI4D field is now entering its second decade, and it is important to reflect on the research that has been conducted, and to consider how HCI4D researchers have addressed the challenge that constitutes the *raison d'être* of HCI4D's existence. Best provided four guidelines to inform researchers embracing this challenge. This study commences by identifying the primary HCI4D-specific themes, and then carries out a systematic literature review of the HCI4D literature to build a corpus to support the analysis. The corpus is analysed to reflect on how well the field's practices align with Best's guidelines. The overall finding is that HCI4D researchers have largely been following Best's guidelines and that the HCI4D field is demonstrating encouraging signs of emerging maturity.

**Keywords**
Human–computer interaction for development (HCI4D), information and communication technology for development (ICT4D), human–computer interaction (HCI), guidelines, Michael Best

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## 1. Introduction

In 2010, Michael Best, the internationally recognised computer scientist and scholar of information and communication technology for development (ICT4D), contemplated the necessities facing the ICT4D field. In a brief theoretical contribution published in the *Information Technologies & International Development (ITID)* journal, Best (2010) enumerated four "grand challenges" that the ICT4D field needs to address to prove itself a progressive intellectual enterprise (2010, p. 52): (1) sustainability, (2) post-conflict and disaster computing, (3) HCI4D, and (4) appliances.

Human–computer interaction for development (HCI4D) is a multi-faceted field that focuses on understanding and designing technologies for under-served, under-resourced, and under-represented populations in a variety of geographic regions (Dell & Kumar, 2016). The HCI4D field, like its parent fields—information and communication technology for development (ICT4D) and human–computer interaction (HCI)—has enjoyed much attention, as evidenced by the significant and burgeoning number of research publications that have appeared since Best (2010) posed the challenges.

Best argued that, in order to address the challenges, researchers ought to: (1) return to the field's "interdisciplinary and holistic roots", (2) avoid "fetishistic techno-utopianism", (3) focus on "fundamental innovation" through "multi-year initiatives", and (4) develop "fundamental shared problems" and tackle the problems with "mixed methods" and strong "evaluation and assessment" (2010, p. 51). A decade has passed since Best published his seminal article, and it seems an appropriate time to gauge how well researchers have responded to the imperatives he proposed. Accordingly, this study, a systematic literature review, probes this core question: To what extent have HCI4D researchers followed Best's four guidelines in carrying out the research in this ICT4D challenge area?

## 2. Research design

The systematic literature review (SLR) was carried out to construct a corpus of HCI4D research published from 2009 to 2019. SLRs are a recognised method of supporting analysis of the literature in a research domain (Paré et al., 2015). The aim thereof is to go beyond merely aggregating existing evidence and to construct evidence-based lessons from the accumulated research (Kitchenham et al., 2009; Grant & Booth, 2009). The processes of data collection, data condensation, data display, drawing conclusions, and verifying conclusions are applied, either allowing the publications to suggest themes (open coding), or using pre-existing themes to constrain and inform the analysis (directional coding) (Miles et al., 2019). Over the past 11 years (2009 to 2019), several researchers have published surveys of the HCI4D literature. We extracted the dimensions and overarching themes from this existing review literature (see Table 1), and used those themes to conduct directional coding analysis, as advised by Bramer et al. (2018).

Different acronyms have been used to refer to research focusing on human-centred design aiming to foster socio-economic development. We acknowledge the ambiguity and even controversy surrounding the term "development", and the fundamental duality between those studies that focus on understanding technology "for development" (where there is a commitment to human and socio-economic development) and those studies that focus on understanding technology in developing countries. Despite the academic discourse, and the critique that the terms "development" and "for development" introduce ambiguity (Toyama, 2010), the term "HCI4D" has survived, as evidenced by increasing research in this area that uses this term in the publication titles or as keywords. This publication-based measure admittedly does not reflect the adoption of the term by government, industry, and the broader community, but that is beyond the scope of this paper.

**Table 1: Themes in existing review literature**

| **Dimensions** | Ho et al. (2009) | Dell and Kumar (2016) | Van Biljon and Renaud (2019) | Van Biljon (2020) | Chetty and Grinter (2007) | **Overarching themes** |
|---|---|---|---|---|---|---|
| Cross-cultural context | • | | | | | Context |
| **Who**: Target users | | • | • | • | • | |
| Developmental needs | • | • | • | • | • | International development |
| **Where**: Geographical distribution | | • | • | • | | Intervention |
| **What**: Technology and interfaces | | • | | • | | |
| **Why**: Focus areas | | • | • | • | | |
| **How**: Research methods | • | • | • | • | | |

Okoli (2015) argues that a rigorous literature review should be systematic, explicit, comprehensive, and reproducible by other researchers who are interested in following







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the same approach in reviewing the topic. We followed the systematic literature review based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) method (Moher et al., 2009), which resulted in the corpus of literature to support the analysis.

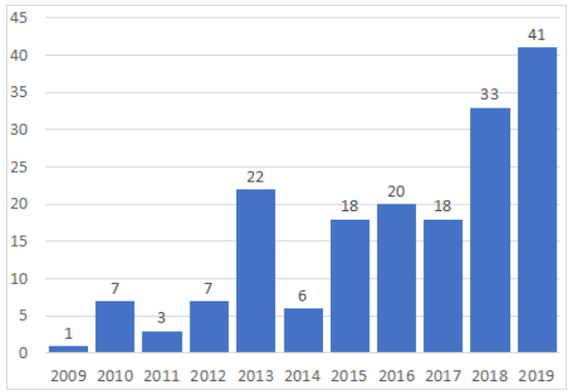
The Scopus database was selected as the search database since it includes many of the titles where the ICT4D and HCI4D conference proceedings are published. The review was conducted in the week of 18 February 2020, using the keyword "HCI4D" and the period 2009 to 2019. The SLR excluded all items that were not peer-reviewed, and we excluded patents and magazine articles. That produced 230 publications, which included items—proceedings of workshops and symposiums, abstracts from books, and bulletins published as conference proceedings—in which the format was condensed and hence not comparable to the other pieces of literature. Removing these items, 176 publications remained to support analysis: 171 conference publications and five journal articles.[1] Using only the term "HCI4D" might be considered a limitation due to the diversity surrounding "4D" terminology. However, given that Best's (2010) grand challenge specifically refers to HCI4D, it was decided that only this single keyword should be used.

## 3. Findings

### *When: Annual publication levels*

Grouping the HCI4D publications in terms of number per year, as depicted in Figure 1, reveals that the annual number has increased since 2009 (from 1 in 2009 to 41 in 2019) with a dramatic increase in 2013, a decline in 2014, and a less obvious decline in 2017, followed by a strong rise in both 2018 and 2019. The reasons for the strong increase in 2013 are debatable but might be attributable to the convergence of a number of biannual conferences as well as the first HCI4D event being organised at CHI2013 that year.

**Figure 1: Number of publications per year**




1 The corpus of 176 items is available at https://tinyurl.com/HCI4D-Corpus

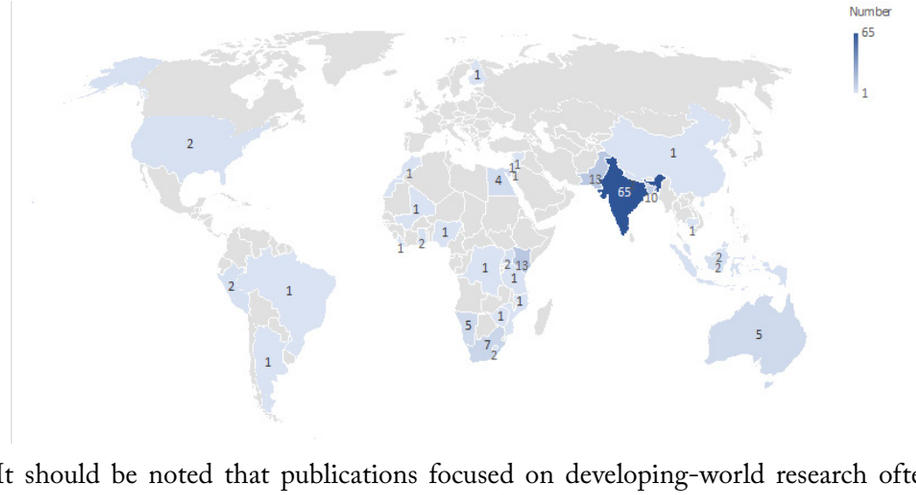




### *Where: Research and author locations*

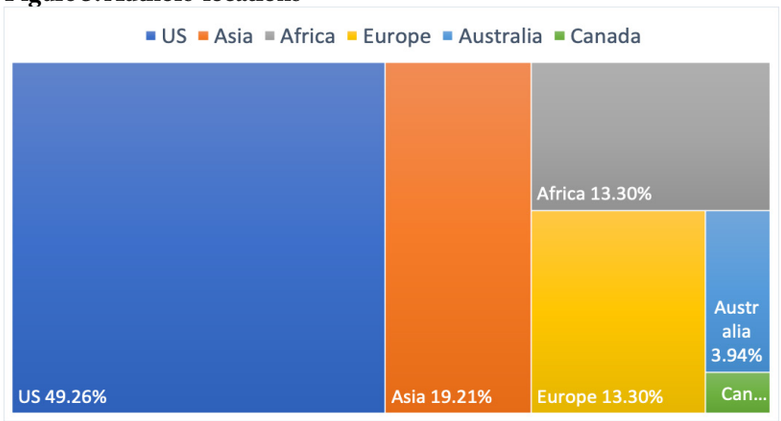
Figure 2 depicts the geographic locations of the research reported in the 176 items reviewed. It shows that the largest amount of HCI4D research covered in the publications has been done in India (65), with Pakistan (13) and Kenya (13) in second place, followed by Bangladesh (10) in third.

**Figure 2: Research locations**




It should be noted that publications focused on developing-world research often have authors based in developed countries (see Bai, 2018; Van Biljon & Renaud, 2019). Figure 3 demonstrates that most (67.5%) of the lead authors in our corpus of literature are based in the US, Europe, Australia, and Canada, i.e., outside the developing world. (If an author worked on five separate publications, they would be counted five times—the graph represents the authorship of the corpus, not the authorship of the HCI4D field.)

**Figure 3: Authors' locations**



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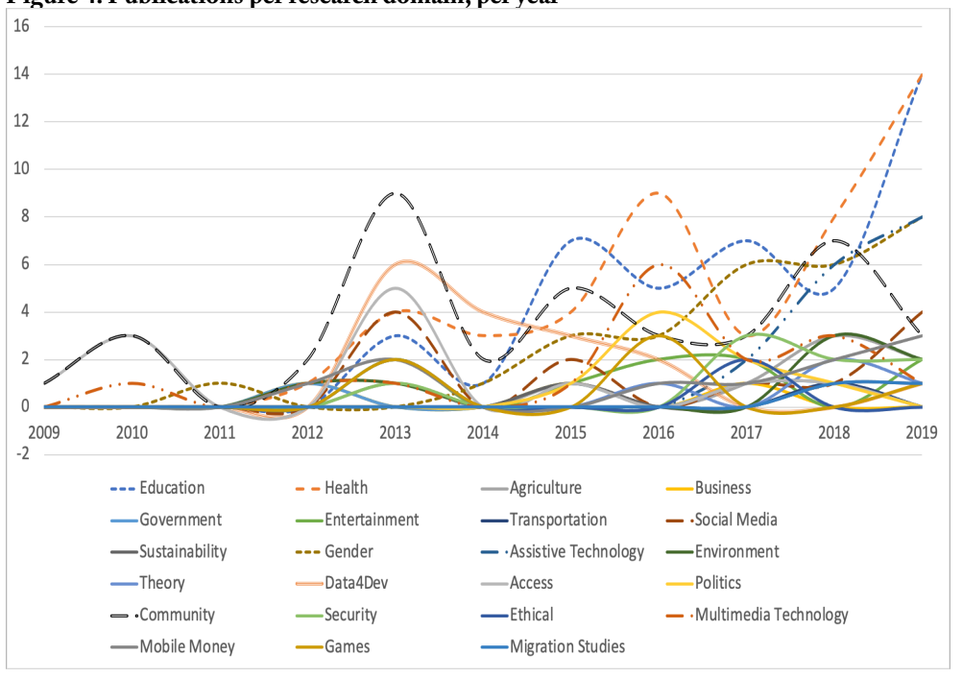
***Why: Research domains***

As seen in Figure 4, the health domain attracted the most attention (28%) in the HCI4D literature in our corpus, followed by education (24%) and gender (18%). The aim was to categorise publications according to the dominant domains, but two domains were selected for some publications. For example, a publication on the use of an app to teach about a medical condition, where the research involved both health and education, was counted in both categories, such that the total number of domain selections is 349 while the total number of publications is only 176. This means that the percentages provided per domain include overlap. Furthermore, some of the domains that emerged, such as *community*, *Data4Dev*, *interactive voice response (IVR)* and *access*, might not be considered independent domains, and *migration studies* might be considered a discipline rather than a domain. This visualisation is provided as a snapshot provided primarily to demonstrate the diversity and reach of the research reported in the corpus.

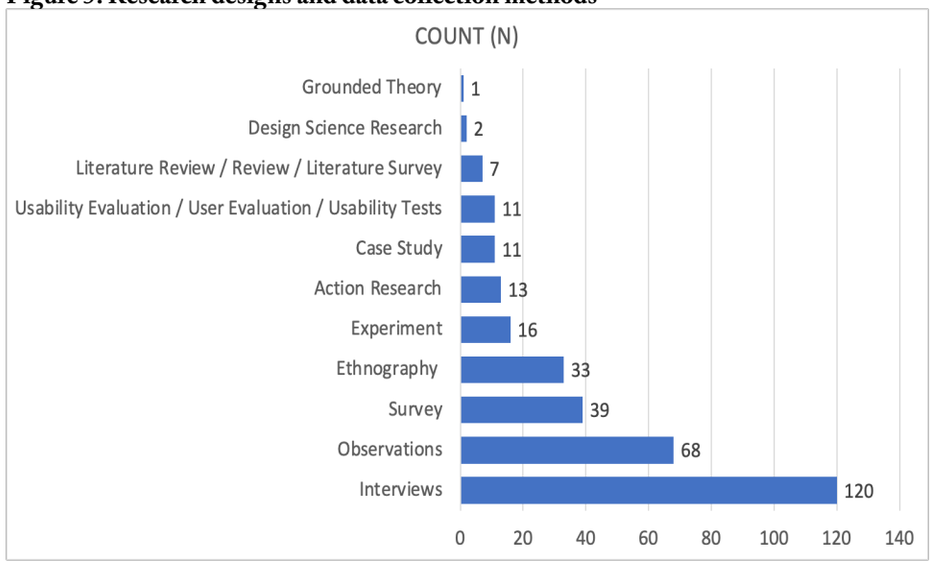
**Figure 4: Publications per research domain, per year**




***How: Research designs and data collection methods***

Figure 5 provides an overview of the methodological information reported in the 176 items of literature. Ethnography, experiment, action research, and case study were found to be the most common research designs, while interviews, observations, and surveys were the most common types of data collection strategies. Given the interdisciplinarity of HCI, there is little standardisation on methodological terminology. For example, some researchers refer to a survey as a research design while others consider it a data capturing method. To avoid misclassification, we do not separate research design and data capturing methods.

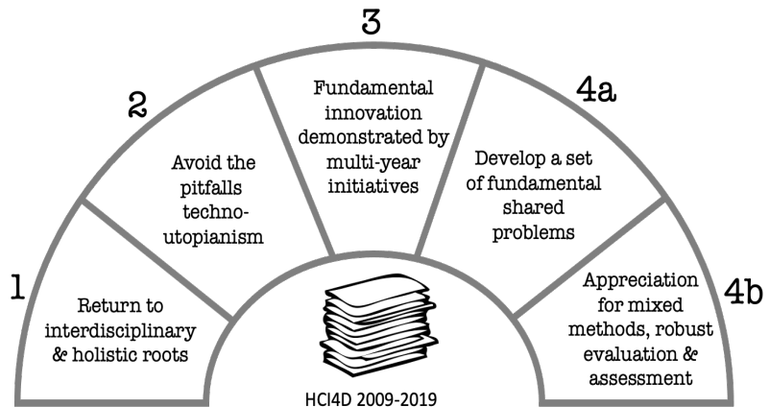
**Figure 5: Research designs and data collection methods**




***Alignment with Best's four guidelines***

We now set out the findings from the analysis of the corpus in respect of alignment with each of Best's (2010) four guidelines. As depicted in Figure 6, we split the fourth guideline into two parts for the purposes of our analysis, with 4a relating to the set of fundamental problems and 4b detailing the research methods used for each.

**Figure 6: Best's four guidelines**




Source: Derived from Best (2010)





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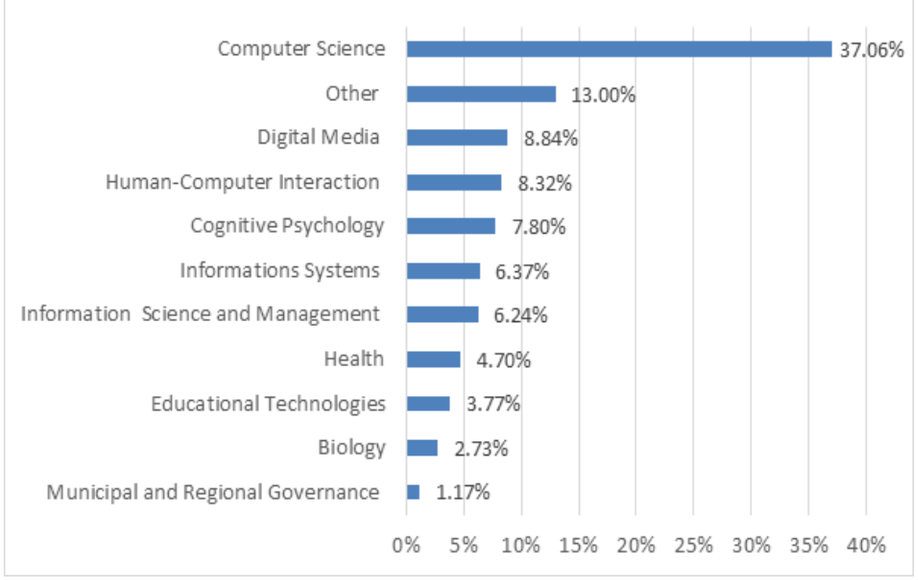
***1: Is the field returning to interdisciplinary and holistic roots?***

Interdisciplinarity occurs when researchers from diverse disciplines work together in carrying out a piece of research. To assess whether the HCI4D field is engaging in this kind of research, the following actions were carried out:

- ascertain the discipline of each publication's authors (based on their institutional home);
- group semantically similar disciplines (for example, Computer Science, Computer Science and Engineering, Computer Engineering and Software Engineering were considered to be one meta-category); and
- tally the number of publications written by authors coming from each discipline.

The final percentages are provided in Figure 7. It is clear that Computer Science and Computer Science-aligned disciplines such as Information Systems, Information Science and Management, Human–Computer Interaction (HCI), and Education Technologies dominate, which is to be expected because HCI4D is grounded in Computer Science. Yet there is still evidence of a great deal of interdisciplinary work. Of the 176 publications, 109 (62%) have authors from at least two different disciplines, while 44 (25%) have authors from three different disciplines. (The "Other" group includes all disciplines which, on their own, make up less than 1% of the total. These disciplines are wide-ranging, and include International Relations, Television and Features, and Organic Chemistry.)

**Figure 7: Author disciplines**








***2: Is the field avoiding techno-utopianism?***

In order to evaluate this aspect, we focused on the maturity of research in the field—on the assumption that a mature field would be one that has moved beyond any one narrow focus, e.g., a focus on the benefits of technology. We categorised each item in the corpus in terms of type of publication and the artefact(s) produced in the publication. Van Biljon and Renaud (2018) use three cross-cutting meta-themes to assess the maturity of the mobile communication technology for development (M4D) field based on an analysis of the M4D conference publications. Adopting the same three purpose-related meta-themes as the basis for the analysis, the publications were categorised according to their stated purpose, as follows:

- *Foundational publications*: Publications that seek to capture and describe the *status quo* towards understanding the user's needs, context, or use of technology. The research design often involves self-reporting during interviews, surveys, or focus groups where the context, needs, expectations, and aspirations are captured. N = 51 (29% of the items in the corpus).
- *Design or intervention publications*: Publications that describe the design, implementation, and evaluation of applications (benefiting from the findings of theme 1 publications, but also extending them). The research design encompasses requirements gathering, artefact development, and evaluation based on users' self-reporting, observations, usability testing, or ethnography. The artefacts include prototypes of ICT systems and technology probes. N = 116 (67%).
- *Abstraction or theorisation publications*: Publications that apply existing knowledge to implement ICT technology, replicate that knowledge in a new context, or extend existing research. That is, these are items that analyse, synthesise, and refine existing research in order to generate abstract new knowledge. Meta-view analyses identified trends and explicitly built on the extant literature, e.g., systematic literature reviews, analysis of trends towards suggesting models and theories, and making recommendations about the way ahead. N = 9 (5%).

Figure 8 shows the number of publications and citations per publication type and the year of the first publication of each type. The first *foundational* publication is from 2009; the first *design or intervention* publication is from 2010; and the first *abstraction or theorisation* publication is from 2014. This progression is to be expected because abstraction or theorisation publications reflect increased maturity in the field, i.e., the field needs to be mature enough to have generated significant research in the *foundational* and *design or intervention* categories if there is to be sufficient material to inform *abstraction or theorisation* publications.



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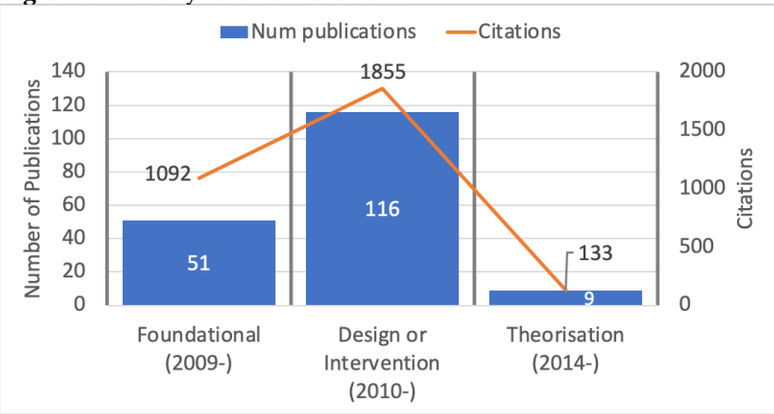
**Figure 8: Maturity of the HCI4D field**




These results indicate that the largest percentage of publications (67%) are those describing a design or intervention. That resonates with the real-world focus of the area. To gain insight into how many of these design and intervention publications produced a new system, the publications were sub-categorised in terms of their artefact contribution. It was found that 83 (47%) do not present any type of system as contribution. New digital systems are presented in 91 (52%) of the publications and non-digital artefacts (e.g., curricula) in two (1%) of the cases. New digital application systems are informed by both target user requirements and academic literature.

In the 91 studies where new systems are developed or tested, the results show that both users and the literature are consulted in 77 (85%) of the cases and only users are consulted in 12 (13%) of the studies. Only 2% of the publications are silent on requirements gathering. This implies that the contextual requirements are considered a priority in much of the HCI4D research, and obtaining end-user input seems to be treated as more important than consulting the research literature. The importance of context in HCI4D is supported by Patterson et al.(2009) and Abdelnour-Nocera and Densmore (2017), but the finding of potential lack of emphasis on engagement with the relevant literature is somewhat novel.

Considering the distribution of the types of publications and the contextual embeddedness of the new technologies developed, it seems as if contextual needs are guiding development, so that techno-utopianism does not appear to dominate the HCI4D field. Resource constraints, which often manifest in the HCI4D context (Toyama, 2010; Dell & Kumar, 2016) necessitate the consideration of cost and sustainability. These resource constraints and contextual requirements mitigate the drive for using new technology, which could explain why techno-utopianism in less pronounced in HCI4D research than in HCI.





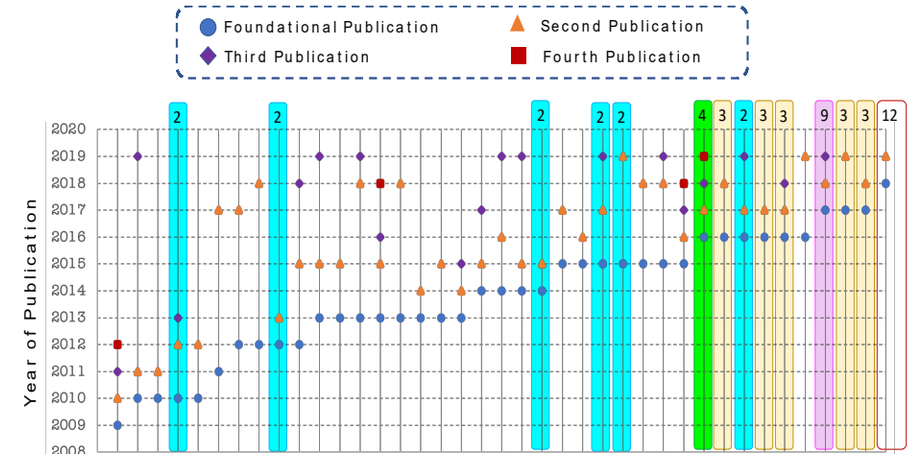
***3: Is the field engaging in fundamental innovation through multi-year initiatives?***

Kondrat'ev (1984) argues that fundamental innovations drive economic growth. A fundamental innovation enables other incremental research to improve, derive from, or extend it. Hence, a way to detect whether a field is embracing this principle is to look for multiple successive publications addressing the same innovation. If a publication introduces an innovation which then leads to multiple other publications extending the original research, it could be argued that the original publication's reported innovation has become fundamental.

To reveal fundamental innovation, two steps were carried out. First, a search for the publication was conducted using Google Scholar. Second, the "cited by" link was used to obtain the list of publications that have cited the source publication (as an indication of the degree to which the research is being built on). When it was found that the citing publication was written by one or more of the same authors as the source publication, and deals with the same topic, that was taken as indicating that one or more of the authors is engaged in a multi-year research initiative.

Of the 176 items in our corpus, 81 have been cited by subsequent publications by at least one of the original authors. This can be considered as evidence of multi-year initiatives. We identified 39 different multi-year publication profiles. These are distinct multi-year innovation research profiles. Figure 9 shows the 39 multi-year publication profiles. Some appear repeatedly, mostly towards 2019. This might well be an indication that the field is demonstrating increasing maturity, showing that researchers are starting to embrace the need for multi-year initiatives and acknowledging that genuine innovation can occur only when researchers extend research rather than continually re-invent.

**Figure 9: Multi-year publication profiles**




Note: Multiple instances are indicated using coloured rectangles, with the total number of instances indicated at the top.



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***4a: Is the field developing a set of shared research problems?***
As seen in Figure 4 above, central themes have emerged, such as health, education, and gender. This provides evidence of shared research problems while other publications lie at the intersection of domains, e.g., the Yadav et al. (2019) study on the potential of chatbots for breastfeeding education links to both health and education.

***4b: Is the field characterised by mixed methods and strong evaluation and assessment?***
The most often-cited data collection method, as seen in Figure 5, is interviews, followed by observations (almost 50% less), and then by surveys. However, as is evident from Figure 8, a range of research designs and data capturing methods is being used. With respect to the evaluation component in the published research, 81 of the 91 publications that present a new digital system report an evaluation procedure. Hence most new digital systems (89%) were subjected to formal evaluation. However, it must be acknowledged that the rigour of the claimed evaluation could not always be deduced from the publications.

## 4. Analysis in terms of Best's guidelines

***Returning to interdisciplinary and holistic roots***
As seen in the findings, there are encouraging signs that researchers from a variety of disciplines are indeed working together, if we use the disciplines of the publication authors as evidence of this. Furthermore, there are suggestions that researchers in all realms of development-related research should work together, as a community (Ho & Veeraraghavan, 2008), and in multidisciplinary, interdisciplinary, or transdisciplinary ways (Walsham, 2017).

***Avoiding the pitfalls of techno-utopianism***
The findings suggest there is a tendency for researchers to design or build new interventions. This is typical of the problem-solving first phase of a new field (Winters & Toyama, 2009), which places primary importance on an intervention showing measurable improvement, but there is evidence of the values-first approach focusing on the construction of a shared perspective between researchers and the communities they research. However, only nine publications were found to be building on the extant literature. While it can be expected for a new field such as HCI4D to spend its first decade on *foundational* publications and *design* or *intervention* publications (the first two types in Figure 8), we anticipate uncovering evidence of greater maturity over the next 10 years, as per the emergence, as seen in Figure 8, of *abstraction* or *theorisation* publications in 2014.

***Engaging in fundamental innovation through multi-year initiatives***
Figure 9 demonstrates a number of multi-year research profiles, which shows that authors are not merely parachuting in to do a single study and then moving on. This is evidence of researchers' commitment to their own innovations. We have to consider this against the dynamic nature of technology development and funding realities





where multi-year initiatives are often not practical despite the best intentions of researchers.

***Developing shared problems, using mixed methods, and conducting robust evaluation and assessment***
Figure 4 shows that a number of shared problems (research domains) have started to emerge, as judged by the attention they have garnered. It can be observed that health and education are enjoying the most attention towards the end of the corpus time span. Many other topics cluster at the bottom of this graph, indicating that there is not, at this stage, implicit acknowledgement that these are compelling shared problems. Still, a large and diverse number of topics are enjoying attention.

***Summary***
The findings suggest that research projects reported in the field of HCI4D are mostly aligned to Best's guidelines. To engender continuation of these positive trends, it would be helpful if conference chairs could ensure that calls for publications specifically include topics that encourage research building on existing research, and other publications aimed at maturing the field. For instance, they could create a category for "systematisation of knowledge" publications (which would feed into *abstraction or theorisation* publications, the third and most mature type in Figure 9), or require those who develop technology to provide their code on GitHub so that other researchers can make use of it.

***Study limitations***
Despite a rigorous approach enforced by the strict application of the SLR as method, any literature survey can be faulted for having made contestable decisions (both intentionally and unintentionally) about which works to include and which elements to emphasise in the works identified. We acknowledge the ambiguity and limitations surrounding the term "development" (Sen, 2001; Toyama, 2010) and the duality in the ICT and development research agenda (Brown & Grant, 2010). However, this article does not attempt to engage with the ongoing discussion on how development should be defined and whether we should distinguish between research conducted *in the developing world*, with people at the margins, and research conducted specifically *for development*. We also recognise the potential limitations of using "HCI4D" as the sole search term—a choice made, as explained earlier, because that is the term used by Best in the seminal 2010 publication. In addition, only one database, Scopus, was used to identify publications to feed into the review and the publications retrieved were mostly conference publications. It might well have been possible to identify a larger and more diverse range of publications if other databases had also been consulted.



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## 5. Conclusion

As the field of HCI4D enters its second decade, a veritable adolescence, we offer, through this study, an analysis of HCI4D publications published 2009 to 2019, in order to present a snapshot of the field. Using Best's guidelines to structure the analysis, this snapshot is provided as an overview of the field, in order to take cognisance of the sophisticated and important work that has been done in this space. In doing systematic literature reviews in fields such as this one, it is necessary to accept that the field is characterised by a wide diversity of terminology and, notwithstanding such constraints, to still push forward with the review exercise in order to generate the available insights.

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# CRITICAL INTERVENTION



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# The Neo-Colonial Political Economy of Scholarly Publishing: Its UK-US Origins, Maxwell's Role, and Implications for Sub-Saharan Africa

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**Abstract**
The prevailing dynamics of today's global scholarly publishing ecosystem were largely established by UK and US publishing interests in the years immediately after the Second World War. With a central role played by publisher Robert Maxwell, the two nations that emerged victorious from the war were able to dilute the power of German-language academic publishing—dominant before the war—and bring English-language scholarship, and in particular English-language journals, to the fore. Driven by intertwined nationalist, commercial, and technological ambitions, English-language academic journals and impact metrics gained preeminence through narratives grounded in ideas of "global" reach and values of "excellence"—while "local" scholarly publishing in sub-Saharan Africa, as in much of the developing world, was marginalised. These dynamics established in the post-war era still largely hold true today, and need to be dismantled in the interests of more equitable global scholarship and socio-economic development.

**Keywords**
scholarly publishing, academic journals, global science, universities, colonialism, decolonisation, impact metrics, distribution rights, copyright, fair use, fair dealing, Robert Maxwell, UK, US, sub-Saharan Africa, South Africa

**DOI:** https://doi.org/10.23962/10539/31367

**Recommended citation**
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## 1. Introduction

It is in the political aspirations and the business models that emerged in the wake of the Second World War that one finds the mechanisms that have subsequently tied journals in as a key component of the career promotion systems in academia, thus turning these publications into big business, and entrenching neo-liberal economic thinking into the supposedly esoteric sphere of scholarly publishing.

In the middle years of the 20th century, the dominance of English-language scholarly publishing was shared between Britain and the US. These two powers had, much earlier in the century, forged a clearly neo-colonial "gentlemen's agreement" that international publishing and distribution rights of all kinds were to be divided up between these two powers, with the UK "owning" the Commonwealth as its territory and world market and the US (then very much the junior partner, in a situation that has changed radically since) getting "the rest of the world". At the heart of this system is the story of Robert Maxwell's post-war career, as he was largely responsible for building up journal publication as a large-scale and ultimately very profitable business in the UK and the US, underpinned by business efficiency (see Henderson, 2004).[1]

Maxwell was not the only newly minted journal publishing magnate in the period, but certainly one of the more colourful, and his connection to the wartime British Information Services provides a telling link with neo-colonial political ambitions. Maxwell showed a high level of business skill, transforming the amateur culture of the academic business, in order to build up scholarly publishing as a major cultural-economic player, in line with linguistic and economic nationalism in the post-war period.

What universities and scholars face today is a commercial academic publishing system that exists for the sake of ever-increasing profits, with control, even of internal university faculty promotions, captured by publishing mega-corporations that are among the most profitable and most powerful companies in the world. What is more, with particular relevance for higher education in Africa and elsewhere in the developing world, the contemporary system is decidedly an imperialist inheritance.

## 2. The origins and rise of today's global scholarly publishing system

Scholars often hark back, when seeking to justify the preeminence of journals in today's scholarly publishing ecosystem, to the idealised aims of the original establishment of what was to become the journal system in the English-speaking world.

1 This article relies to a great extent on Henderson (2004) for details of Maxwell's participation in the history of scholarly publishing.





This was the *Philosophical Transactions of the Royal Society of London*, first published in 1665.[2] In reality, it is more accurate to point to a very different 20th century tradition when locating the underpinnings of the contemporary journal system: an ethos built on post-war English-language nationalism and commercial power, drawing strength from the rise of technological development linked to big business interests. This is a long way from the ideal, espoused in *Transactions*, of mutual communication within a circle of scholars, whose "engagement in such Studies, and delight in the advancement of Learning and profitable Discoveries, doth entitle them to knowledge of what this Kingdom, or other parts of the World, do, from time to time afford […]".[3]

The post-war capture of the global journal business placed it in the hands of the two English-speaking victorious powers, the UK and the US, and the ethos, far from being collaborative, is highly competitive—with "excellence" serving as a core value, and an efficient promoter of growing markets and profits for the dominant powers in control of the system. It is a system underpinned by an understanding of the commercial potential of research to grant a competitive edge for technological and scientific advances generating profits and prestige in these nations.

### *Maxwell and the ascendance of the commercial journal*

Maxwell is best-known as a media magnate and swashbuckling character, rumoured by some to have served as an international double (or triple) agent, who died in 1991 after falling off his yacht in obscure circumstances. Less well-known (except in scholarly publishing circles), but nonetheless an interesting and revealing narrative, is Maxwell's central involvement in the growth of commercial scholarly journal publishing as a business and as a contribution to the intellectual expansion of Britain and the US, as well as other English-speaking powers after the Second World War. What this side of Maxwell's turbulent history reveals vividly is exactly how the post-war development of the political economy of the publishing sector entrenched the English language as the dominant medium of global scholarship and confirmed Britain and the US as the dominant powers whose views and ideologies would inform and direct the sector.

Before the war, German was the dominant language in global science, and Germany was a major force in scientific discovery. When Maxwell emerged on the scene, the German scholarly publishers, who had been hit hard by the war, saw their businesses decimated and their publications expropriated and reproduced outside of the country without payment (Henderson, 2004, pp. 68–69). At the same time, the war had consolidated an understanding of scientific knowledge, and particularly technological research, as an economic force that would be of vital strategic importance in the reconstruction of post-war commerce and political power.

2 *Transactions* is now available in its entirety online, at https://royalsocietypublishing.org/journal/rstl

3 Although, in the inter-war period, there were robust debates on whether this more open and collaborative approach to drawing benefits from research would be the path to take.



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Maxwell, from a modest background in Czechoslovakia, fought for the Allies in Europe, and after the war—by then a decorated war hero—he worked in the British Zone in Germany for the British Information Services. The British recognised the commercial value of German scientific publishing, and Maxwell approached publisher Springer Verlag with an offer to distribute its publications outside of Germany. Given his connection with his British employer, Maxwell was in a position to help the company with essential supplies and to find ways through bureaucratic obstacles.

From here, Maxwell built up a commercial journal business that he eventually named Pergamon Press (see Cox, 1998). As UK and US technological nationalism grew in response to Soviet advances—most notably the Soviet launch of the Sputnik I satellite in 1957—Maxwell increasingly focused on journals that published cutting-edge scientific research. Pergamon Press grew increasingly profitable, and Maxwell invested in the acquisition of sophisticated distribution technology. Rather than the then-conservative focus of the learned society publishers on traditional subject areas, Pergamon Press collared papers on emerging fields such as atomic energy, bought up translation rights in Soviet journals, and, most important, supported the creation of large numbers of new journals in the emerging subject areas. Many of the journals that were created were called "The International Journal of …", signalling the expansive imperial ambitions of the enterprise. Maxwell adopted new technologies as they arose, and invested in effective marketing. What had been a relatively amateur business sector grew rapidly and became professional big business.

***Scholarly journals and international power politics***

The journal publishing business also became a strategic tool for enhancing the power of knowledge in the building of enterprise in the two dominant English-speaking allies. This was a continuation of pre-war developments that linked research in telephony and communications, wireless and radar, transport, military equipment, and nuclear science, to the consolidation of commercial power in large nation-wide companies. In the US, in particular, with Vannevar Bush as a leading activist, this led to the creation of national scientific organisations dedicated to a strategic focus on leveraging science in the war effort. The atomic bomb was the spectacular pinnacle of these investments. Maxwell's capturing of the language hegemony in scientific publishing from Germany—a key element of the strategic development of Maxwell's journal business—thus bolstered the emergence of Britain and the US as the dominant powers in key strategic fields. Nationalistic hegemony came to be built into the journal business (Kleyn & Nicholson, 2018).

***Metrics and rankings – leveraging author prestige***

Another important contribution by Maxwell to the journal system arose from his recognition that editors and authors had traditionally been undervalued by the learned societies, and authors who sought recognition for emerging disciplinary areas were marginalised. Maxwell's Pergamon Press was willing to spend money on attracting





authors and editors: granting them a prestigious status, wining and dining them, empowering them, and supporting their ambitions. The company professionalised the production, marketing, and dissemination of the journals.

Maxwell anticipated the marketing potential of emerging tools such as the Science Citation Index, as developed in 1961 by Garfield's Institute for Scientific Information (ISI). This index, based on work started in 1955, enabled the development of journal bibliographic metrics to help librarians in their selection, for subscription purposes, from the ever-growing number of journals. Journal impact measures (e.g., the impact factor (IF), and then author citation counts), as competitive measures underpinning recognition and promotion, came later. (Impact factors were something that Garfield had not envisaged and did not entirely approve of.)

The ISI ranking system came to regard articles that addressed issues of concern to the UK and the US as capable of delivering impact—and thus status, to the journal concerned and, by extension, to the authors in that journal.

A publishing system that, in its pre-war incarnation, was neglectful of authors had now become excessively attentive to the desire of scholarly authors and their universities for prestige and status. The new system had also made scholarly authors captive to a promotion system delivered through citation counts linked to publication in the higher-ranking scholarly journals—a system upon which they became entirely dependent. What had emerged—and this is very familiar to us now—was a system whereby authors attained higher status and promotions through publishing in highly ranked journals (in topics that, in turn, added to the national and regional aspirations of the North Atlantic powers). At the same time, the cost of the journal subscriptions was not an issue that concerned the authors who drove support for the high-ranking journals—this was the burden of the libraries, essentially captives in a disjunctive business model in which they had to deliver to the desires of prestige- and promotion-hungry scholars.

After a turbulent financial history, Maxwell's journal empire eventually foundered and passed into other hands, finally being sold to Elsevier for USD770 million in 1991 to help fund his newspaper investments. But what Maxwell had been central to creating was a commercial academic publishing model with strong marketing and a high level of responsiveness to strategic developments in scholarship. He shrewdly understood the value that the competitive ranking systems would have for universities, scholarly authors, and their articles—a system that hooks the ecosystem's participants irretrievably into what is in fact a narrow and unreliable system that puts huge stress on library budgets, pushes scholarly books to the margins, and renders a swathe of development-focused and socially responsive research practically invisible. This is a distinctly commercial vision of the mission of academia.



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After Maxwell's death, the consolidation of large academic publishing companies increased, so that today there are essentially five huge journal companies that dominate the global scholarly publishing environment: Reed-Elsevier, Springer, Wiley-Blackwell, Taylor & Francis, and Sage—in what is now one of the most profitable business sectors one can find. Digital media have helped to entrench the value system of the journal empires, offering even more streamlined and efficient online systems for leveraging the metrics that underpin the competitive system of author prestige and university rankings.

It is striking that the business models and strategic structuring of the dominant corporate journals remain very much an artefact of a post-Second World War environment, built on the dominance of the major Allied powers in an increasingly capitalist world. For developing-country universities, scholars, and journals excluded from this system, the need to join the dominant game and share in this "excellence" became irresistible. This has persisted to the present day. The journal system remains a colonised business, one that has to be played by the rules of international power politics, while the interests of the countries that were colonies when this business model was conceived remain at the margins.

**3. How Maxwell's legacy is experienced in sub-Saharan Africa**

At the time of Maxwell's creation of the journal business following the Second World War, sub-Saharan African countries were, with very few exceptions, still colonies, and universities were virtually non-existent. When, post-independence, sub-Saharan African universities began to emerge, they found themselves marginalised in the systems driving the journal publishing business—systems in which, still today, "global" impact tends to be defined in terms of the English language and the interests of the North Atlantic powers. In terms of the impact factor, achieving impact—the value according to which journals are ranked in importance and status and accepted as "quality" and "core" publications—essentially means focusing on topics of interest to North Atlantic powers. Subjects that concern "only" developing countries are regarded as "local". Tropical disease outbreaks, such as the Ebola epidemic that recently devastated West African countries, fall into this definition. (Sub-Saharan African nations were also penalised, in the latter decades of the 20th century, by World Bank policy (linked to structural adjustment programmes), which marginalised African higher education and devalued African research.)

In sub-Saharan Africa, the market for books has been fragmented by decades of territorial licensing. If an Anglophone African publisher has a title with potential beyond its national market, the title will most often be licensed to a UK publisher, which will claim "rest of the world" rights. Buyers in other African countries will then have to buy this UK "world" edition, at a very high cost, rather than the original African edition. Lower-cost "international student editions" are offered in African markets, on a discretionary basis, by UK and US publishers for some large-volume





titles. For the rest of the UK and US titles, students have to pay the full US or UK price—a situation that applies particularly to upper-level specialist textbooks, which tend to be excluded from international rights arrangements or discretionary price reductions for smaller markets.

In the South African context, it is notable that a core point of contention in South African copyright lawmaking at present is the inclusion of "fair use" provisions in the 2017 Copyright Amendment Bill. The provisions in the Bill, which has yet to become law, are similar to those found in US copyright law. Fair use provides—to a greater extent than the South African Act's existing "fair dealing" provisions, modelled on UK law—for copyright materials to be reproduced and used, without the permission of the copyright-holder, for limited purposes, including certain educational uses. The ultimate aim of provisions for US-style fair use and UK-style fair dealing is to balance the interests of society with those of rights-holders. The application of the South African Copyright Act's existing fair dealing provision has been found to be outdated and unable adequately to address the needs of a changing educational landscape that ever-increasingly includes digital components (Baude et al., 2006, pp. 83–84). The COVID-19 pandemic has made it particularly clear that restrictive licensing on ebooks and other increased transactional costs related to access to online materials has disproportionately benefited the rights-holders at the expense of students (Nicholson, 2020).

Public policy in South African jurisprudence is informed by the concept of *ubuntu*, which encompasses values of "humaneness, social justice and fairness" (*S v Makwanyane*, para. 236). With this in mind and taking account of the constitutional obligation that falls on government to make education available and accessible to everyone, it would be incongruous to continue with the existing narrow copyright exceptions with respect to access to educational materials. The current system maintains the status quo, where textbooks and course materials are unaffordable for the majority of local students, while the same materials might cost significantly less in developed countries or other territories with which publishers have struck more generous trade agreements. For students in South Africa, as in the rest of the developing world, the result is one of academic exclusion, which stifles local development and innovation and perpetuates an unequal playing field (infojustice, 2019).

There are many in South Africa who believe the adoption of the proposed broader fair use provision in a new Copyright Act would be a welcome step towards providing more equitable local access to educational materials. However, international publishers—who stand to lose inflows of copyright licence fees, royalties, and other incomes—vehemently oppose this proposed change. A 2018 survey of 15 South African higher education institutions found that they were collectively paying approximately ZAR1 billion annually for access to copyright-protected digital and printed resources (Kleyn & Nicholson, 2018). It was estimated that 80% of this total consist-



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ed of fees paid to international publishers. A further ZAR31 million was being paid to the South African copyright collection society, DALRO (Dramatic, Artistic and Literary Rights Organisation), in the form of licensing fees for copyright-protected prescribed course materials, with the lion's share of the DALRO fees being paid to international publishers and authors (Gray & Czerniewicz, 2018, p. 134). It is crucial to keep in mind that these fees are mostly public funds—i.e., they are fees paid by public universities. These fees represent funds that are not being used, as they should be, to grow local publishing or to reinvest in public education. Also highly problematic is the fact that the majority of these fees sit with the collecting publishers and do not find their way to the original creators and authors (Kleyn & Nicholson, 2018).

If a true decolonisation of South African and other sub-Saharan African educational institutions is to occur, then discordant economic relationships of the sort just outlined must be critically re-examined. The genesis of the current South African Copyright Act was in colonial legislation, which has subsequently been adapted and largely influenced by the Berne Convention (which itself drew significantly from UK legislation and was comprised of a homogeneous European group). Thus it is arguably high time that new legislation is introduced which prioritises local needs and objectives. IP regimes in African countries, as with the scholarly publishing ecosystems, have for too long been underpinned by neo-colonial arrangements. Change will require a move from rigid exclusion to flexible and dynamic inclusion, so as to foster publishing and IP ecosystems that support both developing-world and developed-world scholarship, national ambitions, technological innovation, commercial growth, and sustainable socio-economic development.

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