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International Journal of Science Annals

EDITORIAL

EDITORIAL



EDITORIAL

REVIEW ARTICLE



How Journals Are Indexed in Scopus and Whether This Guarantees Their Quality: A Practical Case of the International Journal of Science Annals



Author's Contribution:

- A – Study design;
- B – Data collection;
- C – Statistical analysis;
- D – Data interpretation;
- E – Manuscript preparation;
- F – Literature search;
- G – Funds collection

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Background and Aim of Study:

Abstract

The present study discusses the necessity and sufficiency of the criteria of the Scopus database for quality assurance of scientific publications, as well as the reviewer's role in the journal evaluation process. The paper analyses the process by which Scopus reviewers evaluate IJSA to ensure the Journal meets the stated criteria for indexing in Scopus.

The aim of the study: to investigate the objectivity of the Scopus journal evaluation – to carry out a comparative analysis of the results of the Scopus reviewer evaluation with the real qualitative and quantitative criteria of a particular journal, and to compare them with the criteria of periodicals already indexed in Scopus.

Material and Methods:

Qualitative and quantitative IJSA analysis methods based on five categories and fourteen selection criteria from Scopus were used. A comparative analysis of scientific periodicals indexed in Scopus has been conducted. We used open databases to study the current state of the research problem: Scopus website, journals websites, journal articles, and social media.

Results:

A case study of a particular journal, IJSA, was used to describe the whole process of preparing, submitting, evaluating, and appealing the evaluation of the Journal in the Scopus database. A journal may indeed meet high criteria for assessing scientific publications, including those declared by Scopus. However, this does not guarantee its indexing in this database because there is a human factor – a Content Selection and Advisory Board (CSAB) reviewer – who has the power to subjectively evaluate the Journal and reject it on formal grounds or his / her misjudgment.

Conclusions:

The decision of the CSAB reviewer is more significant for the inclusion of a journal in Scopus than the fulfilment of the quality criteria of the evaluated Journal. This is illustrated by the fact that some journals cannot be indexed or are excluded from indexing in Scopus, while other journals of lesser quality have been indexed in this database for many years. Today's main problems in scientific periodicals are discussed (paper mills, predatory journals, citation cartels, buying an author's place in a commissioned paper, changing journal ownership, fraudulent websites, etc.). A number of criteria for assessing the quality of journals need to be reviewed, and a balance must be struck between their necessity and sufficiency. This eliminates any possible (or forced) manipulation of journals to meet Scopus indexing criteria.

Keywords:

Scopus, indexing, evaluation procedure, categories and selection criteria, necessity and sufficiency, journal quality.

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Introduction

Scopus is a bibliographic, scientometric, abstract and citation database of peer-reviewed scientific literature. Scopus was launched by academic publisher Elsevier in 2004 and is celebrating its 20th anniversary. Scopus covers 330 disciplines, has over 100 million records, more than 30 active serial titles, content предоставляется from more than 7,000 publishers, selected by an independent Content Selection and Advisory Board, CSAB (Elsevier, 2024).

Among researchers, Scopus was associated with the high quality of the publications it indexes. The quality of publications is the responsibility of publishers, journal editors, and Scopus reviewers, who check the conformity of published material submitted by publishers for indexing based on stated factors and criteria. Not all journals submitted to Scopus are

considered by reviewers to be worthy of indexing, nor will all journals already in the database be indexed in the future. Scopus removes hundreds of journals from indexing each year.

We can, therefore, conditionally distinguish 2 groups with 5 categories of journals (Figure 1). These are as follows

1. Not indexed in Scopus:

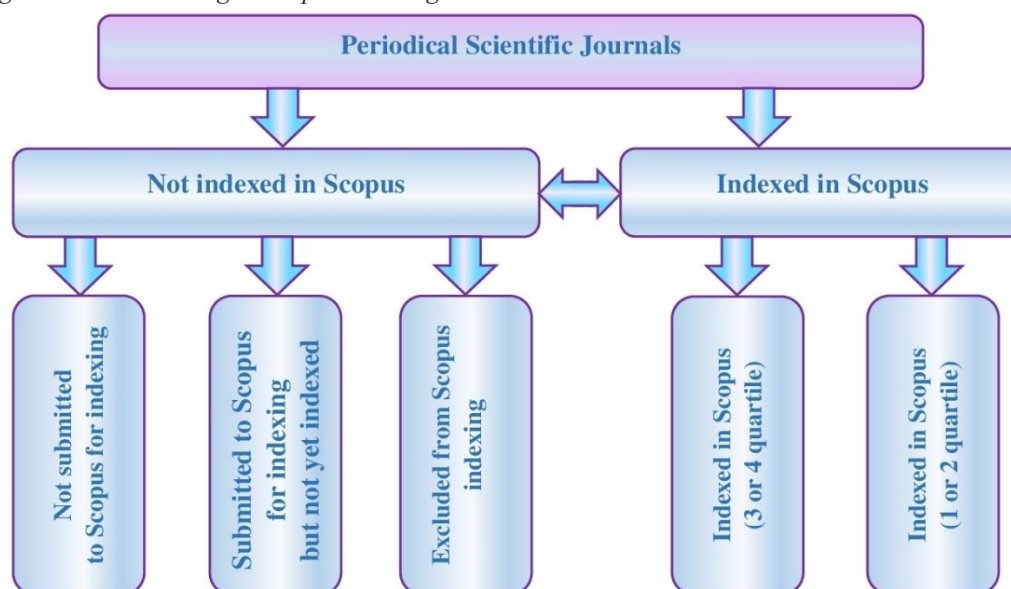
- (a) not submitted to Scopus for indexing;
- (b) submitted to Scopus for indexing but not yet indexed;
- (c) excluded from Scopus indexing.

2. Indexed in Scopus:

- (d) indexed in Scopus (3 or 4 quartile);
- (e) indexed in Scopus (1 or 2 quartile).

Figure 1

Categorising Journals According to Scopus Indexing Criteria



Journals in categories A-B are not indexed in Scopus. They can publish both low-quality and high-quality literature (articles).

Journals in category C are excluded from Scopus based on reviewer judgement for low quality of published literature or other violations.

Journals in categories D-E are indexed in Scopus. They have high-quality published literature.

In the present study, we assume that some journals (categories A-B) may publish articles of high quality and still not be indexed in Scopus, as indexing of the Journal is possible if the publisher applies for Scopus evaluation. Indexing, rejection or exclusion from indexing is determined by an expert (the CSAB reviewer).

In this paper, using the example of a specific journal, the International Journal of Science Annals (IJSA), we examine the whole process of peer review of journal quality in Scopus based on the criteria used by this database.

The aim of the study. To investigate the objectivity of the Scopus journal evaluation - to carry out a comparative analysis of the results of the Scopus reviewer evaluation with the real qualitative and quantitative criteria of a particular journal and to compare them with the criteria of journals already indexed in Scopus and the strategies used by journals to meet the criteria set by Scopus.

Materials and Methods

A qualitative and quantitative analysis of the IJSA indicators was carried out based on 5 categories and 14 quantitative and qualitative selection criteria declared in Scopus. A comparative analysis of the editions of periodical scientific literature indexed in Scopus was used. To study the current situation of the research problem, we used open databases: articles in scientific journals, journal websites and social networks, and electronic correspondence from the official IJSA email. The resulting data were described narratively, with common themes identified.



Results

The IJSA was registered in 2018. It has been published annually, continuously in English, for 7 years. From the first issue, the Journal began implementing the principles of publishing high-quality scientific journals of international standards (Melnyk & Pypenko, 2021). To this end, the Journal invited scholars from 17 countries and 5 continents in the social and behavioural sciences (education, psychology and medicine) to form the IJSA Editorial Board.

A system for selecting qualified reviewers has been developed, as well as a form with a set of criteria for evaluating manuscripts, which can be used by reviewers and is available on the website for authors to read.

The Journal's website is well structured, with information about the editors, and reviewers, an archive of all issues and information about archiving repositories, details of the peer review process and ethical guidelines, a system for tracking plagiarism in manuscripts, instructions and manuscript templates for authors, and much more that is necessary for the quality publication of a scientific journal (Melnyk, 2018).

The Journal has been implementing the principles of golden open access since its first issue. All texts are free of charge for all users and/or the institutions they represent.

In 2020, the Journal was positively reviewed and included in the Directory of Open Access Journals (DOAJ) indexing (DOAJ, 2020).

In 2024, the IJSA was re-evaluated and reaffirmed its compliance with the DOAJ's indexing criteria. DOAJ membership has helped to raise the quality of the Journal

to a higher level through the highly qualified recommendations of DOAJ staff and to increase readership through open access.

It should be noted that in 2021, the Journal was favourably reviewed and accepted for membership by the Committee of Publication Ethics (COPE), where it is currently a member (COPE, 2021).

Membership in COPE has enabled IJSA editors to obtain the most up-to-date information and to address problematic issues relating to ethical standards in journal publishing.

The Journal implements the best publishing practices and technologies for all published articles, including doi, CrossMark, hyperlinks, QR codes, archiving in different formats (pdf, xml, txt, doaj), etc.

The IJSA is represented in more than 40 international scientometric databases, repositories and search engines: DOAJ, ERIH PLUS, Google Scholar, etc. The IJSA is represented at universities and in more than 150 libraries worldwide: Stanford Libraries, University of California Davis Library (United States); Simon Fraser University (Canada); Maastricht University (Netherlands); V.I. Vernadskiy National Library of Ukraine, etc.

The authors' request for the possibility of having their article indexed in Scopus was the reason for IJSA's submission to Scopus for peer review.

Submitting a journal for evaluation for indexing in Scopus involved filling in a special form freely available on the Scopus website.

The first step was registering on the Scopus website and obtaining a registration number, as shown in Figure 2.

Figure 2

Suggested title for Scopus and Obtained ID

Scopus

TITLE SUGGESTION

Thank you for your title suggestion

Thank you for your title suggestion. You will receive an automatic email to confirm your title suggestion. If you do not receive an e-mail confirmation, please check your spam filter.

We strive to evaluate new title suggestions as quickly as possible, however, please allow up to several months for the review process to be completed.

In case you have any questions, you can contact us at title suggestion@scopus.com

Kind regards,

The Scopus Team

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The tracking ID for this title suggestion is: A0BB

You can view the status of your suggestion via the page <https://suggestionstep.scopus.com/progressTracker>

Click [here](#) if you want to suggest another title.

If you also want to suggest this title to one of the Engineering Information databases please complete the following form:
<http://www.ei.org/title-suggestion>

If you also want to suggest this title to the EMBASE database please complete the following form:
<http://embase.com/info/title-suggestions>

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The second step was to complete a six-step form: (1) Agreement, (2) Before completing the form, (3) Contact information, (4) Serial title information, (5) Document upload, (6) Additional information.

Each of these six steps describes some information about the Journal. For example, the first of the six steps requires you to provide information on 16 principles of transparency and best practices in scholarly publishing:

website, journal name, peer review process, ownership and management, governing body, editorial team/contact details, copyright and licensing, author fees, process for identifying and dealing with allegations of research misconduct, publication ethics, publication schedule, access, archiving, revenue streams, advertising, direct marketing. The completion of the first stage of the form is shown in Figure 3.

Figure 3
Completion the Evaluation Form (Agreement Stage) for the IJSA

Scopus TITLE SUGGESTION Help F4

Step 1 - Agreement

Thank you for your interest in Scopus.

- Please read our minimum criteria below carefully and be sure that the title you are suggesting for Scopus meets all of them.
- If you are not the publisher of this title, we recommend that you contact the publisher of the title and request that they complete the suggestion form.
- You can save a draft of the suggestion for at any time and return to your application later (click on 'Save draft'). Please note that your application will be saved for 7 days.

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Titles will only be considered for evaluation if they meet the following minimum criteria:

- The title should publish peer reviewed content.
- The title should be published on a regular basis (i.e. have an ISSN confirmed by the ISSN International Centre). To register an ISSN, please [visit this page](#).
- The title should have English language abstracts and article titles.
- The title should have a publication ethics and publication malpractice statement in the English language on its website.

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Agreement

☒ I am aware of the general guidelines that Scopus uses to select titles.

Publication standards

Please check adherence to our Publication Ethics and Malpractice Statement requirement.

Please provide the publication ethics and publication malpractice statement for this title:

ⓘ

Principles of Transparency and Best Practice in Scholarly Publishing:

- ☒ **Website**
A journal's website, including the text that it contains, shall demonstrate that care has been taken to ensure high ethical and professional standards. It must not contain information that might mislead readers or authors, including any attempt to mimic another journal/publisher's site. An 'Aims & Scope' statement should be included on the website and the readership clearly defined. There should be a statement on what a journal will consider for publication including authorship criteria (e.g., not considering multiple submissions, redundant publications) to be included. ISSNs should be clearly displayed (separate for print and electronic).
- ☒ **Name of journal**
The journal name shall be unique and not be one that is easily confused with another journal or that might mislead potential authors and readers about the journal's origin or association with other journals.
- ☒ **Peer review process**
Journal content must be clearly marked as whether peer reviewed or not. Peer review is defined as obtaining advice on individual manuscripts from reviewers expert in the field who are not part of the journal's editorial staff. This process, as well as any policies related to the journal's peer review procedures, shall be clearly described on the journal website, including the method of peer review used. Journal websites should not guarantee manuscript acceptance or very short peer review times.
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Journals shall have editorial boards or other governing bodies whose members are recognized experts in the subject areas included within the journal's scope. The full names and affiliations of the journal's editorial board or other governing body shall be provided on the journal's website.
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- ☒ **Process for identification of and dealing with allegations of research misconduct**
Publishers and editors shall take reasonable steps to identify and prevent the publication of papers where research misconduct has occurred, including plagiarism, citation manipulation, and data falsification/fabrication, among others. In no case shall a journal or its editors encourage such misconduct, or knowingly allow such misconduct to take place. In the event that a journal's publisher or editors are made aware of any allegation of research misconduct relating to a published article in their journal, the publisher or editor shall follow COPE's guidelines (or equivalent) in dealing with allegations.
- ☒ **Publication Ethics**
A journal shall also have policies on publishing ethics. These should be clearly visible on its website, and should refer to: i) Journal policies on authorship and contributorship; ii) How the journal will handle complaints and appeals; iii) Journal policies on conflicts of interest; iv) Journal policies on data sharing and reproducibility; v) Journal's policy on ethical oversight; vi) Journal's policy on intellectual property; and vii) Journal's options for post-publication discussions and corrections.
- ☒ **Publishing schedule**
The periodicity at which a journal publishes shall be clearly indicated.
- ☒ **Access**
The way(s) in which the journal and individual articles are available to readers and whether there are associated subscription or pay per view fees shall be stated.
- ☒ **Archiving**
A journal's plan for electronic backup and preservation of access to the journal content (for example, access to main articles via CLOCKSS or PubMed Central) in the event a journal is no longer published shall be clearly indicated.
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Business models or revenue sources (e.g., author fees, subscriptions, advertising, reprints, institutional support, and organizational support) shall be clearly stated or otherwise evident on the journal's website. Publishing fees or waiver status should not influence editorial decision making.
- ☒ **Advertising**
Journals shall state their advertising policy if relevant, including what types of adverts will be considered, who makes decisions regarding accepting adverts and whether they are linked to content or reader behaviour (online only) or are displayed at random. Advertisements should not be related in any way to editorial decision making and shall be kept separate from the published content.
- ☒ **Direct marketing**
Any direct marketing activities, including solicitation of manuscripts that are conducted on behalf of the journal, shall be appropriate, well targeted, and unobtrusive. Information provided about the publisher or journal is expected to be truthful and not misleading for readers or authors.

[check all / unchecked all]

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After completing the form at each stage, we completed the submission of the Journal for evaluation.

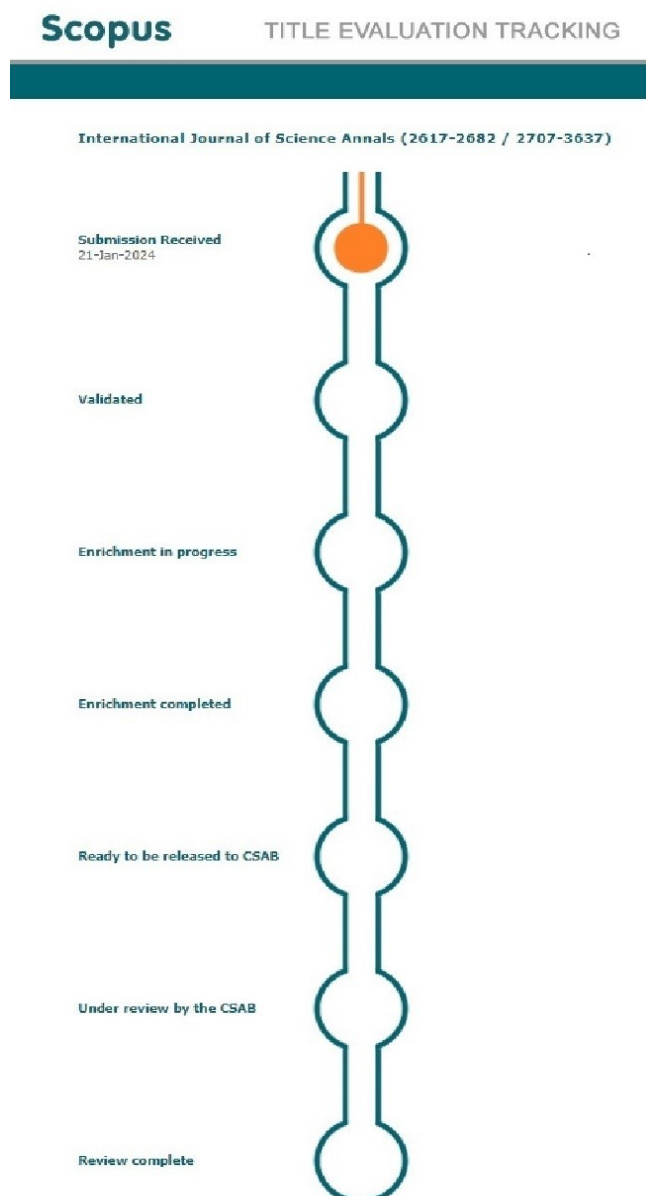
This is confirmed by the receipt of a message in the official Journal email with information about the

registration and start of the IJSA evaluation procedure in Scopus.

On 21 January 2024, we were able to access a graphical representation of the IJSA evaluation tracking image in Scopus (Figure 4).

Figure 4

Confirmation of Journal Submission and Start of Evaluation Process



The evaluation of the Journal by the CSAB reviewer, according to the Scopus official website, implied the examination of the Journal for compliance with the 5 categories and 14 quantitative and qualitative selection criteria:

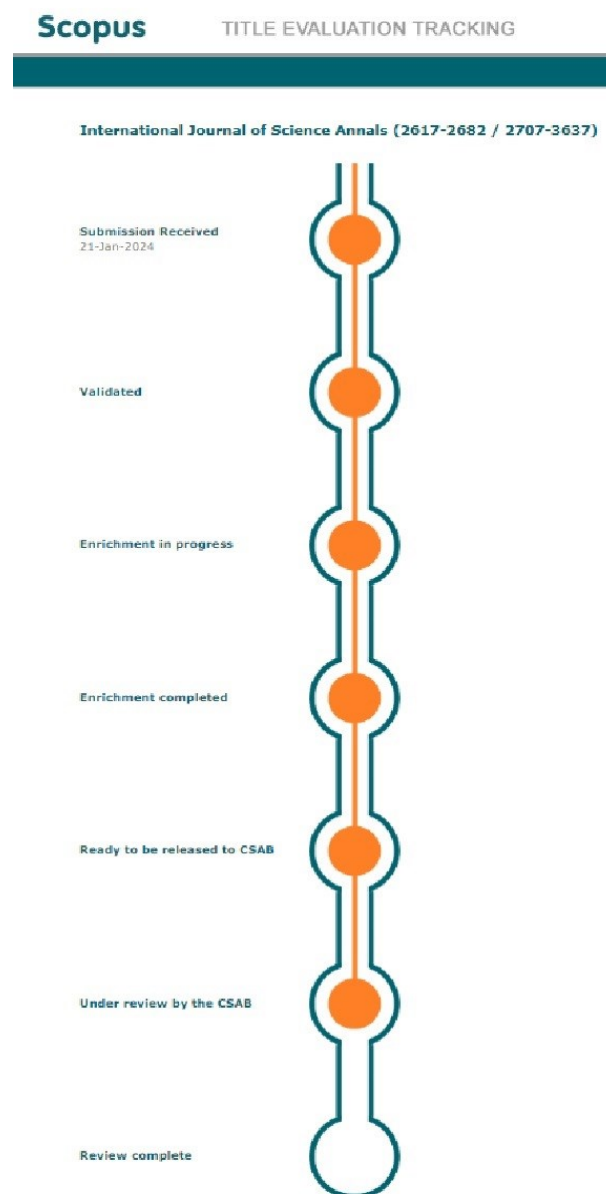
- (1) Journal policy (convincing editorial policy, type of peer review, diversity in geographical distribution of editors, diversity in geographical distribution of authors);
- (2) Content (academic contribution to the field, clarity of abstracts, quality of and conformity to the stated aims and scope of the Journal, readability of articles);
- (3) Journal standing (citedness of journal articles in Scopus, editor standing);
- (4) Publishing regularity (no delays or interruptions in the publication schedule);

(5) Online availability (full journal content available online, English language journal home page available, quality of journal home page).

The evaluation was carried out over 76 days, and it could be monitored periodically through the IJSA evaluation tracking image in Scopus (Figure 5).

Figure 5

Tracking the Evaluation Process



We received a negative answer on 6 April 2024 after 76 days of waiting. In our opinion, it was wrong and unfounded (Figure 6).

The CSAB reviewer's explicit disregard of the facts of IJSA's compliance with the criteria set out in Scopus was the reason for the appeal against this assessment.

On 17 April 2024, we filed a written notice of our intention to appeal the CSAB reviewer's decision, stating the reasons for our disagreement.



Figure 6

Notification of Completion of Journal Evaluation in Scopus

The review of your title for Scopus is complete



From Scopus Title Evaluation Team on 2024-04-05 23:52

 Details  Headers  Звичайний текст

Title: International Journal of Science Annals

ISSN / E-ISSN: 2617-2682 / 2707-3637

Publisher: KRPOCH

Dear Yuriy B. Melnyk,

The title mentioned above has been evaluated for inclusion in Scopus by the Content Selection & Advisory Board (CSAB). The review of this title is now complete and the CSAB has advised to not accept the title for Scopus inclusion at the present time. For your information, the reviewer comments are copied below:

- + In general, the content of the articles is consistent with the scope and aims of the journal.
- + The abstracts are in keeping with Scopus English Language requirements.
- The geographical reach of authorship and/or content is too limited.
- There are a few good, informative articles, but also many articles that make little contribution to the field.
- The journal does not publish enough good articles each year to warrant inclusion in Scopus.
- Low citations in good journals indexed in Scopus
- Many good international journals already cover this subject area.
- poor quality of the references

For future resubmission, the journal needs to increase substantially its international scope in terms of authorship and academic impact.

You may consider publishing more papers by high impact authors from outside your existing countries or sources of authorship. It will also help if published papers cover a broader range of research topics and issues that may speak directly to an international audience.

If in the future these comments are addressed, you may decide to submit a new application at any time after the following date: April 2027.

At that time, you will be required to upload a cover letter detailing how the above comments have been addressed. A full review will be conducted upon resubmission and having addressed all the abovementioned concerns will therefore not guarantee acceptance.

Finally, we strongly advise you to read through our FAQ:

Helping to improve the Scopus submission & success process for editors and publishers.

Practical information for journal editors can be found in our [Role of an editor FAQ](#).

Yours sincerely,

Scopus Title Evaluation Support

titlesuggestion@scopus.com

We dissented because we were convinced that there were procedural and substantive errors in the review process:

1) The CSAB reviewer subjectively selected some criteria (8 out of 14) and provided misleading information about them during the IJSA assessment procedure.

2) The CSAB reviewer did not follow the assessment procedure for IJSA: the correct criteria were not considered, the assessment was not carried out properly, and the reviewer's opinion does not correspond to the facts, the embargo imposed was not justified.

In order to justify the failure to follow the assessment procedure and to address this issue thoroughly, completely and reasonably, we first considered the CSAB reviewers' assessment with our comments and evidence. Then, we analysed the IJSA scores based on 5 categories and 14 quantitative and qualitative selection criteria, as defined by the official Scopus assessment procedure.

On 7 May 2024, we had to reapply to Scopus, what is the status of the review of our appeal? Only on 9 May

2024 we received the official template for the Scopus Title Evaluation Appeal Form. We were then allowed to lodge a formal appeal following the prescribed procedure.

On 12 May 2024, we completed the Title Evaluation Appeal and submitted it to the Scopus email by the deadline.

On 24 June 2024, I asked the Scopus team for an update on my case.

On 12 July 2024, I received a reply asking me to reduce the word count to 300 words.

On 16 July 2024, we complied with these requirements and submitted an updated Scopus Title Evaluation Appeal with reasons for our disagreement evaluation of the Journal (Appendix A).

The Scopus Title Evaluation Appeal was accompanied by an annex (Appeal Against the Assessment of the IJSA, Appendix B) consisting of two sections: 1. The assessment by the reviewers of the CSAB with our comments and evidence. 2. Analysis of IJSA indicators based on 5 categories and 14 quantitative and qualitative selection criteria (with our comments and evidence).



Scopus uses the following criteria to evaluate journals:

I. Journal Policy

1. Convincing editorial policy
2. Type of peer review
3. Diversity in geographical distribution of editors
4. Diversity in geographical distribution of authors

II. Content

5. Academic contribution to the field
6. Clarity of abstracts
7. Quality and consistency with the stated aims and scope of the journal

III. Journal Standing

9. Citedness of journal articles in Scopus

10. Editor standing

IV. Publishing Regularity

11. No delays or interruptions in the publication schedule

V. Online Availability

12. Full journal content available online
13. English language journal home page available
14. Quality of journal home page

Two weeks later, on 28 July 2024, we received the decision on our appeal (Figure 7).

Figure 7

Notice of the Results of the Appeal Against the Evaluation of the Journal in Scopus

The review of your title for Scopus is complete



From Scopus Title Evaluation Team on 2024-07-28 05:40

Details Headers Звичайний текст

Title: International Journal of Science Annals

ISSN / E-ISSN: 2617-2682 / 2707-3637

Publisher: KRPOCH

Dear Yuriy B. Melnyk,

The title mentioned above has been evaluated for inclusion in Scopus by the Content Selection & Advisory Board (CSAB). The review of this title is now complete and the CSAB has advised to not accept the title for Scopus inclusion at the present time. For your information, the reviewer comments are copied below:

After appeal re-evaluation the decision reached was :

The geographical reach of authorship and/or content is too limited/in

- There are a few good, informative articles, but also many articles that make little contribution to the field.

- The journal does not publish enough good articles each year to warrant inclusion in Scopus.

If in the future these comments are addressed, you may decide to submit a new application at any time after the following date: March 2027.

At that time, you will be required to upload a cover letter detailing how the above comments have been addressed. A full review will be conducted upon resubmission and having addressed all the abovementioned concerns will therefore not guarantee acceptance.

Finally, we strongly advise you to read through our FAQ:

Helping to improve the Scopus submission & success process for editors and publishers.

Practical information for journal editors can be found in our [Role of an editor FAQ](#).

Yours sincerely,

Scopus Title Evaluation Support

titlesuggestion@scopus.com

It should be noted the formal nature of the review of the assessment procedure and the subsequent appeal, which is reduced to the use of the keyboard functions “Ctrl+C” and “Ctrl+V” by the reviewer. This method is not complicated to detect by the presence of the exact phrases (remarks) with similar symbols and typing errors in our Journal's evaluation and appeal letters (Figures 6, 7). This is confirmed by the fact that the number of comments has decreased (2 out of 6 remaining), and the embargo period for re-evaluation of the Journal has been reduced (by several months) without any justification or acknowledgement of the reviewer's error in the first evaluation. This situation is disappointing and undermines confidence in the objectivity of the Scopus review to make an informed and fair decision on whether a journal can be indexed.

Therefore, the lack of qualitative and quantitative indicators for some Scopus criteria allows the reviewer

evaluating the Journal to refuse indexing. Publishers are unaware of each criterion's value (weight) in the total score, which influences the decision to index the Journal. Otherwise, how else can we explain the refusal to index the IJSA that meets 12 specific criteria and, according to the reviewer, does not meet 2 “fuzzy” criteria?! Especially when these two criteria are also met by the IJSA, which we have described in detail in the Appendix to the Evaluation Appeal. A comparison of the performance on these criteria for IJSA and some journals indexed in Scopus for many years shows that these criteria are insignificant, as these journals completely ignore them. We will look at this next.

The question of the necessity and sufficiency of the Scopus criteria for the final evaluation of a journal for indexing in this database remains unresolved.

We believe that particular attention should be paid to striking a balance between the necessity and sufficiency



of the criteria and that the outcome of journal inclusion should not depend on the decision of a single reviewer but should be based on the sum of scores on a scale where the criteria are strictly regulated and have their own qualitative and quantitative indicators.

Discussion

The above comments about IJSA are actually problematic for many scholarly journals, including those indexed by Scopus. Especially when these problems are related to issues of international author expansion and/or high citation requirements for articles published in the Journal in the same Scopus database.

The important question in this situation is how journals will address these issues to meet the Scopus criteria. Unfortunately, not all journals can address these issues within the ethical guidelines of scholarly publishing.

In fact, these Scopus requirements for journals have caused several problems. To a lesser extent, these problems depend on internal factors and can be influenced by the Journal. To a greater extent, these problems are influenced by external factors such as the visibility of the Journal in the international information space, its presence in bibliographic and abstract databases of scientific literature, and especially its indexing in Scopus.

In addition, these problems have been exacerbated by the need for scientists to meet the criteria for academic success, which requires them not only to have publications indexed in Scopus but also to be cited in that database. An analogy can be found in determining the quartile of a journal - it depends on the ratio of the number of articles in it to their citations.

It made the situation worse. Journals began to select candidates for authorship more rigorously, based on indicators of the author's published works with a high citation index in Scopus. Such an author provides the Journal with some immunity, protecting it from downgrading and possibly contributing to a higher quartile. A paradox has arisen in which an author with no articles indexed in Scopus has virtually no chance of being published for the same reason. In this way, both the author and the journals have become hostages to citation. We believe this artificially created citation index problem has given rise to "citation cartels" that engage in citation manipulation by adding irrelevant citations.

Secchi (2023), who has been studying this phenomenon for several decades in various disciplines, points out that it represents a tacit or explicit agreement between authors to cite each other more often than they would in a more "sincere" approach to science. In principle, this could be seen as collusion, which could distort scientific progress by influencing the scientist's attention.

We believe that this situation is extremely negative, especially for young scientists. First, young researchers may focus on the artificially created authority of a highly cited publication. Second, young researchers may not be able to internalise the basic principle of scientific citation: the only measure of citation for an author should be the academic duty to argue the facts in the manuscript, not journal metrics or reviewer requirements.

Analysis of the websites of scholarly journals, literature publications and social media provides comprehensive information on the methods used by journals and individual scholars to address these issues.

Let us now look at some examples of how journals meet the criteria for indexing in Scopus to broaden the international composition of authors in their Journal.

It is not uncommon for editorial offices to search for potential authors for their journals on social networks such as LinkedIn and Facebook (Figure 8), which, in principle, corresponds to the norms of advertising. However, there is also the less ethical practice of scientists receiving intrusive multiple emails in their mailboxes inviting them to publish a manuscript in a particular journal. A characteristic feature of these emails is that the sender (publisher or Journal) argues in favour of giving the prospective author a favourable chance to publish his or her future manuscript, as well as a reference to his or her previously published work, which is supposedly highly valued by the sender.

Figure 8

Example of Promotion of a Scopus-Indexed Journal on the Social Network Facebook



This may seem flattering at first, but after receiving similar emails repeatedly, a pattern begins to emerge (Keogh, 2020):

- often use flattering language to describe you and your work;
- grammatical or spelling mistakes in the emails;
- promising quick publication, referring to the "next issue";
- offering a substantial discount for publication;
- mentioning the indexing of the Journal in Google Scholar or ResearchGate shows how prestigious this is and adds credibility to your research.

Authors should be cautious when receiving such emails. There is a high probability that they will fall prey to "paper mills".

Please note that the sender is essentially admitting that the email address received (yours) was taken from another publisher's site. We believe that such actions should be categorised as having the characteristics of a "predatory log".

The term "predatory journal" was coined by Beall (2017), a scholarly communications librarian.

In our view, one of the most serious breaches by such journals should be the practice of creating a clone of another journal's website or using the content of another journal to create one's own website. This practice of



predatory journals has sometimes reached the point of absurdity, as it is possible to find information on the websites of these journals that do not even correspond to their potential. Their websites are primitive, have grammatical and spelling errors, pages contain contradictory information, hyperlinks are missing or incorrect, etc.

Even more egregious is buying an author's place in a commissioned article. On the same social media platforms, you can see posts offering a list of article topics and the cost per space in that article. For ethical reasons, we will not illustrate these contributions or name the journals indexed in Scopus. We assume that this is the work of intermediaries unknown to the editors of these journals.

Let us consider the characteristics that, in our opinion, should be considered by the editorial offices of journals that accept such manuscripts with multinational authorship for publication.

Such a manuscript is usually submitted to the Journal by the same corresponding author. A number of the following indicators characterise it:

- Relevance to the research topic (COVID-19 pandemic, war, refugees, etc.);
- The type of manuscript is in most cases a review article (no empirical component required);
- The authors often have different affiliations and/or live in different countries;
- The authors have not previously published together;
- The authors have no previous publications on the topic.

This problem is much more serious than it seems at first glance. The information in such a "commissioned article" is likely to be equally custom or fictitious and unrelated to reality.

In the context of the above, it is appropriate to consider an example of a manuscript entitled Ukraine – Russia crisis and its impacts on the mental health of Ukrainian young people during the COVID-19 pandemic (Chaaya et al., 2022). In this article, the authors from universities in Rwanda, Lebanon, India, Turkey, Sudan, the USA, UK, have insufficient knowledge of the information about the organisation of psychological help in Ukraine and the demand for these services in Ukrainian society, erroneously claim: "Often, mental health is overlooked in Ukraine due to the social stigma and taboos, yet more during the state of war and pandemics" (Chaaya et al., 2022).

We note that these statements do not correspond to the actual circumstances and give a false picture of the real situation of psychological assistance in Ukraine during martial law. We are well aware of the real circumstances, as the author team has been practising Ukrainian psychologists, researchers and authors of numerous original articles on the state of mental health of young people for more than 20 years, including during the Russian-Ukrainian war (Mykhaylyshyn et al., 2024; Pypenko et al., 2023; Stadnik et al., 2022; 2023).

In order to assess the objectivity of the CSAB reviewer's refusal to include IJSA in Scopus because "*the geographical reach of authorship and/or content is too limited*", let us examine this aspect of the problem in

more detail. To do this, we will analyse several recent issues of journals indexed in Scopus, focusing on the international composition of authors in these journals.

Let us start with a journal called "The Journal of Social Policy Studies / Zhurnal Issledovaniy Sotsialnoy Politiki" (National Research University, Higher School of Economics, 2016). This Journal caught our attention both because of the lack of geographical diversity of the authors and because of one of the issues it addresses. Let us, however, first outline the general characteristics of this Journal before looking at the content of a particular issue. This Journal has been indexed in Scopus since 2016 and has a CiteScore of Q3. Vol. 22 No. 2 (2024) of this Journal is represented by 10 articles and 2 reviews, of which 11 are in Russian; all 25 authors published in this issue are exclusively affiliated with Russian institutions.

It should be noted that we did not set out to analyse the quality of the articles in this Journal or in any other journal. Scopus reviewers and experts should do this. However, we note how cynical an article by a Moscow graduate student on the problems of Syrian migrants looks in this Russian Journal. According to Dibo (2024), "...this protracted conflict has caused varying levels of violence and instability within Syria, forcing many people to seek refuge abroad...".

The substitution of "conflict" for "war" is characteristic of Russian propaganda and censorship. How acceptable this is for a scientific journal indexed in Scopus is a matter for reviewers to decide. Let us just recall that the Russian military (personnel of the air group with diplomatic status), on Russian planes, with Russian bombs and missiles, bombed Syrian cities, as a result of which millions of Syrians became refugees.

This is a situation that I personally experienced when Russia launched a war against Ukraine, calling it a "special military operation" and firing ballistic missiles at Ukrainian cities with civilian populations. One such Russian missile with a cluster warhead exploded in a residential area of the city where I live, damaging civilians and their property, including our publishing house. This is evidenced by the hundreds of thousands of refugees who have fled our city, and by the shrapnel from that rocket that still protrudes from my laptop screen.

Next, consider the example of another journal, Baltic Region (Immanuel Kant Baltic Federal University, 2018), which has been indexed in Scopus since 2018 and has the following quartiles: SJR Q1 (Cultural Studies) / CiteScore Q1 (History, Cultural Studies). Volume 16, No. 1 (2024) of this Journal contains only 8 articles, all in Russian, and all 14 authors published in this issue are from Russia.

The Journal entitled Monitoring Obshchestvennogo Mneniya: Ekonomicheskie i Sotsialnye Peremeny (Monitoring of Public Opinion: Economic and Social Changes Journal) has been indexed in Scopus since 2016 (Public Opinion Research Center, VCIOM, 2016). The Journal has an SJR of Q1, according to its website. Issue 1 (2024) of this Journal contains only 12 articles, 11 of which are in Russian; all 24 authors published in this issue are from Russia.



The next Journal, *Economy of Regions*, has been indexed in Scopus since 2013. The Journal is ranked Q2 in Economics, Econometrics and Finance by SJR, CiteScore and SNIP Scopus (Institute of Economics, the Ural Branch of Russian Academy of Sciences, 2013). Volume 20, Issue 1 (2024) of this Journal is represented by 16 articles in Russian, all 29 authors published in this issue are from Russia.

Another journal in this field, *Ekonomicheskaya Politika / Economic Policy*, has been indexed in Scopus since 2013 (Editorial Board of the Journal *Economic Policy*, 2013). The Journal has Q3 (SJR), Q2 (CiteScore). Volume 19, No. 2 (2024) of this Journal contains only 4 articles printed in Russian, all 8 authors published in this issue are from Russia. The next issue (No. 3, 2024) of this Journal already contains 5 articles, also in Russian, and all 9 authors are from Russia. The next issue (No. 4, 2024) of this Journal is also represented by 5 articles, which are also in Russian, and all 12 authors are from Russia.

It is easy to assume that other issues of these journals have a preponderance of articles in Russian and are not characterised by a wide geographical diversity of authors. It follows that the question of the geographical diversity of authors and the scientific value of these Russian-language journals to the international scientific community is obviously rhetorical.

In considering this issue, attention should be drawn to the diversity of authors in the IJSA's geographical distribution. At the time of Scopus evaluation, the Journal had published articles by 90 authors from 21 countries. In addition, each author has a personal page on the IJSA website with papers published in the Journal. It remains unclear why this information was ignored or deemed irrelevant.

Thus, while some journals cannot be indexed in Scopus or are excluded because of an insufficient (in the reviewer's opinion) international composition of authors, other lower-quality journals have been in this database for many years, have a high quartile and are not affected by the problem of 'geography of authors', and the CSAB reviewers do not see this as a problem.

The analysis of periodical scientific literature shows that there are serious problems for journals to achieve indexing in Scopus and for those already indexed in Scopus.

Malvić et al. (2022) discuss the difficulties small journals face in meeting the stringent criteria of Scopus, such as citation metrics and publication frequency. These challenges can hinder the dissemination of valuable research, especially from emerging scholars and niche disciplines.

When considering the problems of small journals, it is appropriate to start with Donovan (2013). More than a decade ago, the author suggested that in the age of ratings, "small journals" could exist in print and electronically on the web to maximise the benefits (grades, ratings) for the authors' parent institution. Donovan's disappointing conclusion was that journals of this calibre could only serve the local community by filling a gap in some regional publications.

We only partially agree with this author's position on the need for small journals that can be regionally focused and/or serve the university's interests. However, this does not mean these journals are less relevant or of lower quality (Figure 1) if they are not indexed in Scopus. Moreover, we believe that small journals are necessary because they create healthy competition, and it is in such journals that the work of young researchers, who in most cases do not have the opportunity to submit their own research to a Scopus-indexed journal, can be published.

Today, many universities and scientific institutions are autonomous and have their own publishing houses and journals; they often organise their own projects, conferences and competitions, including those at the international level.

To illustrate this model, consider the example of IJSA, which was founded by Kharkiv Regional Public Organisation "Culture of Health" (KRPOCH). KRPOCH has structural subdivisions, including the KRPOCH Scientific Research Institute and KRPOCH Publishing.

The activity of the Institute and the Publishing House extends far beyond the local community, as for more than 10 years, it has been organising the annual International Conferences "Current Issues of Education and Science", "Psychological and Pedagogical Problems of Modern Specialist Formation", as well as the International Competitions "Mental Health in the Digital Society", "Blockchain in the Digital Society", which are aimed at supporting (organisationally and financially) young scientists.

The next issue we feel the need to highlight is the availability of "predatory journals". In his study, Demir (2018) collected data from nearly 25,000 articles and identified a significant number of predatory journals that are indexed, highlighting the need for rigorous review processes.

Singh (2021) states that "Scopus hosts papers from more than 300 potentially 'predatory' journals that have questionable publishing practices". More than 160,000 articles were published in them over 3 years, representing almost 3% of the research indexed in Scopus over this period. The presence of such articles in indexed databases contaminates the scientific literature and provides misleading information about research.

Grudniewicz et al. (2019) describe a case of dubious ideas being disseminated through publications in predatory journals. The authors proposed a consensus definition of predatory publishing to help identify and combat such practices.

Kakamad et al. (2024) consider the problem that predatory journals pose to the scientific community by blurring the line between legitimate and questionable publishing practices. The authors examine the positive and negative characteristics of the three main lists (Beall's, Cabells, and Kscien's lists) that keep track of predatory journals. This group of scholars stresses the need to refine these lists by creating a separate list supported by clear evidence, such as accepting a forged manuscript (established in a shell operation).

Macháček and Srholec (2021) examined differences between countries in the propensity of scientists to



publish in such journals. The study argues that countries with large research sectors at the middle level of economic development, particularly in Asia and North Africa, are most vulnerable to predatory publishing.

O'Rorke et al. (2024) point out that predatory publishers and journals typically use an open-access model with little or no peer review.

The role of publishers in perpetuating these problems cannot be overlooked. Teixeira da Silva and Al-Khatib (2018) criticised some publishers for putting profit ahead of scientific integrity. One of the weakest areas for abuse of trust in the submission and publication system is the peer review process, which leads to the proliferation of low-quality journals in databases.

The commercialisation of academic publications can certainly have negative consequences. Rodrigues et al. (2020) argue that commercial publishers clearly exercise control over the journal field. They are in the business of registering new names according to the interests of their companies, which do not necessarily coincide with the interests of the scientific community or society at large. Therefore, the next issue that deserves attention is an extreme form of commercialisation – purchasing a journal that is known or already indexed in authoritative databases. This is becoming an increasingly common practice. After a change of ownership, such a journal becomes primarily profit-oriented, and the quality of the publications becomes a less important or even irrelevant factor.

A typical case of change of ownership of the Journal *Experimental & Clinical Cardiology*, which had been published for 17 years by a respected Canadian publisher, was widely publicised. The Journal, which had an impact factor of JCR (0.7), was reportedly bought by investors from Switzerland, but their bank accounts are in Turks and Caicos. The new investor changed the business model to open access and APC funding and quickly increased the number of articles from 63 in 2013 to over 1,000 in 2014. "And for \$1,200 they'll print anything - even a garbled mix of fake cardiology, Latin grammar and missing graphs submitted by the Citizen" (Spears, 2014). As the example shows, these problems have been around for many years, but there has been no real mechanism to solve or at least reduce the growth rate of predatory publishers and journals.

It should be noted that this problem has become increasingly relevant in recent years and no longer concerns only "small journals", but also large publishers and journals with a long history.

However, a critical issue is the inclusion of predatory journals in authoritative databases, including Scopus, which needs to be brought to the attention of reviewers and administrators of these databases.

The emergence of "paper mills", which produce fraudulent research papers for a fee by creating fake manuscripts and offering authorship slots to academic clients, with subsequent indexing of these articles in Scopus, has further complicated the situation.

Parker et al. (2024) claim that many thousands of fake paper mill manuscripts have been successfully published in peer-reviewed journals. The authors discuss what is

known about the activities of "paper mills" and how publishers, independent organisations and individuals can work to prevent and detect their activities. Research readers can also play an important role in discovering the mill and informing their peers.

As noted above, citation manipulation is another common concern. Joshi and Pandey (2024) point out that citation bias, excessive self-citation and forced citation are standard techniques used to artificially inflate the impact of scientific articles, undermining the integrity of academic research.

It should be remembered that these techniques distort academic data and mislead researchers. This manipulation not only affects the performance of the Journal but also jeopardises the overall reliability of citation-based assessments.

In the last two years, there has been an increase in the number of cases of illegal authorship related to the use of text generated by artificial intelligence (AI), large language model (LLM) or ChatGPT.

Kendall and Teixeira da Silva (2024) focus on the fact that authorship abuse of articles created using large language models (LLMs) such as ChatGPT is rising in academic science. This group of scholars suggests that society faces unavoidable risks associated with AI technologies, which could contribute to strengthening a predatory publishing "industry". The discovery of AI-generated text is, therefore, becoming a new responsibility for editors, journals and publishers.

Melnyk and Pypenko (2023) believe that apart from the negative aspects of using AI technologies in publishing, there are also positive aspects of using chatbots, which may soon greatly simplify the process of preparing scientific publications. However, the authors' use of chatbots should be strictly regulated and transparent to the public. The authors propose a method to indicate the involvement of AI and the role of chatbots in scientific publishing through a specially designed basic logo.

With the intensive development of digital technologies, another major problem has arisen – the existence of fraudulent websites that "hack" or clone official journal websites.

The researchers point out that Scopus indexes articles from legitimate and cloned journals. This results in articles with different titles being published on overlapping pages in the same issues of the Journal.

Abalkina (2021) describes a method for identifying hijacked journal domains based on an analysis of clone journal archives. This method is based on the argument that fraudulent publishers recycle identical papers to create a fictitious archive.

Shahri et al. (2018) propose a method to detect captured logs using a classification algorithm.

We believe that authors are also responsible for using unethical practices. Mertkan et al. (2021), investigating the reasons why authors choose to publish in predatory journals, identified the following problems: on the one hand, there is pressure on the author to publish the work ("publish or perish"), on the other hand, there is a limited opportunity to publish the work in legitimate journals. This may be particularly important for junior researchers,



who face a “points” system where the number of publications may be more important than quality. In the present study, we do not examine authors' motives for publishing in predatory journals. Probably, it is trivial ignorance or, in their opinion, a simple and easy way to increase their academic ranking. It should be noted that these authors should be aware that such a publication may have serious consequences for their image as researchers and scientists. Therefore, before submitting a manuscript to a publisher or Journal, authors should consider the risks of publishing in a journal with a dubious reputation. An effective way to protect yourself from this type of publication is to pay attention to the ethical standards of the Journal in which you choose to publish.

We fully agree with Chandra and Dasgupta (2024), Kharumnuid and Singh Deo (2022), Tomlinson (2024), who suggest that education in this area should focus on raising young scientists' awareness of the problem, promoting responsible publishing practices, and the implications of engaging with predatory journals for their academic careers.

We believe that one of the most important criteria for assessing the quality of journals is their adherence to the COPE ethical principles. This compliance should not be a mere declaration of such information on journal websites, as is often seen even on “predatory journals” websites. This should be supported by factual evidence of the editorial team's work in this area.

For example, in addition to double-blind peer review of manuscripts, editorial and technical checks for the use of artificial intelligence, etc., IJSA has created a system of triple-checking of the work for possible illegal borrowing of text. Such a check involves all those involved in the publication process (authors, reviewers, editors), as well as the possibility for readers to complain if they find plagiarised text or other people's ideas in the manuscript. When non-standard situations arise, IJSA editors can provide feedback or discuss the problem in the COPE forum.

The second important quality criterion of journals is the possibility of free and unrestricted access to the text of the articles, which makes it possible to cite and use the information obtained correctly. In our experience, the best evaluation of journals in this respect is carried out by DOAJ, which evaluates and maintains journals that adhere strictly to the principles of open access and ethical standards. Indexing a journal in DOAJ is not only prestigious but also practical and helpful for all stakeholders. For example, IJSA includes lists from over 150 libraries worldwide through indexing in DOAJ.

An important criterion for a journal's quality is its indexing in the COPE and DOAJ databases. This gives authors confidence that their manuscripts will be ethically reviewed and their rights protected and that the manuscripts will be open and widely available to the global scientific community.

However, most authors continue to focus exclusively on journals indexed in Scopus. This is a consequence of the need to comply with the criteria for academic success. Such authors fail to appreciate the enormous contribution

that organisations such as COPE and DOAJ make to developing scholarly journals, academic science and society as a whole.

Conclusions

IJSA's experience building an international team of editors and qualified reviewers to prepare and publish articles over 7 years is a good example of its efforts to publish high-quality periodical literature. Authors prefer to publish their manuscripts in indexed journals. This ensures that their ideas are disseminated in the scientific community, contributes to the recognition of their qualifications and enhances the prestige of their academic work.

One of the most respected bibliographic and abstract databases of peer-reviewed scientific literature is Scopus. It is driven by the need of the scientific community to have publications indexed in it to meet the criteria of academic and scientific success.

If specific requirements are met, a publisher can submit a journal for evaluation in Scopus by filling out a special form. The Journal should then be checked for compliance with specific criteria and evaluated by a reviewer. Even if the publisher believes that the Journal fully meets the stated criteria, there is still a possibility that the Scopus reviewer will refuse to index the Journal based on his/her own opinion.

We believe that the objective evaluation of journals for inclusion in scientometric databases, including Scopus, should be based on strictly regulated criteria of qualitative and quantitative indicators and that the outcome of inclusion should not depend on the decision of a single reviewer.

The current procedure for evaluating journals in Scopus and the experience of peer review give us reason to argue that it is necessary to revise the evaluation criteria: to justify the necessity and sufficiency of each of the criteria. This is particularly true for the criteria of geography of authorship and citation of publications by their own database (Scopus). The only metric of citation for authors should be the academic duty to argue the facts presented in the manuscript, not journal metrics or reviewer requirements. Otherwise, the problems of the emergence of “paper mills” and “citation cartels” to manipulate citations and add irrelevant references will not only not be solved but will also be exacerbated by the other problems mentioned above.

In addition, some Scopus criteria require the specification of quantitative indicators. This would remove the subjectivity of the examiner's judgement. The appeal process should not be formalised, and the final decision should be reasoned based on the facts and clear and convincing. This will encourage publishers and journal editors to improve the publishing process and create real prospects for journal indexing in Scopus.

We, therefore, believe that there is a case for reviewing a number of the criteria used to evaluate journals in Scopus in order to strike a balance between their necessity and sufficiency and the possible technologisation of this process to reduce the role of the subjectivity of the human factor in reviewer judgement.



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Ethical Approval

The views expressed in this paper are those of the author and do not necessarily reflect the position of the Kharkiv Regional Public Organization "Culture of Health" (KRPOCH) or its affiliates, the editors and the reviewers.

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Appendix A



Scopus Title Evaluation Appeal Form

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Dear Publisher,

Before you submit the Scopus Title Evaluation Appeal Form, please make sure that you take notice of the conditions of the Scopus Appeal Procedure (see 1.). After that, please fill in the Scopus Title Evaluation Appeal Form (see 2.) and return it to titlesuggestion@scopus.com.

Yours sincerely,
The Scopus Title Evaluation Team

1. Scopus Appeal Procedure (source: [see here, page 13](#))

By returning the form I confirm to have read and understood the terms and conditions of the Scopus Appeal Procedure

2. Please provide us with the title details:

Serial title: International Journal of Science Annals

ISSN/E-ISSN: 2617-2682 / 2707-3637

Publisher: KRPOCH

Publisher country: Ukraine

Subject area:

Primary field: Social Sciences

Primary field sub-fields: Health (social science)

Main field 1: Psychology

Main field 1 sub-fields: Psychology (miscellaneous)

Main field 2: Education

Main field 2 sub-fields: Education

Date rejection letter received: 06-04-2024

Embargo period: April 2027

CSAB comments (please copy from rejection letter):

The title mentioned above has been evaluated for inclusion in Scopus by the Content Selection & Advisory Board (CSAB). The review of this title is now complete and the CSAB has advised to not accept the title for Scopus inclusion at the present time. For your information, the reviewer comments are copied below:

- + In general, the content of the articles is consistent with the scope and aims of the journal.
- + The abstracts are in keeping with Scopus English Language requirements.
- The geographical reach of authorship and/or content is too limited\r\n
- There are a few good, informative articles, but also many articles that make little contribution to the field.
- The journal does not publish enough good articles each year to warrant inclusion in Scopus.
- Low citations in good journals indexed in Scopus
- Many good international journals already cover this subject area.\r\n
- poor quality of the references



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3. Make sure to strictly follow the information from section 1.B. Please explain which significant factual errors have been found. Please do not exceed the maximum of 300 words.

We as the publisher do not agree as we are convinced procedural errors have been made along the review process.

1a) significant factual errors – CSAB reviewers subjectively selected some criteria (8 out of 14) and provided misleading information about them during IJSA assessment procedure.

1b) the evidence is detailed in Section 1 Appendix.

2a) significant factual errors – CSAB reviewers did not follow the assessment procedure for IJSA: the correct criteria were not considered, the assessment was not carried out properly, and the reviewers' opinions do not correspond to the facts, the embargo imposed (April 2027) was not justified.

2b) the evidence and analysis of compliance rates based on 5 categories and 14 quantitative and qualitative selection criteria is detailed in Section 2 Appendix.

3a) significant factual errors – CSAB reviewers did not consider the following criteria:

+IJSA has a convincing editorial policy

+The type of review is clearly stated

+IJSA Editorial Board includes authoritative 30 scientists from 17 countries, 5 continents

+IJSA has a sufficiently diverse geographical distribution of authors

+IJSA consistently publishes articles that are scientifically sound and relevant to an international academic and professional audience

+All IJSA articles have clearly structured abstracts

+IJSA has clear objectives and scope/policy for the Journal

+IJSA has good readability

+IJSA is scientifically significant

+IJSA has a stable publication schedule with no delays in publication

+The full content of the IJSA is available online in various forms

+IJSA has its own website with an accessible home page in English

+IJSA home page has clearly structured elements

3b) the evidence with links is in Section 2 Appendix.

In order to address this issue fully, completely and fairly,

1) we respond to CSAB reviewers' comments by providing evidence of their erroneous decision;

2) we analysis of Journal compliance rates based on Scopus quantitative&qualitative selection criteria (Appendix).



Appendix B



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Appendix

APPEAL AGAINST THE ASSESSMENT
of the International Journal of Science Annals,
ISSN / E-ISSN: 2617-2682 / 2707-3637,
for inclusion in Scopus

On 6 April 2024, KRPOCH Publishing was informed that the assessment of the International Journal of Science Annals (IJSA) for inclusion in Scopus had been completed.

KRPOCH Publishing submits this Appeal in accordance with the procedures and deadlines established for submission to Scopus.

Please accept this Appeal on the grounds of non-compliance with the assessment procedure and misrepresentation by the reviewers of the Scopus Content Selection and Advisory Board (CSAB).

JUSTIFICATION FOR FAILURE TO COMPLY WITH THE ASSESSMENT PROCEDURE

In order to justify the failure to follow the assessment procedure and to address this issue fully, completely and fairly, we first consider the CSAB reviewers' assessment with our comments and evidence (1), and then analyze the IJSA scores based on 5 categories and 14 quantitative and qualitative selection criteria (2), as defined by the official Scopus assessment procedure.

SECTION 1

The assessment by the reviewers of the CSAB with our comments and evidence

Positive assessment:

- + In general, the content of the articles is consistent with the scope and aims of the journal.
- + The abstracts are in keeping with Scopus English Language requirements.

Negative assessment (with our comments):

1.1a) The significant factual error is as follows

- The geographical reach of authorship and/or content is too limited

1.1b) The evidence of why this is an error is as follows

This statement does not correspond to the actual facts. During the evaluation period (January-March 2024), the Journal published 61 papers with 90 authors from 21 countries (Ukraine – 30, India – 19, Indonesia – 13, Portugal – 5, South Africa – 3, Italy – 2, Lithuania – 2, Bulgaria – 2, Egypt – 2, US – 1, Germany – 1, Australia – 1, Argentina – 1, Malaysia – 1, Philippines – 1, Taiwan – 1, Tunisia – 1, Belarus – 1, Kazakhstan – 1, Georgia – 1, Turkey – 1). The content of IJSA has statistically significant indicators of the geographical coverage of authors for an international scientific journal.

The IJSA is based on international collaboration and has a large readership: more than 170,000 from 165 countries <https://ijsa.culturehealth.org/index.php/en/statistics/readers>.

The Journal's website has highly visible pages with statistical data: <https://ijsa.culturehealth.org/index.php/en/statistics/publications>, <https://ijsa.culturehealth.org/index.php/en/statistics/authors>, that could allow the CSAB reviewers to make an objective specific assessment of this Journal indicator, rather than using general phrases that distort fact.

1.2a) The significant factual error is as follows

- There are a few good, informative articles, but also many articles that make little contribution to the field

1.2b) The evidence of why this is an error is as follows

We agree with the first part of this statement about having good journal articles, perhaps original research, which is what the IJSA prefers. However, we strongly disagree with the general negative assessment of "many articles".



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Each manuscript submitted for publication in IJSA is carefully reviewed by two or more highly qualified peer reviewers in the field of the study <https://doi.org/10.26697/ijisa.reviewers>. Manuscripts are then approved by the IJSA Scientific Editors <https://doi.org/10.26697/ijisa.2.1>.

Therefore, the reviewer's statement "there are ... also many articles that make little contribution to the field" should be considered subjective and erroneous. Otherwise, it calls into question the authority and competence of the work of the IJSA Reviewers and Scientific Editors.

Please note that all our reviewers are PhDs and that our Scientific Editors have high scientific indicators, including publications in Scopus journals.

An example is a recent paper https://culturehealth.org/ijisa_archive/ijisa.2024.1.1.pdf published in the Journal on 27 February 2024 by our Scientific Editor - Diego de Leo, who has more than 530 papers and over 107,000 citations in Scopus.

1.3a) The significant factual error is as follows

- The journal does not publish enough good articles each year to warrant inclusion in Scopus

1.3b) The evidence of why this is an error is as follows

Regarding the quality of the articles, we disagree with the assessment of the CSAB reviewers. The issue of quality and quantity of articles is a key issue for many scientific journals. We have an extremely negative view of paper mills. Therefore, our editorial policy is to select quality manuscripts with particular care. The IJSA is the Member of the Committee of Publication Ethics (COPE) https://is.gd/COPE_IJSA. In 2023, the Editorial Office received 119 manuscripts, of which 14 were published and 105 were rejected. The rejection rate for manuscripts was 88%.

We also disagree with the CSAB reviewers' assessment of the number of "sufficient" articles. Highly cited journals in Scopus with no more than 7 articles per issue can serve as an example. In IJSA over the last 3 years, the average number of articles per issue has been 7.14, with original research dominating.

As we are responsible for selecting good articles and publishing them in IJSA in sufficient numbers, we ensure quality reviewing and editing. We therefore believe that the assessment of the CSAB reviewers is unbiased. We believe that the quality of publications should outweigh their quantity in the evaluation process of the CSAB reviewers. The IJSA is paying particular attention to this issue. This is evidenced by an Editorial in our Journal entitled "Dilemma: Quality or Quantity in Scientific Periodical Publishing" <https://doi.org/10.26697/ijisa.2021.2.1>

1.4a) The significant factual error is as follows

- Low citations in good journals indexed in Scopus

1.4b) The evidence of why this is an error is as follows

The IJSA has a consistently high citation rate in scientific journals throughout the years of publication. This is confirmed by indicators in scientific databases https://is.gd/Google_IJSA. The IJSA is well cited in Scopus indexed journals. These citation rates of the Journal are acceptable for its inclusion in Scopus.

If we calculate the CiteScore based on the number of citations over a 4-year period (2018-2021), the CiteScore 2022 value for the IJSA would be $25/40=0.63$. The Journal with this CiteScore could well be in the fourth quartile. IJSA citations in Scopus-indexed journals decreased in 2023. This is due to the fact that the IJSA is not represented in Scopus and to incorrect citations of the IJSA in Scopus-indexed journals, which is confirmed by many examples. But this is a problem with the editorial quality of articles in other journals. The IJSA has no such problems. Each article in the IJSA is provided with information on how to cite it. The online version has a handy copy of how to cite an article in the following standards: APA, Harvard, and Vancouver (e.g. <https://doi.org/10.26697/ijisa.2023.2.3>).

The IJSA recommends and advises authors to cite reputable journals already indexed by Scopus in their manuscripts.

Since the citation of a journal in Scopus is a direct result of its inclusion in this database, the inclusion of IJSA in Scopus can have a positive impact not only on the citations of IJSA, but also on the citations of other good journals.



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1.5a) The significant factual error is as follows

- Many good international journals already cover this subject area

1.5b) The evidence of why this is an error is as follows

In the registration area of our journal (Ukraine) there are not enough international journals covering this subject area. In addition, our journal offers free publication in IJSA to authors from low-income countries, as well as to young scholars from different countries who are winners of international competitions. Other good international journals do not offer this in a practical way.

As a representative of KRPOCH Publishing, which is a member of the international publishing associations PILA and others, as well as COPE, I would like to point out to the Scopus Appeals Officer that if there is a limit, monopoly or restriction on the number of journals in a particular field for inclusion in Scopus, this information, with justification, should be available on the official Scopus website. As we found no such information on the website, this means that the CSAB reviewer's statement is for information only and not a rejection criterion.

1.6a) The significant factual error is as follows

- Poor quality of the references

1.6b) The evidence of why this is an error is as follows

We totally disagree with this assessment. We believe this is a misrepresentation of the facts by the CSAB reviewers.

The IJSA reference list follows APA style (APA 7th edition). The IJSA Technical Editor personally checks each source cited by authors in each article accepted for publication for compliance with the Journal's requirements, as well as the relevance and working status of each reference.

Please note that each article published in IJSA has active hyperlinks in pdf format in the reference list, and a reference list with working hyperlinks is available on the metadata/preview page of each article.

In addition, all references are submitted to the Crossref open network in a separate list. The CSAB reviewers could have easily checked on Crossref's website, but did not <https://www.crossref.org/members/prep/11240>

We can therefore conclude that the CSAB reviewers:

- 1) made an evaluation of IJSA based on less than 8 of the 14 mandatory criteria for evaluating journals in Scopus;
- 2) biased our submission by misrepresenting the facts and failing to note that there are many positive aspects of the IJSA publication, as required by the Scopus evaluation criteria.

Among them are the following:

- convincing editorial policy;
- organizing the peer review process;
- diversity in geographical distribution of editors;
- quality of the journal;
- readability of articles;
- clarity of abstracts;
- quality of journal home page etc.

This fact may indicate the low qualification of the reviewers who evaluated our Journal or a biased negative attitude towards the IJSA evaluation.

As the Journal evaluation for Scopus has 5 categories and 14 quantitative and qualitative selection criteria it can be confidently stated that the CSAB reviewers did not follow the assessment procedure for the IJSA: the correct criteria were not considered, the assessment was not carried out properly, the opinions of the reviewers do not correspond to the facts, the embargo imposed (April 2027) was not justified.



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SECTION 2

Analysis of IJSA indicators based on 5 categories and

14 quantitative and qualitative selection criteria (with our comments and evidence)

Journal Policy

1. Convincing editorial policy

+ The IJSA has a convincing editorial policy, available on the website under “Editorial Policy” <https://doi.org/10.26697/ijsa.3.1> with convenient, up-to-date hyperlinks. The information is categorized into the following sub-sections: Publishing ethics; Co-operating with reviewers, authors, readers; Duties and responsibilities of editors; CrossMark Policy; Correcting; Retracting or Withdrawing Policies; Archiving, etc.

The Journal has separate web pages with editorial policy features:

- Plagiarism policy <https://doi.org/10.26697/ijsa.3.2>
- Open access statement <https://doi.org/10.26697/ijsa.3.3>
- The ethics codex of scientific publications <https://doi.org/10.26697/ijsa.3.4>
- Disclaimer, Privacy statement <https://doi.org/10.26697/ijsa.3.5>
- License terms, Transfer of rights <https://doi.org/10.26697/ijsa.3.6>
- Terms of publications (fee) <https://doi.org/10.26697/ijsa.3.7>

The Editorial Policy of IJSA has been positively evaluated by experts from COPE, DOAJ and others.

2. Type of peer review

+ The type of review is clearly stated (double-blind review). It is supported by highly qualified reviewers. The IJSA has a list of reviewers that is systematically updated <https://doi.org/10.26697/ijsa.reviewers>

The Journal has a clear description of the procedure of the quality control system in textual and schematic form https://culturehealth.org/hogokz_knigi/Journal/Editing_and_reviewing_process.jpg

On the Editing and Reviewing web page <https://doi.org/10.26697/ijsa.2.3>, the information is divided into subsections that cover the specifics of the editing and reviewing process: Review procedure; The review procedure for manuscripts; Evaluation process time; Publication frequency; The reasons for rejection of publication; Appeal to the editor's and the reviewers' decisions, etc.

The Reviewer web page <https://doi.org/10.26697/ijsa.2.2> describes the specifics of the Reviewer selection process; Requirements for reviewers, Guidelines for preparing reviews, etc.

The Journal provides the Reviewer Evaluation Form https://culturehealth.org/hogokz_knigi/Journal/IJSA_reviewer_evaluation_form.pdf and the Response to Reviewer Comments Template https://culturehealth.org/hogokz_knigi/Journal/IJSA_Replies.pdf

3. Diversity in geographical distribution of editors

+ The IJSA Editorial Board includes the most authoritative 30 scientists from 17 countries, 5 continents in the fields of Education, Psychology, and Medicine <https://doi.org/10.26697/ijsa.2.1>

4. Diversity in geographical distribution of authors

+ The IJSA has a sufficiently diverse geographical distribution of authors (90 authors from 21 countries). Information is available on the Journal's website: <https://ijsa.culturehealth.org/index.php/en/statistics/authors>

Each author has a personal page on the IJSA website with papers published in the Journal

For example, <https://ijsa.culturehealth.org/index.php/en/archiv/previous-issues-ijsa/73-georgieva>

Content

5. Academic contribution to the field

+ The IJSA consistently publishes articles that are scientifically sound and relevant to an international academic and professional audience in the field of humanities and health integration. The IJSA publishes research examining the Human as an exposure as well as an outcome. As an exposure, the Journal publishes articles examining how socium influences all aspects of human life and its health <https://doi.org/10.26697/ijsa.4.1>



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6. Clarity of abstracts

+ All IJSA articles have clearly structured abstracts (Background and Aim of Study; Material and Methods; Results; Conclusions). For example, <https://doi.org/10.26697/ijisa.2023.2.2>

7. Quality and consistency with the stated aims and scope of the journal

+ The IJSA has clear objectives and scope/policy for the Journal <https://doi.org/10.26697/ijisa> These are consistent with the content of all issues of the Journal <https://doi.org/10.26697/ijisa.4.1>

8. Readability of articles

+ The IJSA has good readability. The Journal is represented in more than 40 international scientometric databases, repositories and search engines <https://doi.org/10.26697/ijisa.1.3>

Content available online in various formats: pdf, jpg, doaj, xml, txt, etc. For example, <https://doi.org/10.26697/ijisa.2023.2>

Journal Standing

9. Citedness of journal articles in Scopus

+ The IJSA is scientifically significant. The IJSA is cited in other journals, including those listed in Scopus. The value of the ratio of citations to total number of articles for all years of IJSA publication (2018-2023) is 2.63 for Google Scholar and 0.43 for Scopus.

10. Editor standing

+ The IJSA Editorial Board includes the most authoritative 30 scientists in 17 Countries (5 continents) who are responsible for the Journal scientific sections: Social Sciences – 6; Education – 8; Psychology – 6; Health Care Science – 10. All The Editorial Board members are presented on the website with the necessary supporting information: first name and surname, degree, affiliation, country, links to scholarly profiles (Scopus, ResearchGate, ORCID, Google Scholar) and photo. KRPOCH Publishing has formal cooperation agreements with each member of the Editorial Board <https://doi.org/10.26697/ijisa.2.1>

Publishing Regularity

11. No delays or interruptions in the publication schedule

+ The IJSA has a stable publication schedule with no delays in publication. Articles are published online as soon as they are available (peer-reviewed and copy-edited). The Journal collates them into archival print “numbers” (two per year: June, December) and “volumes” (one per year) <https://doi.org/10.26697/ijisa.4.1>

In December 2022, in a combined volume 5, the articles from issues 1 and 2 were published. This is caused by a full-blown war in our country (Ukraine). The premises of our publishing house were badly damaged in bombing raids, and equipment was destroyed. We continue to publish the Journal regularly despite these circumstances. For each article, the submission, acceptance and publication dates are available. In addition, CrossRef DOI, Crossmark linking are implemented for all published papers <https://doi.org/10.26697/ijisa.2023.2>

Online Availability

12. Full journal content available online

+ The full content of the IJSA is available online in various forms:

JPG – <https://doi.org/10.26697/ijisa.4.1>

PDF – https://culturehealth.org/ijisa_archive/IJSA.Vol.6.2.2023.pdf and others.

The full content of the IJSA is also available online in bibliographic databases: DOAJ, OAJI, Scilit, Internet Archive, MIAR, Zenodo, OpenAIRE, etc.

For example, <https://oaji.net/journal-archive-stats.html?number=8882>

The IJSA is represented at universities and in more than 160 libraries around the world: Stanford University Libraries (United States), University of California Davis Library (United States); Simon Fraser University (Canada); Maastricht University (Netherlands); V.I.Vernadskiy National Library of Ukraine, etc. For example, https://is.gd/nbuV_IJSA



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13. English language journal home page available

+ The IJSA has its own website with an accessible home page in English. Base URL: <https://ijsa.culturehealth.org>
DOI: <https://doi.org/10.26697/ijsa>

The Journal's website also offers the option to view all pages in Ukrainian. There is a handy function for switching between languages.

14. Quality of journal home page

+ The IJSA home page <https://doi.org/10.26697/ijsa> has clearly structured elements that allow users to get complete information about the Journal: title proper; abbreviated key-title; publication type; directions; frequency; edition language; print ISSN; online ISSN; linking ISSN; information about the founder and publisher of the Journal; registration certificate numbers of the founder, publisher and Journal; IJSA mission; information about the Editorial Board. indexing, and license.

A handy toggle is available on the log home page to switch to the online submission system <https://doi.org/10.26697/ijsa/online.submission.system> Descriptions and hyperlinks to manuscript preparation instructions for authors, article submission guidelines, manuscript templates, and supporting document forms are available here.

So, we have analyzed the IJSA based on clearly defined 5 categories and 14 quantitative and qualitative selection criteria. This analysis may be useful to the Independent Appeals Officer in making recommendations to the Scopus CSAB, as it is in line with the principle of a transparent selection of journals and a rigorous evaluation mechanism of the journals for the inclusion of their content in Scopus.

On the basis of the above, we request

- 1. To accept the Appeal against the assessment of the International Journal of Science Annals for inclusion in Scopus.**
- 2. To re-evaluate the International Journal of Science Annals and recommend to the CSAB the inclusion of the journal in Scopus.**

May 12, 2024

Respectfully submitted,

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International Journal of Science Annals

**SOCIAL AND
BEHAVIORAL SCIENCES**

Education



SOCIAL AND BEHAVIORAL SCIENCES. Education

REVIEW ARTICLE



Benefits and Challenges of Using Artificial Intelligence by Stakeholders in Higher Education



Author's Contribution:

- A – Study design;
- B – Data collection;
- C – Statistical analysis;
- D – Data interpretation;
- E – Manuscript preparation;
- F – Literature search;
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Background and Aim of Study:

Abstract

The benefits and challenges of using artificial intelligence (AI) in higher education are discussed. This has been the subject of a great deal of discussion among the general public and in the academic periodicals.

The aim of the study: to specify the benefits and challenges of using AI in academic university teaching based on a review of periodical research, and to develop a classification of directions for the use of artificial intelligence in higher education for interacting stakeholders.

Material and Methods:

The present study used a number of theoretical methods: analysis, synthesis, comparison, generalisation, systematisation to define the benefits and challenges of the use of AI by stakeholders; classification and modelling to develop a classification of directions for the use of AI in higher education.

Results:

It highlights the key benefits and challenges of using AI in academic university teaching that stakeholders face. Classification of directions of AI use in higher education is developed. The following four criteria are highlighted: content of education; forms and methods of teaching; diagnosing of learning outcomes; administering of educational services.

Conclusions:

AI offers exciting new prospects for its application in higher education, but there are also many concerns about its rapid development. First and foremost, there are the issues of the ethical and legal implications of using AI in higher education. The results of the study are important for stakeholders involved in developing strategies for the use of AI in higher education. The need to increase digital literacy and prepare all higher education institutions for the intensive process of information technology development in the coming years is highlighted.

Keywords:

artificial intelligence, higher education, benefits of artificial intelligence, challenges of artificial intelligence, stakeholders in higher education.

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Introduction

The rapid evolution of artificial intelligence (AI) is becoming a topic of discussion among the general public and in the scientific literature. Education systems, particularly higher education, were among the first to see the prospects of using AI in the educational process. In the present study, we define the term AI as computer systems, various AI technologies and applications, intelligent learning systems, chatbots, robotic and automated assessment systems that support and enhance education.

We look in detail at the benefits and challenges of using AI to train future professionals in higher education, and the use of AI by students, teachers, and employers.

The aim of the study. To specify the benefits and challenges of using AI in academic university teaching based on a review of periodical research, and to develop a classification of directions for the use of artificial intelligence in higher education for interacting stakeholders.

Materials and Methods

In the present study, we used internet resources to search for information based on the main concepts of AI in education, and analysed previous studies and reviews of periodicals. Studies published in scientific journals in a given field covered the following scientometric bases: Google Scholar. Education Resources Information Center (ERIC), Social Science Citation Index (SSCI), MDPI.

For the review, we selected English-language research studies on the use of AI in higher education that were published in reputable scientific peer-reviewed journals within the last 5 years.

We used a search string that specified such selection criteria: “artificial intelligence”, “higher education”, “artificial intelligence technologies”, “blockchain technology”, “ethics and legal of artificial intelligence”, “AI-based Chatbots”, “benefits AI in higher education”, “challenges AI in higher education”, “stakeholders in higher education”.

A number of theoretical methods were used in the present study: analysis, synthesis, comparison, generalisation, systematisation to define the benefits and challenges of the use of AI by stakeholders; classification and modelling to develop a classification of directions for the use of AI in higher education.

Results and Discussion

Changes have never been so swift as nowadays. In just a few years, higher education has been significantly digitised and enriched with new information technologies. Some of them open up fundamentally new possibilities, namely blockchain technology and artificial intelligence technologies.

The implementation of blockchain technology in education has been considered in numerous studies. Researchers (Bhaskar et al., 2021; Melnyk & Pypenko, 2020; Pypenko & Melnyk, 2020; Raimundo et al., 2021) have studied the challenges and benefits of blockchain technology in different areas of education. They have

concluded that blockchain technology can be applied to solve problems of efficiency, effectiveness, privacy control, technological improvement and others. It should also be noted that despite the positive aspects of blockchain, some researchers (Loukil et al., 2021) argue that several concerns continue to undermine its adoption in education, such as legal, immutability and scalability issues.

Next, we will look in more detail at artificial intelligence technologies, which also have advantages and some serious disadvantages. This has generated widespread controversy among scholars, which continues to be debated at conferences, on the pages of journals and in other media.

Let us first consider the ethical and legal aspects of artificial intelligence in higher education. Previous periodicals (Al-Zahrani & Alasmari, 2024) have largely pointed to the need to pay attention to ethical considerations and recommendations for AI implementation, highlighting the urgent need to address issues such as privacy, security and bias.

A meta-review by Bond et al. (2024), which examined the extent and nature of AI research in higher education, identified research gaps. There is a need for more ethical, methodological and contextual considerations in future research, as well as interdisciplinary approaches to the application of AI in higher education.

Airaj (2024) proposes a human-centred approach to the use of AI in higher education that promotes equitable access to knowledge while respecting privacy and ethics. Discussed through the lens of third generation activity theory, which explores the interaction between three activity systems in higher education: AI teachers, human teachers and students.

Abulibdeh et al. (2024) state that AI-based chatbots have the potential to be integrated into education. However, they argue that this raises ethical issues that require, among other things, a review of curricula, continuing education strategies and compliance with industry standards.

Several studies have identified different approaches to addressing the legitimacy of AI use that stakeholders in higher education may face. At their core, however, they relate to issues of AI licensing, which is an important legal tool. The study conducted by Malgier and Pasquale (2024) focuses on the issues of regulating AI through licensing. Such licensing should be applied to many high-risk areas of AI. The authors believe that “without proper assurances that the abuse of AI has been foreclosed, citizens should not accede to the large-scale application of AI now underway”. Ex-ante licensing of large-scale AI use should become commonplace in jurisdictions committed to enabling democratic governance of AI (Malgier & Pasquale, 2024).

Melnyk and Pypenko (2023), exploring the legitimacy of using AI-based chatbots in scientific research, proposed a new method for indicating the involvement of AI and the role of chatbots in a scientific publication. Researchers (Melnyk & Pypenko, 2023) have developed a basic logo that can be used to signify chatbots’



participation and contribution to publications. For practical applications, the authors have designed and implemented an information technology platform AIC AI Chatbots (<https://doi.org/10.26697/ai.chatbots>), which provides technological solutions related to the use of AI-based chatbots (text, images, videos) in scientific research and publications.

Noteworthy is the work of Pypenko (2023), who proposes the attribution of a product created by humans without the involvement of AI. In the author's opinion, this helps to protect the human right to own activities and to increase the value of natural human labour.

Studies describing AI as a revolutionary technology in higher education have emerged in recent years (Melnyk & Pypenko, 2024). Researchers explored the different uses of AI in higher education, and the benefits and challenges for stakeholders in education systems.

A number of studies have investigated the impact of distance learning, as well as trends in the use of AI-based chatbots in higher education among stakeholders (Aleedy et al., 2022; Al-Sharafi et al., 2023; Pypenko et al., 2020). These studies suggest that blended learning and the adoption of AI chatbots in higher education can be effectively used to assist students with their academic matters, progress monitoring, academic counselling and administrative affairs while studying at university.

Wang et al. (2023) argue that AI can enhance learning and provide personalised educational support. However, there are risks and limitations, among which are privacy concerns, cultural differences, language competence, and ethical implications.

Özer (2024) observes that AI systems have a bias problem and can reproduce biases based on social factors such as religion, culture, gender, race, etc. with training data.

Among other challenges, Crompton et al. (2022) identified a lack of technology skills among students and teachers, and skills directly related to the usability and design of AI tools.

Ahmad et al. (2022) highlighted the following benefits of using AI: minimising the administrative tasks of the educator, assisting with different types of tasks in the form of learning analytics, virtual reality and minimising teacher workload, effective and easy assessment of students.

These benefits of AI in education are highlighted by Clugston (2024): personalised learning, immersive learning experiences, improved student engagement and motivation, cost-effective learning, integrated learning and intelligent tutoring systems, continuous evaluation and improvement over time, raising academic standards and quality of education. Clugston (2024) also highlights the shortcomings of AI: privacy concerns, reliance on technology, lack of human touch, risk of fraud, displacement of teacher jobs.

Celik et al. (2022) argue that AI offers teachers several opportunities to improve planning, implement immediate feedback and assessment. In addition, these scholars have identified several limitations and challenges to the use of AI by teachers, including limited

reliability, technical capability, and applicability in different contexts.

Chan and Zary (2019) noted that the main application of AI in medical education is to support learning, due to its ability to provide personalised feedback. However, the lack of digitisation and the sensitive nature of examinations has limited the use of AI in curriculum review and assessment of student learning.

Chiu et al. (2023) highlighted the following four key educational domains of AI application in education: learning, teaching, assessment and administration, in which thirteen roles were identified. Let us focus on those that are of interest to us for the purposes of the present study: the use of AI in student learning. For the educational domain, four main roles are highlighted: signing tasks based on individual competence; providing human-machine conversations; analysing student work for feedback; increasing adaptability and interactivity in digital environments.

Kuleto et al. (2021) argue that AI and ML are essential technologies that enhance learning, primarily through students' skills, collaborative learning in higher education institutions, and an accessible research environment.

Pisica et al. (2023) describe such benefits of AI in education: can facilitate learning and provide both students and teachers with personalised attention and feedback; the effectiveness of AI tools and applications such as virtual and augmented reality, voice assistants, translation tools, chatbots, gamification, learning and tutoring programmes, instant assessment, etc.

These authors also point to shortcomings that need to be addressed as soon as possible: control of artificial intelligence technologies in terms of careful monitoring, regulation and legislation to avoid ethical violations, confidentiality dilemmas and bias; adaptation of higher education stakeholders to new technologies and methods.

Based on an analysis of current publications and the authors' own practical experience of working in universities, we have developed a classification of AI implementation in higher education in 4 main directions.

Classifying the directions of implementing AI in higher education:

1. Content of Education.
2. Forms and Methods of Teaching.
3. Diagnosing of Learning Outcomes.
4. Administering of Educational Services.

The directions for the use of AI in higher education for interacting stakeholders are illustrated in Figure 1.

The classification we propose allows us to specify the benefits and identify the challenges (problems) identified by researchers on the directions for the use of artificial intelligence in higher education for interacting stakeholders.

Key benefits of using AI in higher education:

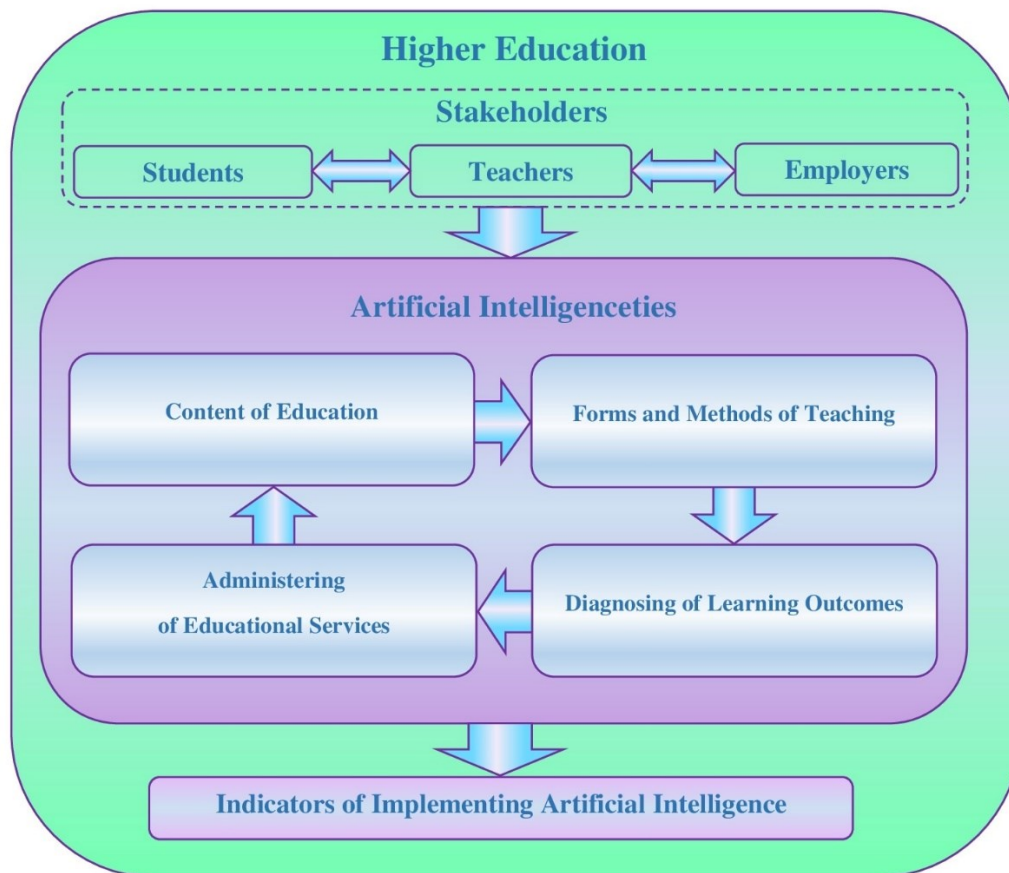
1. Benefits for the content of education (analysing huge amounts of data and transforming it into educational content).
2. Benefits of forms and methods of teaching (use of innovative methods and technologies such as virtual and

augmented reality; voice assistants; translation tools; chatbots).
 3. Benefits of diagnosing learning outcomes (no bias, speed of information processing).

4. Benefits of administering educational services (raising academic standards and quality of education, optimising the planning of educational processes, cost-effectiveness).

Figure 1

Directions for the Use of Artificial Intelligence in Higher Education for Interacting Stakeholders



Significant challenges (problems) faced by stakeholders in using AI in higher education:

1. Challenges for the content of education (creating incorrect information, biasing training data, relying on technology and not having equal access to AI tools).
2. Challenges of forms and methods of teaching (lack of human contact, students' lack of technological skills, lack of consideration for language and cultural differences of users, limited exposure of students to different points of view).
3. Challenges of diagnosing learning outcomes (biased scoring algorithms, risk of cheating, and no recourse).
4. Challenges of administering educational services (limited technical capacity and reliability, threats to privacy and security, ethical and legal implications).

Conclusions

The application of AI in education is a relatively new phenomenon for researchers and practitioners. AI offers exciting new prospects for its use in higher education, but there are also many concerns about its rapid development.

Most researchers expressed concern about the ethical and legal implications of using AI in higher education.

Increasingly, academics are calling for a consensus on the safe and responsible implementation of AI in education.

We believe that digital literacy and the readiness of all stakeholders in higher education for the intensive process of information technology development in the coming years is necessary.

Our proposed classification of directions for the use of AI in higher education allows us to specify the benefits and prepare stakeholders for the challenges they may face in implementing AI in their universities.

Ethical Approval

The study protocol was consistent with the ethical guidelines of the 1975 Declaration of Helsinki as reflected in a prior approval by the Institution's Human Research Committee. Research permission was granted by the Committee on Ethics and Research Integrity of the Scientific Research Institute KRPOCH (protocol no. 024-2/SRIKRPOCH dated 10.08.2023).

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International Journal of Science Annals

SOCIAL AND BEHAVIORAL SCIENCES

Psychology



SOCIAL AND BEHAVIORAL SCIENCES. Psychology

ORIGINAL RESEARCH



Mental Health and Life Satisfaction of University Students Influenced by War



Authors' Contribution:

- A – Study design;
B – Data collection;
C – Statistical analysis;
D – Data interpretation;
E – Manuscript preparation;
F – Literature search;
G – Funds collection

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Background and Aim of Study:

Abstract

The current situation in Ukraine, where active hostilities are taking place, has had a significant impact on students' mental health and life satisfaction.

The aim of the study: to identify the impact of war on the mental health and life satisfaction of university students.

Material and Methods:

The study was conducted in Ukraine in November 2024. A total of 219 students between the ages of 18 and 35 were surveyed. Respondents were divided into two groups. Group 1 (n=107): those who had been temporarily displaced (in Ukraine and in EU countries), including 20.6% of men and 79.4% of women. Group 2 (n=112): those who had not left their usual place of residence (Ukraine without active hostilities), including 21.4% of man and 78.6% of women. The mental health and life satisfaction of university students influenced by war were assessed using three psychological measures: the Satisfaction with Life Scale (SWLS), the Patient Health Questionnaire (PHQ-9), and the Generalised Anxiety Disorder (GAD-7).

Results:

The SWLS, PHQ-9, and GAD-7 scores showed high internal consistency (Cronbach's alpha of 0.827 to 0.961) in both groups of students. Significant negative correlations of high / moderate strength were found between the SWLS and PHQ-9 depression symptoms / the GAD-7 anxiety disorder. Students who had been internally displaced were extremely dissatisfied (13.1%) and dissatisfied (23.4%) with their lives. These levels of dissatisfaction are almost one-third higher than those who did not leave their usual place of residence (8.9% and 17.9%, respectively). Further detailing of mental health features revealed the presence of depression and anxiety among all the studied groups of students. At the same time, severe depression (8.4%), moderately severe depression (29.0%), and severe anxiety (20.6%) were almost twice as common among students in Group 1 as among students in Group 2 and require psychological support.

Conclusions:

The war had the greatest impact on the mental health and life satisfaction of students who were forced to seek refuge at home and abroad. The data obtained calls for developing and implementing appropriate social and psychological support methods for students affected by the war. These methods should be comprehensive and involve the integration of psychological support into the structure of universities, including individual and group counselling, crisis intervention, psychological training, and student support programmes.

Keywords:

mental health, life satisfaction, anxiety, depression, students, temporarily displaced persons, war



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Introduction

The last decade has seen an increase in military conflicts worldwide. In particular, on the territory of Europe, Ukraine is currently engaged in a full-scale war on a scale not seen since the Second World War (Mykhaylyshyn et al., 2024).

As this war threatens the lives of the entire population of this country, a significant number of its citizens have been forced to leave their homes and normal lives to seek refuge within and outside the country. Millions of people have been forced to leave their homes as a result of the massive destruction (Leon et al., 2022; McKee & Murphy, 2022). All of this has led to significant changes in the lives of Ukrainians and affected their mental health. This was particularly felt by more vulnerable groups, including young students (Pypenko et al., 2023). Displacement creates a deep sense of loss, insecurity, and difficulty in adapting to a new environment, and disrupts social networks, including family and community ties. This adds to the emotional burden, increasing depression and anxiety and affecting quality of life (Stadnik et al., 2022).

University students are experiencing social transformations (social crisis, forced displacement, destruction of social ties), educational changes (introduction of new technologies based on distance learning), and psychological strain due to constant stress, which affect their quality of life.

The aim of the study. To identify the impact of war on the mental health and life satisfaction of university students.

This study focuses on the subjective well-being and characteristics of mental disorders of university students living in extreme conditions.

The data obtained are important for the development of appropriate measures of psychological support and psychoprophylaxis for students in war conditions.

Materials and Methods

Participants

The study was conducted during the Russian-Ukrainian war at Uzhhorod National University (Ukraine) in November 2024. The respondents were 219 students aged between 18 and 35. They were divided into 2 groups:

Group 1 – university students who had been temporarily displaced, living in a relatively safe place (Ukraine) or in a safe place (EU country): 107 persons, including 22 (20.6%) males and 85 (79.4%) females.

Group 2 – university students who had not left their usual place of residence, living in a relatively safe place (Uzhhorod, Ukraine, area of no active hostilities): 112 persons, including 24 (21.4%) males and 88 (78.6%) females.

Due to the active phase of the war in Ukraine, the survey of students was conducted remotely by posting psychological methods on the Google Forms platform. In addition, students were observed during distance and face-to-face teaching. Where necessary, individual interviews were conducted.



Mental Health Measures

The Satisfaction with Life Scale, a 5-item scale, SWLS (Diener et al., 1985) was used to assess students' life satisfaction and quality of life. In the present study, the adapted Ukrainian version of the questionnaire by Stadnik and Melnyk was used (<https://forms.gle/9GoFoTZjWnMxrMW5A>).

The SWLS aims to measure the overall perception of quality of life. This allows each respondent to rate the importance of life domains according to their values and provides an overall judgement of life satisfaction. Each of the 5 items is rated on a 7-point Likert scale (1 - strongly disagree; 7 - strongly agree). Higher scores indicate greater life satisfaction.

The SWLS scores showed good internal consistency. The Cronbach's alphas were 0.961 and 0.879 for Group 1 students (who had not left their usual place of residence) and Group 2 students (who had been temporarily displaced), respectively.

Symptoms of depression were assessed using the Patient Health Questionnaire, a 9-item depression scale, PHQ-9 (Kroenke et al., 2001).

In the present study, the Ukrainian adaptation of this questionnaire by Stadnik and Melnyk was used (<https://forms.gle/74BKVXRWHgtL9D75A>).

The PHQ-9 is the depression module. It is widely used in clinical and research settings. It contains 9 questions that meet the criteria for diagnosing depression. Answers to each question are rated on a Likert scale (0 – not at all; 1 – several days; 2 – more than half the days; 3 – nearly every day). The individual answers to the questions are added up to a score of 0 to 27. The severity of depression is usually classified as follows: minimal depression (0-4), mild depression (5-9), moderate depression (10-14), moderately severe depression (15-19), and severe depression (20-27).

The Cronbach's alphas for the PHQ-9 scores in the present study were 0.827 and 0.843 for Group 1 students (who had not left their usual place of residence) and Group 2 students (who had been temporarily displaced) respectively.

The Generalised Anxiety Disorder, a 7-item anxiety scale, GAD-7 (Spitzer et al., 2006) was used to assess anxiety.

As in the two previous diagnostics, we used the adapted Ukrainian version of this questionnaire by Stadnik and Melnyk (<https://forms.gle/5BLmcVxjs36fJ4tR6>).

The GAD-7 is used to measure or assess the severity of generalised anxiety disorder. Each item on the GAD-7 is rated on a Likert scale (0 – not at all; 1 – several days; 2 – more than half the days; 3 – nearly every day).

The individual answers to the questions are combined into a score from 0 to 21, where (0-4) is minimal anxiety, (5-9) is mild anxiety, (10-14) is moderate anxiety, and (15-21) is severe anxiety.

In the present study, we obtained Cronbach's alphas of 0.877 for the GAD-7 scores of Group 1 students (who had not left their usual place of residence) and 0.879 for the GAD-7 scores of Group 2 students (who had been temporarily displaced).

The psychological methods and research procedure used in the study were approved by the Committee on Ethics and Research Integrity of the Scientific Research Institute KRPOCH (protocol no. 024-1/SRIKRPOCH dated 10.08.2023).

Statistical Analysis

All data analysis was performed using IBM SPSS Statistics for Windows (Version 30.0).

The reliability (internal consistency) of the scales was assessed by evaluating internal consistency using Cronbach's alpha test as well as item-test correlations. Scales show good internal consistency when Cronbach's alpha is greater than 0.7. In addition, Pearson correlations were performed between all the items in the scales (inter-item). A value greater than 0.4 indicated that the item was homogeneous in measuring the scale. Divergent validity was evaluated by correlating total scores on the Satisfaction with Life Scale (SWLS) with total scores on the Patient Health Questionnaire (PHQ-9) and Generalised Anxiety Disorder (GAD-7). Convergent validity was assessed by correlating the PHQ-9 total score with the GAD-7 total score. Pearson correlation coefficients were used for both convergent and divergent validity.

Correlation coefficient value between -1 and 1, where a value of -1 indicates an overall negative linear correlation, 0 indicates no correlation, and +1 indicates an overall positive correlation. A strong correlation was indicated by a correlation coefficient value of ≥ 0.5 .

Results

Life satisfaction is a complex, multifactorial, and structurally dynamic phenomenon that serves as a generalised assessment of an individual's quality of life. The issue of life satisfaction is relevant for Ukraine in today's environment.

War has a detrimental effect on people's physical and mental health.

There are, therefore, many factors that determine life satisfaction (personal security, health, family, work, acceptance of circumstances, freedom of choice, etc.), but they all relate to the quality of one's own life.

This is related to the affective aspects of subjective well-being status, such as happiness, joy, depression, anxiety, and stress.

Life satisfaction is, therefore, an important indicator of an individual's quality of life and psychological well-being (Stadnik, 2023).

Table 1 shows the descriptive statistics for each item (life satisfaction criteria): the mean, the standard deviation, and the 95% confidence intervals for Group 1 and Group 2.

The average score of satisfaction with life was 17.26 points (SD 6.64) for Group 1 and 18.66 points (SD 5.93) for Group 2.

The analysis of the reliability of the SWLS showed an internal consistency of 0.961 and 0.879 (Cronbach's alpha) for students who had not left their usual place of residence (Group 1) and students who had been temporarily displaced (Group 2).



Similarly, we confirmed that the inter-item correlation was significant. All items were moderately and highly correlated, with values ranging from 0.563 to 0.896 in both groups (Table 2).

Table 3 shows the life satisfaction among university students during the war.

Table 1

Descriptive Statistics for the Satisfaction with Life Scale Items

Items	Mean		Standard deviation		95% Confidence intervals			
	Group 1	Group 2	Group 1	Group 2	Group 1		Group 2	
					Lower	Upper	Lower	Upper
Item 1	3.28	3.40	1.37	1.33	3.01	3.55	3.20	3.68
Item 2	3.32	3.63	1.30	1.27	3.08	3.60	3.36	3.86
Item 3	3.41	3.44	1.60	1.37	3.11	3.75	3.17	3.72
Item 4	3.64	4.21	1.31	1.29	3.36	3.92	3.97	4.44
Item 5	3.61	3.97	1.58	1.83	3.32	3.91	3.64	4.28
Total	17.26	18.66	6.64	5.93	15.95	18.58	17.42	19.75

Table 2

Inter-Item Correlation Matrix for the Satisfaction with Life Scale Items

Items	Item 1*	Item 2*	Item 3*	Item 4*	Item 5*
Item 1*	-	0.896	0.796	0.789	0.797
Item 2*	0.761	-	0.814	0.830	0.844
Item 3*	0.757	0.700	-	0.856	0.864
Item 4*	0.579	0.563	0.548	-	0.890
Item 5*	0.649	0.595	0.688	0.615	-

Notes. *Correlation is significant at the 0.01 level.

Correlations for Group 1 are shown above the diagonal and those for Group 2 are below the diagonal.

Table 3

The Assessment of Life Satisfaction Levels among University Students during the War

Life satisfaction level	Group 1, %			Group 2, %		
	Total	Male	Female	Total	Male	Female
Extremely dissatisfied	13.1	27.3	9.4	8.9	8.3	9.1
Dissatisfied	23.4	13.6	25.9	17.9	16.7	18.2
Slightly dissatisfied	22.4	13.6	24.7	30.4	25.0	31.8
Neutral	1.9	4.6	1.2	2.7	4.2	2.3
Slightly satisfied	26.2	27.3	25.9	25.9	29.2	25.0
Satisfied	13.1	13.6	12.9	14.3	16.7	13.6
Extremely satisfied	0.0	0.0	0.0	0.0	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0	100.0

When analysing the level of life satisfaction, it can be seen that the indicators of extremely dissatisfied (13.1%) and dissatisfied (23.4%) with their lives are almost one-third higher among the students of Group 1 who were forced to change their place of residence during the war (living in Ukraine and the EU) than among the students of Group 2 who did not leave their usual place of residence (8.9% and 17.9%, respectively). This was manifested in concerns about their health and the lives of their loved ones, worries about their future in the context of war, socio-economic insecurity, and

deterioration of their financial situation. The percentages of students who are extremely satisfied (0.0%) and satisfied (13.1%) with their lives are about the same for Group 1 (0.0% and 13.1%) and Group 2 (0.0% and 14.3%), with no statistically significant differences.

The gender peculiarities were that the proportion of men in Group 1 who were extremely satisfied with their lives reached 27.3%, which was the highest of all the gender groups and almost three times higher than the proportion of women in Group 1 (9.4%). This indicates their low



psychological well-being and quality of life. It should be noted that the absolute dissatisfaction and dissatisfaction with their lives of men and women in Group 2 are almost identical and have no statistically significant differences.

Life satisfaction is thus a complex, structurally dynamic phenomenon that assesses an individual's quality of life and psychological well-being and depends on many factors. War is a powerful factor that negatively affects life satisfaction. Our research has shown that internally displaced students living in Ukraine and the European Union have indicators of being extremely dissatisfied (13.1%) and dissatisfied (23.4%) with their lives, which are almost a third higher than students who have not left their usual place of residence. At the same time, this indicator is significantly higher for men than for women,

which indicates their low psychological well-being and quality of life. All of this requires psychological help to acquire positive thinking skills, to communicate with positive people and to solve their deep personal problems. Thus, the study showed that even living in safe conditions (in Ukraine and in the EU) does not improve the psychological well-being and quality of life of internally displaced persons but causes a significant emotional distress and the need for psychological help and support.

Further details of psychopathological symptoms were measured using the PHQ-9, and GAD-7 questionnaires. Table 4 shows the manifestations of depression among university students during the war, using the PHQ-9 scores.

Table 4
Levels of Depression Severity among University Students during the War

Depression level	Group 1, %			Group 2, %		
	Total	Male	Female	Total	Male	Female
Minimal	9.4	36.4	2.4	19.6	45.8	12.5
Mild	19.6	13.6	21.2	34.8	16.7	39.8
Moderate	33.6	13.6	38.8	26.8	12.5	30.7
Moderately severe	29.0	22.7	30.6	14.3	16.7	13.6
Severe	8.4	13.6	7.1	4.5	8.3	3.4
Total	100.0	100.0	100.0	100.0	100.0	100.0

Depression is a state of decreased mood, activity, and willpower. Depression is a risk factor for suicide. In Group 1 students, severe depression (8.4%) and moderately severe depression (29.0%) are almost twice as common as in Group 2 (4.5% and 14.3% respectively). At the same time, minimal depression (19.6%) and mild depression (34.8%) are much more common among students in Group 2. The gender differences in depression were as follows. Men in Groups 1 and 2 had a higher proportion of minimal symptoms of depression (36.4% and 45.8%, respectively), than women (2.4% and 12.5%, respectively). This indicates that they probably have latent depression, which manifests itself in substance

abuse, somatic disorders, and behavioural problems. In addition, we found a significantly higher prevalence of severe depression among men in Groups 1 and 2 (13.6% and 8.3%, respectively) than among women (7.1% and 3.4%, respectively). This probably indicates the presence of significant maladjustment in this group of students.

The descriptive statistics for each item (patient health criteria): the mean, the standard deviation, and the 95% confidence intervals for Group 1 and Group 2 are shown in Table 5.

The average score of depression severity was 11.45 points (SD 5.44) for Group 1 and 10.58 points (SD 5.47) for Group 2.

Table 5
Descriptive Statistics for the Depression Scale (Patient Health Questionnaire) Items

Items	Mean		Standard deviation		95% Confidence intervals			
	Group 1	Group 2	Group 1	Group 2	Group 1		Group 2	
					Lower	Upper	Lower	Upper
Item 1	1.64	1.51	0.91	0.87	1.46	1.80	1.31	1.68
Item 2	1.22	1.26	0.90	0.94	1.05	1.42	1.20	1.59
Item 3	1.56	1.39	1.07	0.99	1.37	1.79	1.20	1.59
Item 4	1.72	1.36	0.96	0.90	1.51	1.89	1.21	1.57
Item 5	0.97	0.98	0.83	0.82	0.76	1.16	0.84	1.14
Item 6	1.25	1.07	1.02	0.89	1.04	1.42	0.92	1.27
Item 7	1.35	1.29	0.94	0.89	1.15	1.51	1.12	1.47
Item 8	0.96	0.96	0.85	0.87	0.81	1.12	0.79	1.10
Item 9	0.77	0.76	0.90	1.04	0.58	0.94	0.56	1.00
Total	11.45	10.58	5.44	5.47	10.36	12.62	9.51	11.51



The analysis of the reliability of the PHQ-9 showed an internal consistency of 0.827 and 0.843 (Cronbach's alpha) for students who had not left their usual place of residence (Group 1) and students who had been temporarily displaced (Group 2). Similarly, we confirmed that the inter-item correlation was significant.

All items had moderate to high correlations with the scale (item test), with values, ranging from 0.401 to 0.597 in both groups (Table 6).

Table 7 shows the manifestations of anxiety among university students during the war.

Table 6

Inter-Item Correlation Matrix the Depression Scale (Patient Health Questionnaire) Items

Items	Item 1*	Item 2*	Item 3*	Item 4*	Item 5*	Item 6*	Item 7*	Item 8*	Item 9*
Item 1*	-	0.412	0.467	0.413	0.485	0.510	0.440	0.427	0.482
Item 2*	0.579	-	0.497	0.589	0.409	0.470	0.506	0.544	0.578
Item 3*	0.484	0.492	-	0.503	0.549	0.503	0.494	0.411	0.484
Item 4*	0.588	0.413	0.567	-	0.546	0.449	0.515	0.496	0.551
Item 5*	0.441	0.430	0.543	0.537	-	0.432	0.526	0.483	0.559
Item 6*	0.409	0.530	0.517	0.597	0.425	-	0.527	0.541	0.565
Item 7*	0.567	0.480	0.401	0.421	0.417	0.583	-	0.583	0.509
Item 8*	0.551	0.576	0.489	0.466	0.621	0.424	0.445	-	0.524
Item 9*	0.466	0.554	0.416	0.401	0.408	0.418	0.535	0.458	-

Notes. *Correlation is significant at the 0.01 level.

Correlations for Group 1 are shown above the diagonal and those for Group 2 are below the diagonal.

Table 7

Levels of Anxiety among University Students during the War

Anxiety level	Group 1, %			Group 2, %		
	Total	Male	Female	Total	Male	Female
Minimal	14.0	13.6	14.1	28.6	54.2	21.6
Mild	27.1	18.2	29.4	33.9	8.3	40.9
Moderate	38.3	36.4	38.8	26.8	12.5	30.7
Severe	20.6	31.8	17.7	10.7	25.0	6.8
Total	100.0	100.0	100.0	100.0	100.0	100.0

Anxiety is characterised by the expectation of adverse developments, bad premonitions, fear, tension and excitement, leading to chronic fatigue and a deterioration in the quality of life. The feeling of severe and moderate anxiety was more pronounced among students in Group 1 (20.6% and 38.3%, respectively) than in Group 2 (10.7% and 26.8%, respectively), which manifested itself in an inability to concentrate, helplessness, confusion, extreme anxiety and negatively affected the activity and quality of the students' learning. Minimal anxiety (28.6%) and mild anxiety (33.9%) prevailed among students in Group 2. Gender differences between the study groups included a significant prevalence of severe anxiety among males in Groups 1 and 2 (31.8% and 25.0%, respectively) compared to females (17.7% and 6.8%, respectively), indicating their significant maladjustment. Indicators of mild anxiety were most pronounced in women in Group 2 (40.9%) and minimal anxiety in men in Group 2 (54.2%), indicating a better state of mental health. Thus, the study of students' mental health showed the presence of depression and anxiety in all the groups of students studied, which definitely affected their life satisfaction. At the same time, the rates of severe depression (8.4%), moderate depression (29.0%) and severe anxiety (20.6%) among students in Group 1 were almost double those of students in Group 2 (4.5%,

14.3%, and 10.7%, respectively). This manifested itself in feelings of tension, anxiety, emptiness, loss of interest in learning, low self-esteem, occasional agitation, or general apathy. Even staying in safe conditions is stressful for internally displaced students. Lack of permanent housing, financial difficulties and uncertainty about the future lead to increased dissatisfaction with their lives and increased manifestations of depression and anxiety. This requires developing and implementing appropriate social and psychological support methods for students affected by the war.

The descriptive statistics for each item (anxiety disorder criteria): the mean, the standard deviation, and the 95% confidence intervals for Group 1 and Group 2 are shown in Table 8. The average score of anxiety disorder was 9.80 points (SD 4.82) for Group 1 and 9.81 points (SD 4.82) for Group 2.

The analysis of the reliability of the GAD-7 showed a high internal consistency (Cronbach's alpha) for students who had not left their usual place of residence, Group 1, and students who had been temporarily displaced, Group 2. Similarly, we confirmed that the inter-item correlation was significant.

All items had high correlations with the scale (item test), with values ranging from 0.402 to 0.689 in both groups (Table 9).



Table 8

Descriptive Statistics for the Anxiety Scale (Generalised Anxiety Disorder) Items

Items	Mean		Standard deviation		95% Confidence intervals			
	Group 1	Group 2	Group 1	Group 2	Group 1		Group 2	
					Lower	Upper	Lower	Upper
Item 1	1.87	1.81	0.96	1.01	1.71	2.08	1.63	1.97
Item 2	1.23	1.19	0.91	0.94	1.06	1.42	1.04	1.36
Item 3	1.40	1.35	0.91	0.94	1.22	1.60	1.20	1.49
Item 4	1.47	1.27	0.94	1.06	1.29	1.68	1.05	1.45
Item 5	1.21	0.80	0.85	0.87	1.03	1.37	0.65	1.00
Item 6	1.57	1.36	0.91	0.99	1.32	1.75	1.13	1.53
Item 7	1.07	0.94	0.86	0.90	0.89	1.21	0.78	1.13
Total	9.80	9.81	4.82	4.82	8.83	10.80	7.62	9.72

Table 9

Inter-Item Correlation Matrix the Anxiety Scale (Generalised Anxiety Disorder) Items

Items	Item 1*	Item 2*	Item 3*	Item 4*	Item 5*	Item 6*	Item 7*
Item 1*	-	0.630	0.653	0.618	0.406	0.591	0.443
Item 2*	0.649	-	0.781	0.477	0.400	0.419	0.415
Item 3*	0.689	0.687	-	0.565	0.409	0.422	0.437
Item 4*	0.673	0.523	0.606	-	0.407	0.618	0.554
Item 5*	0.409	0.457	0.440	0.402	-	0.489	0.443
Item 6*	0.630	0.474	0.440	0.643	0.641	-	0.517
Item 7*	0.402	0.481	0.408	0.508	0.501	0.491	-

Notes. *Correlation is significant at the 0.01 level.

Correlations for Group 1 are shown above the diagonal and those for Group 2 are below the diagonal.

The internal consistency results for the scales (the Satisfaction with Life Scale, SWLS, the Patient Health

Questionnaire, PHQ-9, and the Generalised Anxiety Disorder, GAD-7) are presented in Table 10.

Table 10

Internal Consistency for the SWLS, PHQ-9, and GAD-7

Measures	Cronbach's alpha values	
	Group 1	Group 2
Satisfaction with Life Scale (SWLS)	0.961	0.879
Patient Health Questionnaire (PHQ-9)	0.827	0.843
Generalised Anxiety Disorder (GAD-7)	0.877	0.879

The internal consistency results showed that the scales of the SWLS, the PHQ-9 and the GAD-7 had a high degree of internal consistency with Cronbach's alpha values above 0.8. The results indicate that all items contributed well to measuring the SWLS, the PHQ-9,

and GAD-7 scales, as all item correlations were above 0.4.

Table 11 shows the correlations between the SWLS and the corresponding validation measures of psychopathological symptoms.

Table 11

Correlations between the SWLS, PHQ-9, and GAD-7 Scores

Validity measures	Patient Health Questionnaire (PHQ-9)	Generalised Anxiety Disorder (GAD-7)	Satisfaction with Life Scale (SWLS)
<i>Convergent validity</i>			
Patient Health Questionnaire (PHQ-9)	-	0.797	-0.448
Generalised Anxiety Disorder (GAD-7)	0.762	-	-0.614
<i>Divergent validity</i>			
Satisfaction with Life Scale (SWLS)	-0.414	-0.586	-

Notes. *Correlation is significant at the 0.01 level.

Correlations for Group 1 are shown above the diagonal and those for Group 2 are below the diagonal.



The significant positive strong correlation ($r \geq 0.50$) between the PHQ-9 (depression symptoms) and the GAD-7 (anxiety disorder) scores provided evidence of convergent validity ($r = 0.797$, $p < 0.001$ and $r = 0.762$, $p < 0.001$ for Group 1 and Group 2, respectively).

These results are consistent with the findings of other studies on anxiety and depression (Almadani et al., 2024; Blenkiron and Goldsmith, 2019; Casares et al., 2024; Fortini et al., 2024; Mukuria et al., 2024; Sikström et al., 2023; Titov et al., 2022; Xiao et al., 2022).

As expected, depression symptoms (PHQ-9) and anxiety disorder (GAD-7) were negatively correlated with the Satisfaction with Life Scale (SWLS). The correlations obtained had moderate ($r \geq 0.30$) and high ($r \geq 0.50$) effect sizes.

The significant negative correlations of moderate strength were found between the SWLS and the PHQ-9 depression symptoms ($r = -0.448$, $p < 0.001$), and high strength between the SWLS and the GAD-7 anxiety disorder ($r = -0.614$, $p < 0.001$) for Group 1 students (who had been temporarily displaced). For students in Group 2 (who had not left their usual place of residence), significant negative correlations of moderate and high strength were found ($r = -0.414$, $p < 0.001$; $r = -0.586$, $p < 0.001$ respectively). This significant negative correlation supported the evidence for a divergent validity.

The results are consistent with the findings of other studies (Neto et al., 2024; Sikström et al., 2023; Titov et al., 2022; Valenti & Faraci, 2024; Xiao et al., 2022).

Therefore, we observed a significant increase in depression and anxiety among students who were forced to change their place of residence during the war, probably related to being in a place far from home, an unfamiliar place.

They cannot adequately assess the threat to their homes because they only know about it from the media and their relatives back home. These factors increase uncertainty, depression, and anxiety, deepening the chronic stress phase.

The loss of control over one's situation and one's life, the difficulty of adapting to new living conditions, aggravated by the blurring of one's personal identity and the longing for one's place of residence, are also reasons for the destructive effects.

Discussion

Psychological research ("Mississippi Scale for Combat-Related Post-traumatic Stress Disorder"; "Depression Anxiety Stress Scales"; "Insomnia Severity Index" techniques were used), conducted in Ukraine among military men aged 18 to 40 during low-intensity warfare and the coronavirus pandemic confirms that military personnel with combat experience are significantly less likely to suffer from anxiety, depression, stress, and sleep disorders than military personnel without such experience (Melnyk et al., 2020).

These points to the possibility of triggering the adaptation processes of the individual in extreme conditions, burdened by the simultaneous conditions of warfare and pandemic.

The General Health Questionnaire, to assess psychological well-being and emotional stability, and the Social Support Questionnaire, to determine the specifics of emotional support, practical support, and social integration, have been used in psychological studies of student youth. These studies have found a correlation between general health measures and psychological well-being and permanent residence in or near a combat zone (Stadnik et al., 2023). The authors suggest that the closer the students are to the combat zone, the greater the negative impact on their mental health.

Experiences of insecurity, instability, violence and prolonged stress caused by war can have long-term negative effects on students' mental health, which become apparent after several years (Yousef et al., 2021; Kassa et al., 2024). One of the main threats is the development of post-traumatic stress disorder, which can be manifested by persistent memories of war experiences, anxiety attacks, emotional detachment and difficulties in maintaining social relationships (Yousef et al., 2021; Kassa et al., 2024; Kassaye et al., 2023).

The effects of chronic stress can also manifest themselves in a variety of psychosomatic disorders, such as sleep disturbances, chronic fatigue, cardiovascular and digestive disorders, neurodegenerative disorders or autoimmune diseases (Oroian et al., 2021). These processes can be further complicated by prolonged uncertainty, feelings of insecurity, lack of support and financial hardship, which raises the need for long-term programmes that promote a systemic approach to individuals' adaptation, psychological and physical recovery (Yousef et al., 2021; Oroian et al., 2021).

Spiritual support can meaningfully complement psychological and social support measures for students who have been through various traumatic experiences (Hogue, 2024). Research shows that various religious practices, such as meditation, prayer, participation in religious ceremonies, and spiritual counselling, help to cope with the negative consequences of violent experiences, reduce anxiety and build emotional resilience (Hogue, 2024; Deikus & Vveinhardt, 2024; Vveinhardt & Deikus, 2021).

Universities could, therefore, offer intervention programmes, meditation groups, spiritual counselling services, or reflective spaces to help build an inclusive and supportive community and forge meaningful interpersonal relationships (Idoate et al., 2019; Scalora et al., 2020; Scalora et al., 2022).

Conclusions

Every Ukrainian felt the effects of the war. Millions of Ukrainian citizens have been forced to flee their homes and/or adapt to new living conditions in order to save their lives.

Students, as one of the most vulnerable sectors of the population, are affected by social changes (social crisis, forced displacement, destruction of social ties), changes in education (introduction of new technologies and distance learning), and psychological stress due to constant stress (death of relatives and friends, loss of housing and property, financial problems, etc.).



The disruption of social networks, including family and community ties, adds to the emotional distress, increasing depression and anxiety and affecting students' mental health and life satisfaction.

A study we conducted in November 2024 showed that Group 1 students who are internally displaced and living in Ukraine and the European Union have indicators of absolute dissatisfaction (13.1%) and dissatisfaction (23.4%) with their lives. This is almost a third higher than for Group 2 students who did not leave their usual place of residence (8.9% and 17.9%, respectively). This was manifested in concern for their health and the lives of their relatives, worries about their future in the context of war, socio-economic insecurity and deterioration of their financial situation. At the same time, absolute dissatisfaction with life among men in Group 1 reached 27.3%, the highest of all gender groups and almost three times higher than among women in Group 1 (9.4%). This indicates their low psychological well-being and quality of life.

Further examination of mental health characteristics revealed the presence of depression and anxiety in all groups of students studied. At the same time, the rates of severe depression (8.4%), moderate depression (29.0%) and severe anxiety (20.6%) among students in Group 1 were almost double those of students in Group 2 (4.5%, 14.3% and 10.7%, respectively). This manifested itself in feelings of tension, anxiety, emptiness, loss of interest in learning, low self-esteem, occasional agitation or general apathy.

Thus, students who have been forced to change their place of residence and are currently in safe conditions remain under the influence of stressors. Lack of permanent housing, financial difficulties and uncertainty about the future lead to increased dissatisfaction with their lives and increased manifestations of depression and anxiety. This requires the development and implementation of appropriate methods of social and psychological support for students affected by the war, especially for those who have been internally displaced and need to continue their distance learning at university. This activity should be comprehensive and include psychological, social, medical and other types of support for students. The main areas of support can probably include individual and group counselling, crisis intervention, psychological training, and student support programmes.

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Ethical Approval

The study protocol was consistent with the ethical guidelines of the 1975 Declaration of Helsinki as reflected in a prior approval by the Institution's Human Research Committee.

Research permission was granted by the Committee on Ethics and Research Integrity of the Scientific Research Institute KRPOCH (protocol no. 024-1/SRIKRPOCH dated 10.08.2023). Informed consent was obtained from all the participants.

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SOCIAL AND BEHAVIORAL SCIENCES. Economics

REVIEW ARTICLE



Technology Factors Required for Adopting Cloud-Based Big Data Analytics in South African Banking



Authors' Contribution:

- A – Study design;
- B – Data collection;
- C – Statistical analysis;
- D – Data interpretation;
- E – Manuscript preparation;
- F – Literature search;
- G – Funds collection

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Background and Aim of Study:

Abstract

South African banks are generally known for early technology adoption. While this is so, there is a need to integrate some of the fourth industrial revolution technologies such as big data analytics and cloud computing collectively referred to as cloud-based big data analytics; and subsequently consider technology related aspects required for adopting integrated technologies of this nature. The aim of the study is to identify technology related factors that are necessary for adopting cloud-based big data analytics in South African banking.

Material and Methods:

A qualitative research approach was followed as well as an interpretivism paradigm and a single case study research strategy. Semi-structured interviews were employed for data collection from eleven professionals in the Information Technology division of a South African bank.

Results:

In total, 35 technology factors required for adopting cloud-based big data analytics were identified in this study and furthermore categorized into; internal cloud-based big data analytics criteria, cloud-based big data analytics capabilities or skills, cloud-based big data analytics data integrity levels, data security and readiness for adopting cloud-based big data analytics and cloud-based big data analytics external criteria.

Conclusions:

The results of this study could imply that the adoption of cloud-based big data analytics in the banking sector takes into consideration an outsourcing model or setting. In this structure, technology factors are not only specific to the bank concerned. The banking sector has its own technology requirements that banks are expected to adhere to or take into consideration, while some technology factors could only be addressed by the cloud-based big data analytics service providers. The identified factors could be used in the conceptualization of a cloud-based big data analytics framework in future research.

Keywords:

cloud-based big data analytics, technology adoption, cloud computing, banking innovation, data as a service.

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Introduction

South African banking organizations have been in the forefront of technology adoption. Today, computing advancements have introduced Fourth Industrial Revolution (4IR) technologies in the banking sector such as big data analytics (Ajibade & Mutula, 2020), machine learning, artificial intelligence, blockchain (Melnik & Pypenko, 2020; 2024; Paramesha et al., 2024) and cloud computing (Adwan & Alsaeed, 2022) among others.

This paper focuses on the integration of big data analytics (BDA) and cloud computing, termed cloud-based big data analytics (CBBDA). It is important that these technologies are well defined, to provide a theoretical background of CBBDA.

Cloud computing offers a model facilitating convenient, on-demand network access to a customizable pool of computing resources (Mell et al., 2009). Cloud computing technology does not only provide storage but also offers processing speed for the analysis of big data (Lutfi et al., 2022).

However, there are still concerns around data protection, privacy, and governance around storing data in the cloud managed by other organizations providing the cloud service. There are, however, ways to ensure that data is safe and adequately protected in the cloud, which is not covered in this paper.

Big data analytics entails the analysis and processing of both structured and unstructured data, which are large in volume and, therefore, require the application of technologies, techniques, and algorithms that enable the extraction of insights from big data and scalability (Nkatekho, 2024). Big data analytics needs high-performance processors to effectively deliver the outcome for computing data mining algorithms (Stergiou et al., 2018). BDA and cloud computing combination propose operative results that produce valuable insights in reduced time.

The relationship between big data analytics and cloud computing is that big data analytics needs high-performance processors to effectively deliver the outcome for computing data mining algorithms (Stergiou et al., 2018). BDA and cloud computing combination propose operative results that produce valuable insights in reduced time.

CBBDA is a service model through which BDA processes are hosted by either a private or public cloud (Talia, 2013). BDA therefore requires scalable storage to cater for the growing data and high process power to run the complex analytical tasks within acceptable timelines. Infrastructure is shared among numerous clients, supports applications, activities, and processes in a timely and cost-effective manner (Berisha & Meziu, 2021).

According to Khan et al. (2018), CBBDA – also called Data-as-a-Service (DaaS) – is a model, in which data is readily accessible through a cloud platform. In other words, DaaS is a new approach of retrieving important business data within a current data centre also referred to as CBBDA. DaaS could also be viewed as a service, in which files are made available to users over a network

(Internet). In their study Khan et al. (2018) illustrates the use of cloud computing for large data analytics by implementing MapReduce.

MapReduce or Hadoop model is widely favored for processing data across computer clusters, and Hadoop is essentially an open-source iteration of the MapReduce framework, originally intended as a distributed file system. Various cloud-based frameworks are available for BDA, such as Spark, Hadoop, Twister, and Hadoop Reduce, in addition to MapReduce. Cloud computing is employed to carry out BDA, and the frameworks are utilized to store data of any configuration (Khan et al., 2018).

CBBDA, as outlined by Zhao (2024), utilizes cloud computing infrastructure to efficiently analyze and process large volumes of data. It uses multi-core processors and advanced scheduling methods for the optimization of data processing tasks and develops a core structure analysis model for data fusion and acquisition, particularly in real-time operating system (RTOS) environments.

There are several CBBDA platforms such as Cloud-Based Big Data Mining and Analyzing Services Platform that are integrated due to the fact that it combines cloud-based big data mining and services for analyzing data. Particularly, the R language is integrated in this platform to provide services for advanced data analysis (Tsai et al., 2015).

Another CBBDA platform is Cloud-Based Big Data Analytics Software, a study by Romero and Navarro (2022) investigated the type of CBBDA software installed by firms when cloud-based packages became available. The study found that SAP-adopters had a competitive advantage manifested through productivity, particularly in technology, when CBBDA software was introduced.

A study by Khan et al. (2018) highlighted the importance of a CBBDA platform that supports various sectors including retail, security, energy, as well as financial services, among other sectors. This platform provides the necessary storage space, processing power, and intelligent analytics capacity to meet the data analysis requirements of these sectors.

Cloud-Based Big Data Analytics-as-a-Service (BDAaaS) is another CBBDA platform that utilizes cloud computing infrastructure to perform high-performance distributed computing for advanced analytics in healthcare and other industries (Romero & Navarro, 2022). Snowflakes are prominent for their availability, unique shared-data architecture and elasticity for efficient data processing and analytics (Dageville et al., 2016). Databricks on the other hand provide a collaborative platform that integrates with Apache Spark for big data analytics purposes. Data specialists such as data scientists, data engineers and machine learning experts can easily collaborate and perform machine learning tasks in the cloud. This provides sophisticated and advanced analytics solutions (Khan et al., 2017).



While CBBDA is a combination of BDA and cloud computing, there is a need to distinguish BDA and CBBDA. With regards to BDA, the organization has full control and does not have to worry about compliance and security. The cost of having a BDA on premises is quite high and there are a lot of configurations that must take place. While in CBBDA there is a concern about security and compliance in terms of the Protection of Personal Information and other government compliance needs, as it is hosted on the cloud that the organization does not fully control. There is less configuration, support, and maintenance that must be done as the cloud provider fully supports it. In addition to that, it is affordable, flexible, and easily scalable (Ajimoko, 2018).

Organizations globally spent billions of dollars (\$187 billion to be precise) on BDA in 2019, with close to 92% of companies investing in big data related initiatives from the year 2019 onwards (Lutfi et al., 2022). The problem is that South African banking sector is expected to keep abreast with latest technologies, yet adopting integrated fourth industrial revolution technologies can be challenging, as there is a need to ensure that technology related issues are addressed for seamless transition, adoption and implementation. While studies such as Berisha and Meziu (2021) have identified factors and issues that are related to big data analytics and cloud computing, research on technology factors, especially in the context of South African banking institutions, remains limited. It is worth noting that every industry has its own technology structure (Ghouri et al., 2021; Grassi et al., 2022).

The aim of the study. To identify the technology-related factors necessary for the adoption of cloud-based big data analytics in a South African banking institution.

Materials and Methods

This study followed an interpretivism paradigm that enabled the researchers to embark on an inductive research process required to identify the technology-related factors required for the adoption of CBBDA in South African financial institutions. Goldkhul (2012) suggests that interpretivism entails conducting research with people, rather than with inanimate objects.

This study took a single case study of the South African bank that provides financial services to the middle- and low-income markets. According to Saunders et al. (2019), a research strategy is the method that researchers use to answer their main research question. The research strategy is founded on research questions and objectives, existing information on the subject to be investigated.

Additionally, interview questions were aimed to collect data from which technology factors for the adoption of CBBDA in the selected bank were identified. Purposive sampling was employed to identify and recruit eleven IT professionals and a set defined criteria related to the goal of this study (years of experience working in South

African financial institutions, active involvement in decision-making processes related to adopting new technology projects, and a strong academic and business background in the Information Technology (IT) sector). Moreover, developing a single case study sampling strategy requires principled decisions about the persons to be interviewed, events or processes to be observed, and the time frame and settings in which data would be collected. Sampling in a single case study also requires linking whom or what is being investigated with the research questions being investigated such that unbiased sampling is achieved (Robson, 1993). Research ethics applications, approvals and requirements were approved and adhered to in this study.

Results

The study intended to identify and describe technology factors necessary for the adoption of CBBDA in a typical South African bank. First, the researchers familiarized themselves with the data, initiated the coding framework based on the CBBDA adoption framework proposed by Ajimoko (2018), this was followed by the identification of the factors from the interview responses, categories and corresponding interpretation and contextualization of results within the context of this study.

Participants narrowed down on their understanding of their understanding of CBBDA concept within the technological context. The tables in this section present the analysis of data in line with the goal of the study. The first column shows the objective of the interview question posed to the participants, the second column shows interview extracts, and the third and last column shows the researcher's comments.

The results presented in this section are organised according to the technology factors identified:

- Section 1 Internal technology criteria.
- Section 2 Organisational CBBDA technology capabilities or skills.
- Section 3 Factors related to acceptable levels of data integrity.
- Section 4 Data security and being it's readiness for CBBDA.
- Section 5 External technology adoption criteria.

Internal Cloud-Based Big Data Analytics Adoption Criteria

The first theme identified from the data analysis concerned internal technology adoption criteria derived from responses from six IT professionals as presented in Table 1.

According to the participants' responses, a thorough evaluation of various technological criteria for the CBBDA adoption should be taken into consideration. Stability is a key consideration as it enforces reliability and consistency of the CBBDA system in handling large financial datasets.



Table 1
Internal Cloud-Based Big Data Analytics Adoption Criteria

What the researcher wanted to know	Examples of extract (s) from a supporting case(s)	Researchers' analysis / comments
Internal technology adoption criteria that motivate the organisation to adopt Cloud-based big data analytics services	<p>"...from an Internal measure one of the most important aspects to adopt CBBDA, is for stability and storage. As it can get very expensive and hard to manage internal storage infrastructure."</p> <p>"Ability to integrate with other existing services the business has. The ease of use of the technology along with learning. The cost of technology is also taken into consideration. But the key one is business value in terms of usefulness."</p> <p>"...The ease of integration as well as the greatest benefit at the least cost is one of the criteria being used. The reusability of the solution as well as ease of customisation rate highly in the decision to select the CBBDA services..."</p> <p>"Yes, financial institutes have an influence in how vendors build their cloud-based systems in terms of what laws need to be considered before creating a service that would be considered by financial institutes. There's also a need for service providers to maintain a good reputation".</p> <p>"... Banks within South Africa realised that data could drive the business decision better, because some banks are international and also operates in UK, Australia and in South Africa they adopted a lot of international stands to drive decision making using data. Our organisation went into research mode for the best tools that can be used, and when they bought Microsoft Azure Suite that was a stand across each unit. Power BI within the Azure Infrastructures is now used to drive data within the bank..."</p> <p>"... The need for intelligence driven solutions."</p>	<p>Participants outlined the following internal criteria for CBBDA adoption:</p> <ul style="list-style-type: none"> - Stability. - Storage. - Ease of integration. - Reusability of the solution. - Ease of customisation. - Vendor support models. - Interaction of CBBDA with existing services. - CBBDA ease of use. - Learning new technology. - Need for intelligent driven systems. - Institutional financial laws for IT systems. - Cloud based infrastructure to support CBBDA. - Cost. - CBBDA business value. - CBBDA benchmarks.

Storage capabilities should be prioritized, especially in the banking sector where financial big data is forever growing exponentially from banking transactions and corresponding infrastructural issues. Thus, capabilities ought to be customized particularly for CBBDA systems and the requirements in the banking sector.

Concerning CBBDA solutions, they ought to be reusable, scalable and flexible enough to accommodate various data needs as they arise. Vendors that provide CBBDA services are expected to ensure that models for supporting the banking sector and banks are in place such that reliable CBBDA support is provided accordingly in line with the needs and requirements of the bank concerned.

The interaction of CBBDA with existing services should be smooth and non-disruptive, promoting ease in the integration process. User-friendliness, ease of use and learning curves for new technologies are criteria for CBBDA adoption.

Intelligent-driven systems were noted in the responses as being important for data-driven decision-making in the South African banking sector.

Interview responses also highlighted the importance of compliance with institutional financial laws for IT systems, highlighting compatibility of cloud-based infrastructure to support CBBDA within the South African banking sector. Banking technological systems operate within an organizational setting, thus institutional financial laws should be considered for compliance, compatibility with CBBDA solutions. In

this way, IT and business-related expectations and governance requirements in the South African banking sector could be met.

A notable aspect in the responses was on the emphasis of technology investments which are dependent on the costs of an organisations. Even within the banking sector, cost considerations cannot be overlooked. These cater for adoption of CBBDA, its implementation in various divisions of the bank as well as operational expenses. Akin to the CBBDA cost related issues is the CBBDA business value and benchmarks that could help banks to measure the overall performance, impact and performance of CBBDA solutions in meeting organisational goals.

The findings reveal that the South African banking sector places emphasis on ensuring that CBBDA meets their requirements and was a perfect fit with what IT professionals hoped to accomplish. This is in accordance with Ajimoko (2018), who mentioned that organisations must be certain that their potential innovations, alignment and fit of both technology and organisation before adoption cannot be overlooked.

Organisational Cloud-Based Big Data Analytics Technology Skills or Capabilities

The second theme focuses on CBBDA skills or capabilities. This theme was consistent among four participants; and the corresponding extracts are presented in Table 2.



Table 2

Organisational Cloud-Based Big Data Analytics Technology Skills or Capabilities

What the researcher wanted to know	Examples of extract (s) from a supporting case(s)	Researchers' analysis / comments
Participants view on their organisation's technological / skills capabilities required to deliver value from Cloud-based big data analytics	<p>"The capabilities required from our organisation is definitely to get the correct resources with the right skills so that we can get the best value from this journey."</p> <p>"Shortage of skill to handle the different facets of Cloud based big data analytics. However, the company is currently working on that and some of us are looking into courses to learn."</p> <p>"Our organisation has been actively recruiting of data specialist with the necessary experience and knowledge."</p> <p>"Financial institutions are currently the drivers of Cloud based big data analytics because of them having to essentially play the "gate keeper" role to make sure that they are ahead of the curve when it comes to data driven analytics."</p>	<p>Participants view on their organisation's technological / skills capabilities required to deliver value from Cloud-based big data analytics. Participants outlined the following technological skills or capabilities required to deliver value from CBBDA:</p> <ul style="list-style-type: none"> - Skills to acquire correct resources. - Upskilling. - Recruitment. - Maintain technology leadership role.

Shortage of skills and resources within the organisation to handle various aspects of CBBDA have been flagged as a major drawback. Even though this is the case, the organisation is currently trying to recruit people with appropriate skills. Financial institutions also aim to maintain technology leadership roles.

Data Integrity Acceptable Level

The third thing pertains to factors influencing data integrity acceptable level in a cloud based big data analytics environment within the banking sector. The responses highlight big data characteristics that require attention for cloud based big data analytics adoption interview extracts from four participants from which the theme was derived are presented in Table 3.

Table 3

Factors Influencing Data Integrity Acceptable Level

What the researcher wanted to know	Examples of extract (s) from a supporting case(s)	Researchers' analysis / comments
Factors influencing data integrity acceptable level	<p>"As this is still very new in our organisation, we are still in phase of defining the correct data integrity technology or standards."</p> <p>"With financial institution needing to comply against regulatory laws such as POPPIA and all other requirements by the regulators, the usage of data needs to follow strict rules irrespective of usage. This includes analysis of the data for any purpose as they are still required to abide by any regulatory standards."</p> <p>"... Data integrity will be the same as the initially before moving to the cloud, work will be required on how to make keep the client's information safe outside organisation on prem servers and now within AWS/Azure services..."</p> <p>"... Accuracy and verifiability are key..."</p>	<p>Participants highlighted the following factors that could influence data integrity acceptable level in the financial institution:</p> <ul style="list-style-type: none"> - Data integrity standards. - POPI Act. - Data consistency. - Accuracy. - Verifiability.

The interview responses highlight the necessity of high levels of data integrity for banks to be able to outline principles and practices for accurate and reliable use of data and financial information following the use of CBBDA solutions in the financial institution for trust and compliance purposes.

Within the South African context, the Protection of Personal Information Act (POPIA) is one of the regulatory frameworks that banks should adhere to protect customer data and maintaining its integrity. Moreover, banks provide their service to different categories of customers and account holders whose data should be protected.

In addition to data protection is data consistency centred around uniformity of data across different data sources. Accuracy is another data related characteristic or criterion that requires meticulous validation for the elimination of errors and discrepancies in financial data. Furthermore, this data also needs to be verifiable allowing stakeholders and customers in particular to authenticate the accuracy of financial data through audit trials and validation mechanisms.

Based on this analysis, these factors could instil stakeholder confidence and ensure compliance with legal and standards in the financial sector.



Data Security and the Bank's Readiness to Adopt Cloud-Based Big Data Analytics

The fourth theme is based on the notion that big data should be secured and migration to the cloud should be

well thought of. Corresponding interview extracts from are presented in Table 4.

Table 4

Data Security and Readiness for Cloud-Based Big Data Analytics

What the researcher wanted to know	Examples of extract (s) from a supporting case(s)	Researchers' analysis / comments
Organisational position in terms of data security and their readiness for Cloud-based big data analytics	<p>"... a lot has been done in terms of security for this. But as it also still relatively new for us, there are still a lot that needs to be researched and explored to get this correct..."</p> <p>"... Security for client information is mostly pushed by regulators, and it keeps financial institutes honest. Application of big data within the organisations is a learning curve on the organisation as they need to learn the best way to use the client's data to drive business decisions and products that suits the client..."</p> <p>"...The organisation is absolutely ready for cloud-based data analytics as data security has increased in leaps and bounds over the past few years as a result of people needing to work remotely and the financial sector therefore made sure that they are not vulnerable to customer data that is being accessed by hackers who are not a part of the organisation..."</p>	<p>Regarding security measures, the organisation has undertaken significant efforts and implemented upgrades; nonetheless, there remains potential for further enhancement. Other data security and readiness issues include:</p> <ul style="list-style-type: none"> - Data security benchmarks. - Regulator's requirements.

In accordance with the interview responses, there is a need for considering data security benchmarks, as well as ongoing security upgrades for protecting sensitive financial information. This is fundamentally crucial considering the busy nature of the banking sector as well as the systems used to provide services.

Similarly, regular upgrades to security measures are necessary in banks in order to adapt to being proactive as far as cybersecurity is concerned.

These proactive efforts such as adopting the latest security technologies and enhancing protocols, ensure resilience of CBBDA systems in cases of potential cybersecurity risks.

This could subsequently ensure safe financial data analysis when CBBDA is adopted.

External Cloud-Based Big Data Analytics Adoption Criteria

The fifth theme encompasses technology adoption criteria external to the bank. Thus, cloud based big data analytics adoption could be influenced by external drivers that are eminent in the banking sector. These criteria could cater for national and global business enabling the banks to consider all the stakeholders involved in cloud based big data analytics adoption. Table 5 presents the evidence of the data collected from five IT professionals.

Table 5

External Cloud-Based Big Data Analytics Adoption Criteria

What the researcher wanted to know	Examples of extract (s) from a supporting case(s)	Researchers' analysis / comments
External technology adoption criteria that motivate the organisation to adopt Cloud-based big data analytics	<p>"...From external criteria I believe scalability is one of the most important reasons for CBBDA adaption and the pressure keeping up with technological trends to remain relevant in the market and be one of the most innovative organisations..."</p> <p>"... Word of mouth and reliability, business owners across the country within the same sectors they communicate and knowing that the tool works for one organisation others will follow based on those factors..."</p> <p>"...From my years of experience pressure of competition and compatibility appeared to be of significant influence for financial institution to adopt CBBDA..."</p> <p>"With financial institution needing to comply against regulatory laws such as POPIA and all other requirements by the regulators, the usage of data needs to follow strict rules irrespective of usage. This includes analysis of the data for any purpose as they are still required to abide by any regulatory standards."</p> <p>"... Staying within the regulator's requirements and the cost of on-premises services compared to cloud-based services. Cloud based services can scale, and allow you to do more when required as you can scale up or down depending on the data requirements..."</p>	<p>The following external technology factors were outlined in the participants' responses:</p> <ul style="list-style-type: none"> - Innovations. - Introduction of new technologies. - Scalability. - Marketing of CBBDA by other financial institutions. - Reliability of CBBDA solutions. - Competition. - Compatibility. - POPIA considerations. - Regulator's requirements.



Various external technology criteria were identified from the responses. Innovations is an unavoidable criteria that could help banks to take advantage of technologies that could help them to be and strategy-oriented and competitive.

With innovation comes the introduction of new technologies that could significantly have an impact on the adoption of CBBDA. Thus, banks are compelled to adopt CBBDA tools for the improvement of their analytical capabilities.

Scalability as a technological criterion is concerned with the banks' ability to adapt and adjust accordingly as the data volumes and business needs change.

Insights pertaining to CBBDA success and best practice in other banks is an external technology criteria that could in tandem influence CBBDA adoption in other banks.

The reliability of CBBDA solutions is another criterion identified from the responses for sustained performance and accurate data analytics.

Banks are competitive in nature and could thus consider compatibility with existing systems. It is worth noting that compliance seems to be an internal and external factor that cuts across various divisions and perspectives of the bank.

Discussion

Internal Cloud-Based Big Data Analytics Criteria

This theme summarizes the adoption of CBBDA that is reliant of internal technological factors, such as system stability, efficient storage solutions, seamless integration, and customization to fit various organizational needs. It emphasizes the role of vendor support, user-friendly interfaces, and the necessity of keeping up with new technology; as well as the need for banks to comply with financial regulations, adherence to cost-efficient mechanisms, and developing a strong cloud infrastructure.

Literature suggests that building a detailed framework for Big Data-as-a-Service involves tailoring technology stacks to match specific data and computing needs, enhancing customization in BDA solutions while addressing storage and processing needs to achieve optimal business value (Khan et al., 2017; 2018).

Cloud-Based Big Data Analytics Capabilities

This technology related theme focuses on CBBDA adoption that depends on IT skill management. These are not general IT skills but those concerned with accurate resource utilization. However, there is a need for upskilling existing teams and strategically recruiting individuals with specialized knowledge in CBBDA. Another aspect that is of utmost importance in the banking sector is maintaining a technology leadership role by ensuring a workforce with CBBDA skills.

Integrating institution systems such as ERP Platforms with CBBDA focuses enable a synthesis of CBBDA capabilities (Romero & Navarro, 2022).

Data Integrity

This theme highlights core principles of CBBDA related data governance and compliance with emphasis on rigorous adherence to data integrity standards that are in place. It specifically highlights issues pertaining to

precision, uniformity, and adherence to regulations, which are key to the South African banking sector. The theme also brings to light the importance of data consistency for reliability and precision in CBBDA processes.

Literature also promotes availability and reliability of CBBDA platforms as it is important for uninterrupted operations and data-driven decision-making (Valmohammadi & Varae, 2022).

Data Security and Bank's Readiness for Cloud-Based Big Data Analytics Adoption

This theme focuses on data security as one of the factors required by South African banking sector for the creation of a secure and compliant environment to protect valuable financial data assets.

This is a technological factor that is not only current and relevant but also revolves around establishing a robust and secure data ecosystem with stringent data security benchmarks specific to industry standards are also necessary for the adoption of CBBDA and aligning CBBDA operations with mandates set forth by relevant authorities in the banking sector. Developing and employing a proactive cybersecurity strategy or approach is also a factor that is necessary for the adoption of CBBDA in the South African banking sector, particularly due to the sensitivity of financial data.

Supporting literature by Edu et al. (2021) stress the importance of integrating CBBDA in banks, however, security and integrity of confidential financial data within the cloud environment ought to be prioritized.

Cloud-Based Big Data Analytics External Criteria

This theme revolves around external technological criteria required for the adoption of CBBDA in the South African banking sector, through a combination of innovation, scalability, and technological evolution.

The pursuit of innovations and strategic integration of new technologies also accommodate analytical capabilities that require CBBDA solutions. In this strategic and innovation consideration, reliability and particularly scalability seem to be a key requirement as far as the adoption of CBBDA is concerned. Furthermore, the importance of collaborations and shared insights within the IT industry create a platform for CBBDA marketing within the banking sector. Compatibility with industry standards becomes crucial in shaping a proactive and compliant CBBDA solution for the banking sector.

Supporting literature by Giebe et al. (2019) reinforces CBBDA external criteria by recognizing big data analytics as a sustainable tool necessary for the promotion of customer loyalty and delivering customer-centric services in the banking and finance sector.

Conclusions

Big data analytics are computing and CBBDA were introduced as well as existing literature related to the study particularly highlighting extent research findings CBBDA platforms followed by the gap addressed in this study. The qualitative methods employed were discussed, explaining how participants were selected in the South African bank, a research strategy and data collection



instrument employed to carry out this study. The results of this study could be contextualized in such a way that we can banks or any typical bank in a developing country considering the adoption of CBBDA based on internal technology criteria, external technology criteria, prioritisation of data characteristics such as integrity and security, while the required CBBDA capabilities are in the process of being improved, the overall readiness of CBBDA should be thoroughly assessed.

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Ethical Approval

This study obtained ethics approval from the Tshwane University of Technology. Ethical clearance was granted under the number: FCRE/ICT/2021/03/003.

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SOCIAL AND BEHAVIORAL SCIENCES

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SOCIAL AND BEHAVIORAL SCIENCES. Health Care Sciences

ORIGINAL RESEARCH



An Information Security Assessment Model for Bring Your Own Device in the South African Healthcare Sector



Authors' Contribution:

- A – Study design;
- B – Data collection;
- C – Statistical analysis;
- D – Data interpretation;
- E – Manuscript preparation;
- F – Literature search;
- G – Funds collection

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Background and Aim of Study:

Abstract

The healthcare sector stands at the forefront of industries embracing personal-device usage for professional tasks. Permitting to Bring Your Own Device (BYOD) for healthcare professionals presents information security hurdles that pose challenges for decision-makers in the healthcare field, despite the considerable benefits associated with BYOD. The aim of the study: to develop an information-security assessment model for BYOD in the South African healthcare sector to guide healthcare decision-makers.

Material and Methods:

The main focus of the study was the South African private healthcare sector, Gauteng Province. The target population size of 170 with a sample size of 118 with the feedback responses with additional 10, which were also included in the analysis data statistics that was done for 128 received responses. The instrument used for the closed-ended questionnaire was SPSS 28.0.1.1 and the expert judgement technique for the validation questionnaire. Factors from the diffusion of innovation theory, the electronic protected health information security framework, cybersecurity knowledge, skills, abilities and external variables were adapted to inform the conceptual model.

Results:

The following factors have the most significant contributions to the development of an information security assessment model for BYOD in the South African healthcare sector: training is the most influential factor with a predictive power of 64.0% ($\beta=0.640$) at $p=0.001$; security threats with 61.3% ($\beta=0.613$) significance level $p=0.020$; conversely, security controls had a predictive power of 50.9% ($\beta=0.509$) at $p=0.001$.

Conclusions:

This study has developed a contextual information-security assessment model for BYOD within the South African healthcare sector. In practical terms, this model offers guidance to healthcare decision-makers in seamlessly integrating BYOD practices into daily operations; and aids in cautious planning, guided by the insights provided by the security-assessment model for BYOD.

Keywords:

healthcare, private, information security, bring your own device, South Africa.

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Introduction

Information Communication Technology (ICT) plays a vital role in facilitating various business solutions, by offering a wide range of technical and software application platforms for organizations to enhance their operational efficiency. With the continuous evolution of technology, organizations are harnessing these advancements to stay competitive in the market. This has led to a gradual shift towards digital platforms and products for day-to-day operations, transforming information technology (IT) from a mere service provider into a strategic asset driving current business operations (Omboga et al., 2021; Pypenko, 2019). Additionally, there is a rising trend of mobility adoption, in which employees utilize their personal devices for both personal and professional tasks. Some organizations, especially in developing countries, have implemented permissive policies allowing the use of personal devices for business purposes (Pypenko, & Melnyk, 2021; Wani et al., 2021).

The utilization of personal devices, such as cellphones, computers, laptops, and tablets in business operations has been proven to boost employee morale, enhance work performance, and save costs (Mahat & Ali, 2018). Employees feel more flexible and comfortable using familiar devices anytime, anywhere. Smart mobile devices are increasingly prevalent in workplaces as organizations embrace Bring Your Own Device (BYOD) policies (Downer & Bhattacharya, 2022). This practice positively impacts business processes, necessitating strategic planning, user awareness, and training (Kholoanyane, 2020). BYOD adoption brings multiple benefits, including improved performance, enhanced business processes, cost-efficiency, and heightened employee morale, leading to increased productivity (Coker, 2021). Leveraging personal devices enables organizations to realize numerous advantages, ranging from cost savings to enhanced productivity and morale. This approach fosters a more agile and connected workforce, particularly crucial in sectors such as healthcare where rapid access to information can be lifesaving (Ujakpa et al., 2019).

In South Africa, the healthcare sector faces challenges in delivering timely services due to inadequate technology support for digital health platforms, mobile health, and smart technology such as BYOD. Such technologies could benefit both the public and private sectors, including medical aid schemes (Ali et al., 2021). The increasing demand for BYOD as a service underscores its importance in organizational infrastructure, given its agility, business flexibility, boosted employee morale, improved productivity, and enhanced employee satisfaction (Abdulkarim & Binord, 2021). These factors highlight the potential of BYOD to enhance workplace productivity and efficiency.

Despite the acknowledged benefits of BYOD in enhancing organizational efficiency, there is a critical need for an information-security assessment model specifically tailored for the South African healthcare sector. This sector, already grappling with inadequate technology support, urgently requires a contextualized

model to assess and mitigate security risks associated with BYOD adoption. Developing such an information-security assessment model is essential to ensure the overall operational efficiency of healthcare providers in South Africa. To address this research gap, the study developed an information-security assessment model for Bring Your Own Device in the South African healthcare sector.

The aim of the study. To develop an information-security assessment model for BYOD in the South African healthcare sector from the perspective of behavioral science, specifically within the niche of Business Information Systems.

This research diverges from the traditional pure computing system approach, focusing instead on understanding the factors that influence information security in BYOD environments. By examining the interactions between the identified factors, the study aims to create a contextual model that addresses the unique security challenges within the domain of the study. This approach underscores the importance of integrating human-centered insights with technical solutions to enhance security measures within the South African healthcare sector.

Materials and Methods

The study employed design science research methods, which aimed to develop artefacts to address research problems. This process involves five iterative steps (Kuechler & Vaishnavi, 2011). Firstly, there is awareness of the problem, influenced by preliminary investigations that identified the absence of a contextual information-security assessment model for BYOD in the South African healthcare sector. Next, the suggestion of the artefact as a potential solution is made based on existing theories. Following that is the development phase, in which the artefact is created using various theories to formulate an assessment-security model for guiding BYOD implementation in the South African healthcare sector.

Validation involves measuring the validity of the developed artefact through expert judgment. Finally, in the conclusion phase, the results obtained through expert judgment are presented. A group of selected experts validated the developed model, contributing to the validation process of the artefact. Kuechler and Vaishnavi (2011) commented that the results of an artefact or developed model are reflected in the conclusion stage of design-science research.

Design science research (DSR) functions as a problem-solving paradigm focused on advancing human understanding by creating innovative solutions (vom Brocke et al., 2020). In essence, DSR seeks to enhance knowledge domains in technology and science by crafting new artefacts that tackle challenges and improve their respective environments. This study adhered to the principles of design science research in line with its overarching objective: the development of an information-security assessment model tailored for BYOD implementation in the South African healthcare sector.



In this study, the researcher collaborated with the ICT directorate, who facilitated the distribution of the questionnaire to employees and IT subject matter experts in the healthcare sector. Before distributing the questionnaire, a permission letter was issued, and the contact person was assured that data collection would be anonymous, private, and solely for research purposes. A Google Form was created, and a link was sent to the ICT directorate to aid in distributing it to healthcare staff. The research adopted a mixed-method approach, integrating both quantitative and qualitative analyses. In line with this methodology, a survey questionnaire was adopted, gathering data from a total of 128 randomly selected individuals. Expert Judgement was used in this study, and the validity of the developed artefact was determined by the experts' responses to the developed model validation questionnaire. The reliability of the measuring instrument was tested and was reliable based on the output in Table 1.

Table 1
Overall Reliability Statistics of the Measuring Instrument: Reliability Statistics

Cronbach's alpha	Number of items
0.959	54

According to Yin (2014), measuring instrument with values above 0.7 threshold are acceptable and deemed reliable. The overall reliability of the questionnaire with 54 items as demonstrated in Table 1 was found to be 0.959, which reliability was considered good since it was above the recommended threshold of 0.7, and comparing the number of items in the questionnaire.

Results

The results demonstrated indicated that all hypotheses were supported after data analysis at an acceptable at the p value with a significant value less than 0.05, which is acceptable; and therefore, the conceptual model was not iterated before it was taken to the experts for validation. The reliability statistics table demonstrated relationships between constructs were supported.

The sample size of 128 respondents was considered and therefore, Part one focused on gathering demographic information such as organization, age, gender, profession, race, educational level, and years of service. Part two centered on assessing participants' knowledge of computers, information security, and BYOD. Participant's demographics are shown in Table 2, which is broken down into the relevant categories.

Table 2
Frequencies of Participants' Demographics

Variables	Frequency			
	Person	Percent	Valid percent	Cumulative percent
Organisation	Public healthcare	18	14.1	14.1
	Private healthcare	88	68.8	82.8
	Pharmaceutical	11	8.6	91.4
	Clinical services	11	8.6	100.0
	Total	128	100.0	—
Years in the organisation	2 years or less	10	7.8	7.8
	3-5 years	24	18.8	26.6
	6-10 years	56	43.8	70.3
	10 years+	38	29.7	100.0
	Total	128	100.0	—
Highest level of education	Matric/Certificate	19	14.8	14.8
	Diploma	54	42.2	57.0
	Bachelor's degree	37	28.9	85.9
	Postgraduate	15	11.7	97.7
	Other	3	2.3	100.0
	Total	128	100.0	—
Gender	Male	65	50.8	50.8
	Female	58	45.3	96.1
	Other	5	3.9	100.0
	Total	128	100.0	—
Age	<25 years	8	6.3	6.3
	26-35 years	40	31.3	37.5
	36-45 years	59	46.1	83.6
	46-55 years	17	13.3	96.9
	55+ years	4	3.1	100.0
	Total	128	100.0	—



The outcomes in Table 2 take the individuals' operational space into account. Some of participants (14.1%) work within the public sector; these are individuals who have partnered with the private sector. About 68.8% of participants work within the private sector space. Some of responses (8.6%) were received for both pharmaceutical and clinical services that are also partnering with the private healthcare sector. More responses were attained from the private healthcare sector, at about 68.8% responses.

The outcomes in Table 2 take the individuals' years within the organization into account. Some of participants (7.8%) had 2 years or less of service. About 18.8% of participants had between 3-5 years of service. About 43.8% of the largest group of participants had 6-10 years of experience within the organization; and 29.7 % of participants had 10 years + of service.

There were 14.8% of participants with matric/certificate. Participants with a bachelor's degree made up 28.9% of the group, while those with a post-graduate degree made up 11.7%. Participants with "other" numbered 2.3%, while the 42.2% of survey respondents with a diploma yielded the highest percentage.

Both genders participated in the survey, according to the findings. The percentage of male participants was 50.8%, while the percentage of female participants was 45.3% and 'other' made up 3.9% of participants. The highest number of responses was from male participants at 50.8%.

Participants who were under 25 years made up 6.3% of the total. Some 31.3% of participants were between the ages of 26 and 35; 46.1% were between the ages of 36 and 45; and 13.3% were between the ages of 46 and 55. Participants who were 55 and above made up 3.1% of

the total. According to the table, individuals who were between the ages of 36 and 45 made up the highest percentage of participants at 46.1%.

Pearson's Correlation of the Constructs

Correlation, in a general sense, assesses the connection between variables; and quantifies the degree of association between two variables (Talaat & Gamel, 2023). When two variables change in magnitude, they do so either in the same direction (positive correlation) or in the opposite direction (negative correlation) in correlated data. This technique gauges the relationship between continuous variables that are both dependent and independent. Additionally, this method can have both advantages and drawbacks. A negative correlation suggests that, as the value of one variable increases, the value of the other variable decreases; whereas a positive correlation indicates that as one variable's value increases, the value of the other variable also increases. Table 3 indicates factors grouped together with a positive and a significantly high correlation with one another. Correlation coefficient values, as outlined by Schober et al. (2018), range from -1 to 1, with -1 indicating a perfect negative correlation; and 1 indicating a perfect positive correlation. Pearson's correlation approach was employed in this study to represent the relationship between the constructs. According to Xiong et al. (2020), if p is greater than 0.01 but less than or equal to 0.05, a strong assumption about the null hypothesis must be made. If p is less than or equal to 0.01, it indicates a very strong assumption about the null hypothesis. The correlation between the constructs utilized in this study is depicted in Table 3, which illustrates the relationship between the constructs employed in this study.

Table 3
Pearson's Correlation of the Constructs

	Constructs	ISA	SECT	POL	SECC	COMP	COMPL	TRN	SECM
ISA	Pearson Correlation	1.000	–	–	–	–	–	–	–
SECT	Pearson Correlation	0.655**	1.000	–	–	–	–	–	–
POL	Pearson Correlation	0.465**	0.691**	1.000	–	–	–	–	–
SECC	Pearson Correlation	0.420**	0.648**	0.705**	1.000	–	–	–	–
COMP	Pearson Correlation	0.324**	0.527**	0.694**	0.635**	1.000	–	–	–
COMPL	Pearson Correlation	0.358**	0.558**	0.556**	0.631**	0.704**	1.000	–	–
TRN	Pearson Correlation	0.498**	0.583**	0.606**	0.675**	0.490**	0.459**	1.000	–
SECM	Pearson Correlation	0.676**	0.793**	0.812**	0.828**	0.753**	0.741**	0.763**	1.000

Note. ISA – information-security abilities factors; SECT – security-threats factors; POL – policy factors; SECC – security-controls factors; COMP – compatibility factors; COMPL – complexity factors; TRN – training factors; SECM – information security assessment model for BYOD; ** Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed).



The table shows that information-security abilities (ISA) factors have a significant relationship of 0.655 (2-tailed) with security threats, with a significant relationship at the 0.01 level.

Policy factors have a significant relationship of 0.465 (2-tailed), with ISA factors; and security threats with a significant relationship of 0.691 (2-tailed) both at the 0.01 level.

Furthermore, the security control factor has a significant relationship with ISA of 0.420 (2-tailed), a significant relationship with security threats of 0.655 (2-tailed), and policy factor with a significant relationship of 0.648 (2-tailed) both at the 0.01 level.

Meanwhile, the compatibility factor has a significant relationship with the ISA factors of 0.324 (2-tailed), with security threats of 0.527 (2-tailed), with the policy factor of .705 (2-tailed), and a significant relationship with security controls of 0.625 (2-tailed) and all at the 0.01 level.

Moreover, the complexity factor has a significant relationship with ISA factors of 0.358 (2-tailed), with security threats of .558 (2-tailed), with policy of 0.556 (2-tailed), with security control of 0.631 (2-tailed), and lastly a significant relationship with compatibility of 0.704 and all at the 0.01 level.

Furthermore, the training factor has a significant relationship with information-security ability factors of

0.498 (2-tailed), with security threats of 0.583 (2-tailed), with policy of 0.606 (2-tailed), with security controls of 0.675 (2-tailed), with compatibility of 0.490 (2-tailed) and with complexity of 0.459 (2-tailed) and all at the 0.01 level.

Furthermore, there is high value concerning the correlation of security controls and policy of 0.705 (2-tailed) that is at the 0.01 level.

For this reason, an information-security assessment model for BYOD can be integrated into day-to-day operations of the healthcare sector.

The variables show a positive significant relationship at a 2-tailed which is supported by Pearson correlation at a *R* value of 96.9% prediction and a *p* value less than 0.05.

Regression Analysis

In addition to descriptive analysis, a regression analysis was performed to assess the predictive capability of the overall model and the individual contributions of each independent variable to this prediction.

The analysis revealed a robust predictive power for the model at 94.0% ($R^2=0.940$).

The specific contributions of each independent variable to this prediction are detailed in the results presented in Table 4.

Table 4
*Regression Coefficients**

Model	Unstandardized coefficients		Standardized coefficients	<i>t</i>	Sig.	Collinearity statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	0.867	0.561	–	3.155	0.002	–	–
ISA	0.207	0.152	0.242	7.944	0.001	0.429	1.630
SECT	0.613	0.259	0.091	2.362	0.020	0.434	1.602
POL	0.273	0.305	0.164	4.172	0.001	0.257	1.887
SECC	0.509	0.279	0.208	5.403	0.001	0.353	1.836
COMP	0.124	0.259	0.162	4.344	0.001	0.369	1.712
COMPL	0.298	0.246	0.181	5.281	0.001	0.453	1.408
TRN	0.640	0.112	0.187	5.723	0.001	0.475	2.107

Note. *Dependent variable: SECM – information security assessment model for BYOD; ISA – information-security abilities factors; SECT – security-threats factors; POL – policy factors; SECC – security-controls factors; COMP – compatibility factors; COMPL – complexity factors; TRN – training factors.

The results presented in Table 4 reveal significant contributions of various factors to the development of an information security assessment model for BYOD in the South African healthcare sector.

Training emerged as the most influential factor, with a predictive power of 64.0% ($\beta=0.640$) at $p=0.001$, followed by security threats at 61.3% ($\beta=0.613$) significance level $p=0.020$.

Conversely, security controls exhibited a predictive power of 50.9% ($\beta=0.509$) at $p=0.001$. According to

Ahamed et al. (2023), a Variance Inflation Factor (VIF) exceeding 10 indicates problematic multicollinearity. However, Table 3 indicates that all VIF values were below 5, indicating an absence of multicollinearity.

Testing of the Hypotheses

Based on the regression and correlational analysis, the set hypotheses were tested; and the results are presented in Table 5.



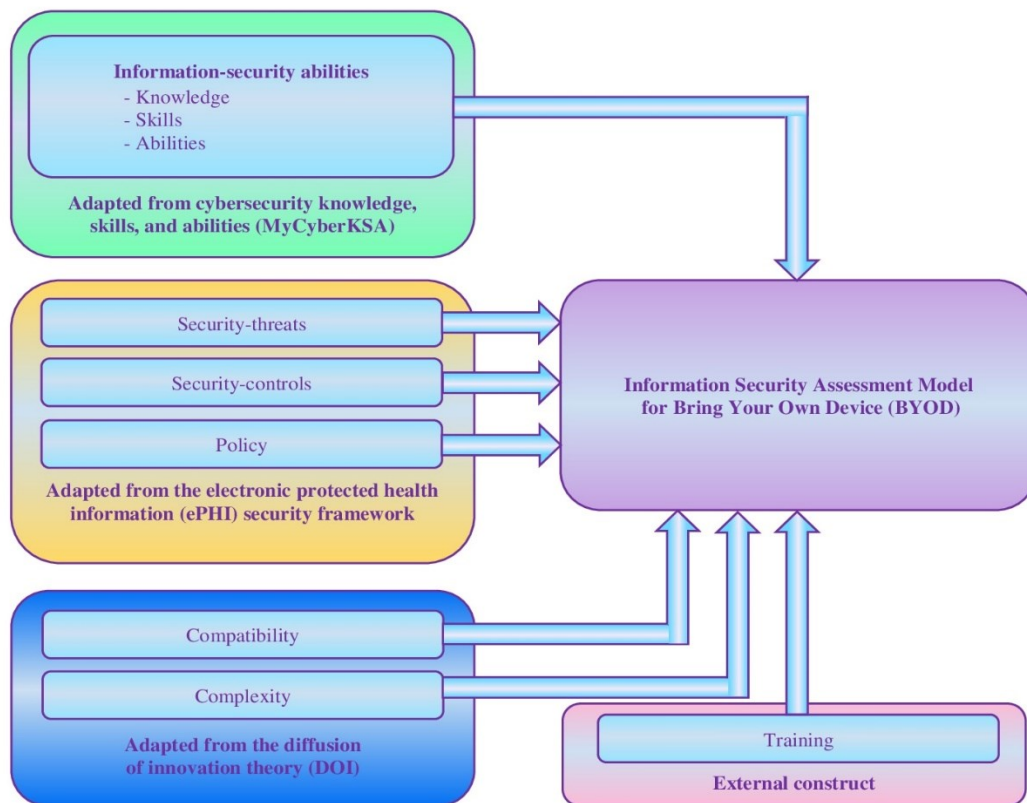
Table 5
Testing of the Hypotheses

Hypotheses	Results	Action
H1-Information-security abilities factors, skills, and knowledge in the organisation influence the development of an information-security assessment model for BYOD	$P=0.001<0.05$	Supported
H2-Security-threats factors in the organisation influence the development of an information-security assessment model for BYOD	$P=0.020<0.05$	Supported
H3-Policy factors in the organisation influence the development of an information-security assessment model for BYOD	$P=0.001<0.05$	Supported
H4-Security-controls factors in the organisation influence the development of an information-security assessment model for BYOD	$P=0.001<0.05$	Supported
H5-Compatibility factors in the organisation influence the development of an information-security assessment model for BYOD	$P=0.001<0.05$	Supported
H6-Complexity factors in the organisation influence the development of an information-security assessment model for BYOD	$P=0.001<0.05$	Supported
H7-Training factors in the organisation influence the development of an information-security assessment model for BYOD	$P=0.001<0.05$	Supported

Based on these findings, a conceptual model for an information security assessment model for BYOD in the

South African Healthcare Sector was developed, as illustrated in Figure 1.

Figure 1
An Information Security Assessment Model for Bring Your Own Device in the South African Healthcare Sector



Model Validation

The validation of the proposed information-security assessment model for BYOD in the South African healthcare sector was conducted with seven experts who provided comprehensive feedback. The reviewers, possessing diverse qualifications and extensive experience in information security, unanimously agreed on the model's relevance, suitability, and significance.

They indicated that the model is highly appropriate for improving business productivity, guiding decision-makers, and enhancing security measures within the healthcare sector. The feedback from the experts highlighted that the model effectively addresses the necessary constructs and requires no modifications, confirming its adequacy and applicability. From the feedback obtained from the seven experts' review, the



model is considered relevant, suitable, and significant, and it will serve as a guide for decision-makers in assessing information security for BYOD in the South African healthcare sector. The developed artifact was not modified as all the constructs were supported.

Discussion

The results of this study, all 7 variables were all supported and found to be significant to be integrated into the day-to-day healthcare operations.

Information-Security Abilities Factors

It was predicted that H1-Information-Security Abilities Factors will have a significant influence on the information-security assessment model for BYOD integration into the South African healthcare sector. The findings of this study, depicted in Figure 1, supported the hypothesis. Information-security abilities emerged as influential and significant factors in developing an information-security assessment model for BYOD integration. Dash and Ansari (2022) underscored the necessity of considering extensive competencies such as skills, experience, and knowledge, along with their interrelationships, to craft a practical security model. Within the healthcare sector, information-security abilities for BYOD signify the depth of skills and knowledge relevant to the information-security domain. These assessment models are typically constructed and upheld by experts within the security domain.

As noted by Chowdhury and Gkioulos (2023), the escalating demand within modern enterprises for proficient security professionals has spurred the proliferation of various programmes and initiatives aimed at imparting security skills and knowledge. Despite increased awareness among enterprise staff regarding security threats, the incidence of successful attacks against companies has shown little to no decline over the years.

Security-Threats Factors

It was predicted that H2-Security-Threats Factors will have a significant influence on the information-security assessment model for BYOD integration into the South African healthcare sector. This hypothesis predicted a positive correlation between the security threats factor and the integration of the information-security assessment model for BYOD in this study. The questionnaire was designed to evaluate the organization's readiness regarding mitigation plans for information-security breaches and employee awareness. Vulnerabilities in hardware, software, and networks, along with tactics such as phishing scams and social-engineering techniques, are frequently exploited by attackers. These threats often propagate through channels such as drive-by downloads, malicious email attachments, and deceptive applications (Aslan et al., 2023). The hypothesis confirmed that the security factor significantly influences the integration of an information-security assessment model for BYOD into the South African healthcare sector. Furthermore, this influence can be strengthened through preventive measures such as established protocols, training programmes, tailored policies, and mitigation strategies.

Policy Factors

It was predicted that H3-Policy Factors will have a positive influence on the information-security assessment model for BYOD integration into the South African healthcare sector. This hypothesis was validated, impacting the development of the information-security assessment model for BYOD integration. Farid et al. (2023) define an information-security policy as a widely recognized foundational framework for organizational information security, serving a pivotal role in communicating both acceptable and unacceptable actions concerning the organization's assets to employees. Consequently, this hypothesis bolsters the information-security assessment model for BYOD integration.

Security-Controls Factors

It was predicted that H4-Security-Controls Factors will have a significant influence in the information-security assessment model for BYOD integration into the South African healthcare sector. The hypothesis received support based on the findings presented in Figure 1 of this study. Access control measures are indispensable for safeguarding the information and assets of the healthcare sector against both internal and external threats, thereby reducing vulnerability to physical and cyberattacks (Ayedh et al., 2023). Alshurideh et al. (2023) aver that security measures within computer systems include various techniques such as speech analysis, firewalls, and digital signatures, aimed at protecting software, devices, and data contained within the system. However, the security of BYOD technology faces contemporary challenges, including inadequate security controls on devices commonly used by healthcare professionals, concerns regarding device locking and authentication; and issues related to the security of mobile-device applications (Wani et al., 2020). Consequently, the validated hypothesis indicates that the security-controls factor significantly influences the integration of an information-security assessment model for BYOD into the South African healthcare sector. Furthermore, this influence can be augmented by implementing robust access-control mechanisms for personal devices to safeguard confidential patient information in the healthcare sector.

Compatibility Factors

It was predicted that H5-Compatibility Factors will have a significant influence in the information-security assessment model for BYOD integration into the South African healthcare sector. The hypothesis was validated as per Figure 1 in the study. This indicates that employees and experts in the healthcare sector indeed perceive their daily activities to impact the information-security assessment model for BYOD. Neves and Mello (2018) posit that security models compatible with a company's technologies and infrastructure should remain under the company's control; and devices with unfixable vulnerabilities should be prohibited. Additionally, according to Liao et al. (2021), the compatibility perspective is predominantly utilized and particularly relevant for understanding users' technology usage behaviour. Four compatibility principles compatibility with established work practices, chosen work style, prior



experience, and value are linked to IT innovation within the enterprise context. The compatibility factor demonstrates a substantial influence on the integration of the information-security assessment model for BYOD into the South African healthcare sector.

Complexity Factors

It was predicted that H6-Complexity Factors will significantly influence the information-security assessment model for BYOD integration into the South African healthcare sector. Complexity refers to how difficult it is to comprehend or utilize a particular system or technology, which impacts perceptions of innovation. Almaiah et al. (2022) suggest that when technology is less complex and characterized as simple, it is perceived as highly sophisticated and advantageous, especially if it includes new technologies and inventive features. The complexity of the developed model needed validation by a group of experts to ensure its integration into the healthcare sector's daily operations and services would not be overly complex. The validation process involved experts, who positively responded to the model. Testing and validation of newly designed models are crucial, as stated by Hao et al. (2021), necessitating thorough examination by a group of individuals or a pilot group before deployment across the organization. Complex systems, as highlighted by Freund et al. (2021), offer significant opportunities for innovation within existing and potential fields of application. Strategic complexity management frameworks or models for system deployment encapsulate the complexity of IT systems. A survey questionnaire was developed to gather information about the complexity of integrating a developed artefact into existing processes.

Training Factors

It was predicted that H7-Training Factors will positively influence the information-security assessment model for BYOD integration into the South African healthcare sector. The hypothesis found support in the study's findings, as illustrated in Figure 1. Beltempo et al. (2022) stressed ongoing research aimed at improving security training across the healthcare sector for all employees. This study gave precedence to the training factor, evaluating the number of healthcare-sector employees undergoing information-security and BYOD training. The survey questionnaire specifically targeted the information-security-awareness training posture among healthcare-sector employees. Alahmari et al. (2023) underscored the critical role of effective security training as the primary defence against security breaches. These researchers advocated for the IT department to prioritize delivering information-security awareness training, with regular updates on security risks and fraudulent methods, ensuring that employees maintain vigilance and prevent unauthorized access to organizational information systems, whether using personal or organizational devices.

The supported hypothesis highlights the importance of the training factors, which may sometimes be overlooked, but nevertheless significantly enhances employees' vigilance when using personal and organizational devices for work-related tasks. In

conclusion, all seven supported constructs contribute to an information-security assessment model for BYOD integration, indicating its potential success in the South African healthcare sector. Decision-makers can effectively integrate this model into their day-to-day operations and services, bolstering overall security measures. Furthermore, future studies should also explore the financial aspects of BYOD. This study only focused on identifying factors that influence the development of the artefact, excluding the financial aspects. The developed model can be the baseline for additional factors to be incorporated into the type of research to be undertaken.

Conclusions

Adopting new technology platforms presents significant challenges for daily business operations, but it is essential for maintaining competitiveness. Successful integration of new systems requires ongoing support, monitoring, and maintenance. This study developed an information-security assessment model for BYOD in the South African healthcare sector, with a focus on equipping stakeholders with the necessary knowledge for the secure use of personal devices. The research involved 128 respondents and 7 experts, all data collected was valid and used for analysis. The study followed the design science research process to identify key factors, and develop, and validate the model. The validity of the model within the research domain was confirmed by the experts. However, the study proposed further investigation into the financial implications of BYOD, which may influence security measures.

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Ethical Approval

The study obtained ethical clearance from the institution Ethics Committee (Ref. No. FCRE/ICT/2022/08/002(1).

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SOCIAL AND BEHAVIORAL SCIENCES. Health Care Sciences

ORIGINAL RESEARCH



Data Interoperability Assessment Model for Health Information System in South African Public Healthcare



Authors' Contribution:

- A – Study design;
- B – Data collection;
- C – Statistical analysis;
- D – Data interpretation;
- E – Manuscript preparation;
- F – Literature search;
- G – Funds collection

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Background and Aim of Study:

Abstract

The increasing use of information technologies in healthcare has enhanced communication between its stakeholders and has also reduced health cost. As a result, data interoperability has become a priority which has increased the need to assess whether health information systems (HIS) used are interoperable enough to support this call. The aim of the study: to assess the data interoperability of the HIS used in the South African public healthcare.

Material and Methods:

Based on the conceptual model with the constructs of core, policy, societal, engagement as well as acceptance and use readiness and parameters of functional, syntactic and semantic interoperability, a measuring instrument in the form of closed-ended questionnaire was designed. Statistical data was collected from Information Technology personnel in three district hospitals of Gauteng Province in South Africa.

Results:

Hypotheses 1, 3 5, 6a and 6c predicted the influence of core readiness, societal readiness, use readiness functional interoperability and semantic interoperability on HIS data interoperability readiness respectively and were all accepted. Hypothesis 2, 4 6b predicted the influence of policy readiness, engagement readiness and syntactic interoperability on HIS data interoperability readiness and were all rejected.

Conclusions:

The developed model can be used to enhance research on data interoperability that is a major challenge in the use of information technology in healthcare. The sharing of information among different levels of medical personnel is essential for healthcare quality, efficiency, and safety of care provided to a patient. To enable this, systems should be able to connect and exchange information with each other without limitation. Such also enables better workflows, reduce ambiguity, and allows data transfer among systems and healthcare stakeholders.

Keywords:

health information systems, interoperability assessment, interoperability parameters, readiness assessment, South African healthcare

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Introduction

In today's information age with increasing digitization, information technology (IT) has become an indispensable part of healthcare institution. IT has the potential to improve the health of patients and the performance of providers. This will lead to improved quality, cost savings, and greater patient engagement in their own healthcare (Richemond & Huggins-Jordan, 2023). As result, health institutions in South Africa (SA) are also implementing different IT solutions to improve their health data management systems to enhance healthcare service delivery. However, this various health information technology they implement run independently and lack uniform data standards as different suppliers provide them and, thus, have different architectures, databases, and infrastructures (Torab-Miandoab et al., 2023).

South Africa, classified as a middle-income country, grapples with legacy systems functioning in isolation, presenting challenges in safeguarding sensitive information, including patient privacy (Peng & Goswami, 2019). Hence, this fragmented approach to data management poses significant obstacles to safeguarding patient privacy and protecting sensitive information. Health information systems are not integrated, which underpins the fact that information systems are operating in silos (Torab-Miandoab et al., 2023). South Africa's health information systems are not integrated, and although they currently use schemas that could potentially help patient information be shared, the issue of systems working in silos makes it difficult for patient information to be shared. This creates a serious challenge with data interoperability. As a result, a number of these electronic health information systems (HIS) used in some hospitals are unable to interoperate with each other for data synchronization and exchange (Savage & Savage, 2020).

According to Torab-Miandoab et al. (2023), although the adoption of HIS has improved the quality of healthcare information and services, the interoperability of these systems still requires attention. The inability to allow the interoperability of health data and to have a comprehensive, interoperable supporting infrastructure can be addressed through standardization. Standardization in this context enables automatic data interchanges to enhance smart hospitals and improve decision-making. Further, the high rate, speed, and volume of big data further shows the need for standardized formats that in turn enable systems to interoperate (Richemond & Huggins-Jordan, 2023). It is therefore critical that healthcare address standards to improve and address the current data fragmentation. Dixon et al. (2020) highlight that interoperability improves effective organizational communication and the integration of efforts. This shows that interoperability of health information systems is a major factor for enabling healthcare institutions to improve medical service delivery.

Currently, SA is working on initiatives to standardize the National Health Insurance System (NHI) to improve data quality and exchanges of data (Naidoo et al., 2023).

The implementation of an Electronic National Health Insurance can be used to facilitate the tracking of patients with the intention to enhance accuracy of data and completeness of healthcare. The importance of health in society cannot be overemphasized, and the corresponding data is expected to be extremely relevant and of good quality. According to Tsegaye and Flowerday (2021), it is important to understand patient data so that more prominent decisions may be taken to improve the use of integrated patient information. Interoperability occurs only when there is interaction between the systems at three levels: functional, syntactic, and semantic interoperability (Blobe & Scott, 2018). Despite the three-level view of interoperability, drivers thereof should be taken into consideration. Management issues are of the utmost importance for aligning interoperability initiatives with national priorities in the healthcare sector. This includes investments in interoperability initiatives, strategies, policies, service, standards, and infrastructure (Savage & Savage, 2020).

Accessibility to large quantities of accurate health data is required to understand medical and scientific information in real-time, evaluate public health measures before, during, and after times of crisis as well as preventing medical errors. Much as this is so, there are challenges towards easy accessibility and sharing of health data (Savage & Savage, 2020). Among these challenges is the lack of proper guidance is the functional interoperability in the healthcare sector (Szarfman et al., 2022). Additionally, Tsegaye and Flowerday (2021) also note that there is limited research on addressing interoperability when implementing technologies in healthcare. They indicate that although the South African healthcare institutions use schemas, health information systems are not interoperable as they do not exchange information among each other.

There is a plethora of literature on the use of technologies in health that has been conducted worldwide and in the South African perspectives. Kante and Ndayizigamiye (2021) work was on the analysis on the national digital health strategy for South Africa relating to the use of the Internet of Medical Things (IoMT) in healthcare. Their study focused on examining situational, structural, cultural, and environmental factors. Their study revealed that most research has been concentrating on the adoption of technologies in health but paying little attention on their interoperability. They recommended that national digital health strategy should provide a framework for the adoption and use of HIS as well as the interoperability and compatibility of these systems with the existing technologies.

The study of Mbunge et al. (2022) on the virtual healthcare services and digital health in South Africa indicated that six factors, namely perceived usefulness, perceived ease-of-use, organization, environment, technology, innovation, and vendor management influence readiness of private health sectors to adopt HIS. They however noted that challenges of infrastructural and technology, organizational and



financial issues, policy and regulatory challenges, cultural and resistance as well as interoperability impede successful implementation of HIS. They recommended for the need to adjust eHealth policies to accommodate effective use of innovative technologies in healthcare that enables resources sharing. However, this can only be achieved if the implemented HIS are interoperable enough to enable the sharing of resources among health facilities.

Achieng and Ruhode's (2023) investigated the context-based factors that influence HIS implementation in resource-constrained public hospitals. Their study identified factors including implementation of policies, planning and support strategies, analysis of healthcare information systems suitability as well as interoperability. The study observed that interoperability is essential plays a role of standards, protocols, technologies, and mechanisms that allow data to flow between diverse systems with minimal human intervention since it enables diverse systems to communicate with each other and share information in real time. Their study recommended for more studies to investigate the compatibility and interoperability of health information systems for successful implementation, especially in public sectors.

Several theoretical models have been developed to explain users' behavioural intentions to accept and use technologies. Consequently, various research studies have been conducted to address interoperability readiness in healthcare (Achieng & Ruhode, 2023). Additionally, there are frameworks and models that have been developed specifically to inform technology readiness. Among them are Technology Reading Index (TRI) (Parasuraman, 2000), that explains the overall state of mind resulting from a gestalt of mental enablers and inhibitors that collectively determine a person's predisposition to use new technologies (Bakirta & Akkas, 2020).

Other studies have depended on TRI either by replicating or extending it to conduct research on technology readiness. In each studies, some factors have been added either from the literature or other theories and frameworks of technology acceptance and use (Robin et al., 2020).

Researchers Nilsen et al. (2020) used the TRI by introducing new factors such altitude, education and training, technology compatibility to address issues of interoperability, inadequate infrastructure, and lack of standardization.

Five constructs of core readiness, policy readiness, societal readiness, engagement readiness, and use and acceptance readiness were identified and derived from literature. Additionally, interoperability levels were reconceptualized into three perspectives and included in the conceptual model these are Functional, Syntactic, and Semantic interoperability. The attributes of the readiness factors were derived from literature in this manner: a. Core readiness attributes: Need to change, Education and training, Awareness, Willingness to change, E-health project planning, Trust on the use of technology (Yusif et al., 2020). Policies readiness

attributes: Socio-political, technical, and regulatory factors, Legislature and political economy (Kouroubalia et al., 2019; Pypenko & Melnyk, 2021; Tsegaye & Flowerday, 2021). Societal readiness attributes: Sociocultural factors, Interaction among members, Local communities (Yusif et al., 2020; Ilorah et al., 2017). Engagement readiness (Yusif et al., 2020; Ilorah et al., 2017) attributes: Physical accessibility, and acceptability of services, Communication experiences (Ennis-Cole, Cullum and Iwundu, 2018), Socio-economic (Ogundeji, Ohiri and Agidani, 2018), Resistance to change/ Need to change. The last readiness construct is Acceptance and Use Readiness with attributes: Education and training, Willingness to change, Training of users, Cultural settings of diverse population groups in the society (Yusif et al., 2020; Ilorah et al., 2017).

Tsegaye and Flowerday (2021) suggested that interoperability levels due to functional interoperability will influence the interoperability readiness of health information system data. In terms of semantic interoperability, a health system that is semantically integrated allows the exchange of data among organizations and their internal ecosystems by ensuring that the data exchanged is interpreted correctly and does not miss its meaning (de Mello et al., 2022). The syntactic level on the other hand enables the exchange of data by supporting the same protocol in a standardized format (Villarreal et al., 2023).

These constructs are presented in the Figure 1, showing the hypothesis derived from the constructs.

The aim of the study. To assess the data interoperability of the Health Information System used in the South African public healthcare.

Materials and Methods

Based on the conceptual model, a close-ended questionnaire was developed to collect data from three district hospitals in Gauteng province, South Africa. The questionnaire was distributed online using Survey Monkey. For ethical purposes, and to protect privacy and anonymity, a link was sent to the contact person at each district hospital who then distributed it to the respondents using their mailing lists. Respondents filled the questionnaire and on completion they clicked the submit button that delivered the completed questionnaire in the Survey Mokey database.

Population and Sampling

The targeted population for this study consisted of individuals who were actively involved or uses HIS and are somehow knowledgeable about the data sharing between health facilities. These were basically IT professionals, data quality mentors, medical professionals, and administration professionals. From the pre-exploratory study conducted, it was revealed that there are approximately fifty individuals in each hospital that form the category of the participants of this study, making the overall population of this study to be 150. Based on the Krejcie and Morgan (1970) tool for determining the sample size of the finite population, a sample size of 108 respondents was needed for data



collection. Simple random sampling was then used to distribute the Survey Monkey link to the respondents.

Questionnaire Coding

Before data analysis was conducted, the questionnaire was coded to allow easy transcription in the statical package. Analysis was conducted using the Statistical Package for Social Scientists (SPSSv25). The questionnaire coding was as follows. Core Readiness was coded as CRead and its four attributes as CRead – CRead4, Policy Readiness as PRead and its three attributes as PRead1 – PRead3, Societal Readiness as SRead and its three attributes as SRead1 – Sread3, Engagement Readiness as Eread and its four attributes

as ERead1 – ERead4, Acceptance and Use Readiness as AURad and its three attributes as AURad1 – AURad3. The Functional Interoperability was coded as FunInt and its three attributes as FunInt1 – FunInt3, Semantic Interoperability as SemInt and its three attributes as SemInt1 – SemInt3 and the Syntactic Interoperability also known as Data Ontology was coded as SynInt and its three attributes as SynInt1 – SynInt3.

Results and Discussion

Table 1 presents a detailed analysis of frequencies of the respondents' demographics and situational variables.

Table 1

Frequencies of Respondents' Demographics

Variables	Item	Frequency		
		Person	Percent	Cumulative percent
Gender	Female	69	55.6	55.6
	Male	54	43.5	99.2
	Response	1	0.8	100.0
	Total	124	100.0	–
Age	21–30 years	27	21.8	21.8
	31–40 years	64	51.6	73.4
	41–50 years	23	18.5	91.9
	50 years and above	9	7.3	99.2
	Response	1	0.8	100.0
	Total	124	100.0	–
Working experience	0–3 years	13	10.5	10.5
	12 years and above	30	24.2	34.7
	4–7 years	37	29.8	64.5
	8–11 years	43	34.7	99.2
	Response	1	0.8	100.0
	Total	124	100.0	–
Organization duration	0–3 years	38	30.6	30.6
	12 years and above	20	16.1	46.8
	4–7 years	42	33.9	80.6
	8–11 years	23	18.5	99.2
	Response	1	0.8	100.0
	Total	124	100.0	–
Job position	Administration professional	14	11.3	11.3
	Data quality mentor	8	6.5	17.7
	IT professional	47	37.9	55.6
	Medical professional	14	11.3	66.9
	Other	40	32.3	99.2
	Response	1	0.8	100.0
	Total	124	100.0	–
Involvement in planning / implementation	No	83	66.9	66.9
	Response	1	0.8	67.7
	Yes	40	32.3	100.0
	Total	124	100.0	–
Experience in usage of health information system	No	68	54.8	54.8
	Response	1	0.8	55.6
	Yes	55	44.4	100.0
	Total	124	100.0	–
Awareness of health information system data interoperability	No	80	64.5	64.5
	Response	1	0.8	.8
	Yes	43	34.7	34.7
	Total	124	100.0	–



Regression Analysis

Regression analysis explains the relationship between two or more variables of interest (Creswell & Creswell, 2018). From the model summary, the overall prediction of the model to inform HIS data interoperability readiness assessment was 86.1% ($R^2=0.861$).

Table 2 presents results of the regression analysis. The regression analysis explains each construct's contribution to the overall prediction of the model.

Table 2
Regression Analysis

Model	Unstandardized coefficients		Standardized coefficients	<i>t</i>	Sig.	Collinearity statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	0.199	0.181	—	1.102	0.274	—	—
PRead	0.030	0.084	0.031	0.355	0.723	0.214	4.677
CRead	0.266	0.074	0.252	3.589	0.001	0.328	3.051
SRead	0.100	0.062	0.116	1.983	0.040	0.311	3.212
ERead	0.070	0.082	0.072	0.856	0.394	0.227	4.403
AURead	0.354	0.064	0.423	5.498	0.000	0.272	3.675
FUNInt	0.300	0.046	0.356	6.501	0.000	0.539	1.856
SEMIInt	-0.188	0.081	-0.157	-2.307	0.023	0.348	2.872
SYNInt	0.027	0.056	0.021	0.476	0.635	0.835	1.198

Note. *Dependent variable – HISDIRead; VIF – variance inflation factor; PRead – policy readiness; CRead – core readiness; SRead – societal readiness; ERead – engagement readiness; AURead – acceptance and use readiness; FUNInt – functional interoperability; SEMInt – semantic interoperability; SYNInt – syntactic interoperability.

Results in Table 2 indicates that with the exception of policy readiness (PRead), engagement readiness ERead and syntactical interoperability the rest of the constructs showed that they have a significant contribution to the overall prediction of the model. Additionally, all the values of the Variance Inflation Factor (VIF) were

below the recommended value for multicollinearity to exist implies that there was no multicollinearity. By using the critical ration *t*-value demonstrated in Table 2, the testing of the hypotheses was deduced as presented in Table 3.

Table 3
Hypotheses Testing

Hypothesis	Results	Action
H1: Core readiness has a direct influence on health information system data interoperability readiness	$P = 0.001 < 0.05$	Accepted
H2: Policies readiness has a direct influence on health information system data interoperability readiness	$P = 0.723 > 0.05$	Rejected
H3: Societal readiness has a direct influence on health information system data interoperability readiness	$P = 0.040 < 0.05$	Accepted
H4: Engagement readiness has a direct influence on health information system data interoperability readiness	$P = 0.394 > 0.05$	Rejected
H5: Acceptance and Use Readiness has a direct influence on health information system data interoperability readiness	$P = 0.000 < 0.05$	Accepted
H6a: Interoperability levels due to functional interoperability will influence health information system data interoperability readiness	$P = 0.000 < 0.05$	Accepted
H6b: Interoperability levels due to syntactic interoperability will influence health information system data interoperability readiness	$P = 0.635 > 0.05$	Rejected
H6c: Interoperability levels due to semantic interoperability will influence health information system data interoperability readiness	$P = 0.023 < 0.05$	Accepted

The final model with the constructs of core, societal, acceptance and readiness, and the parameters of

functional and semantic interoperability is shown in Figure 2.

Figure 1

The Conceptual Model for Data Interoperability Assessment for Health Information System in South African Public Healthcare

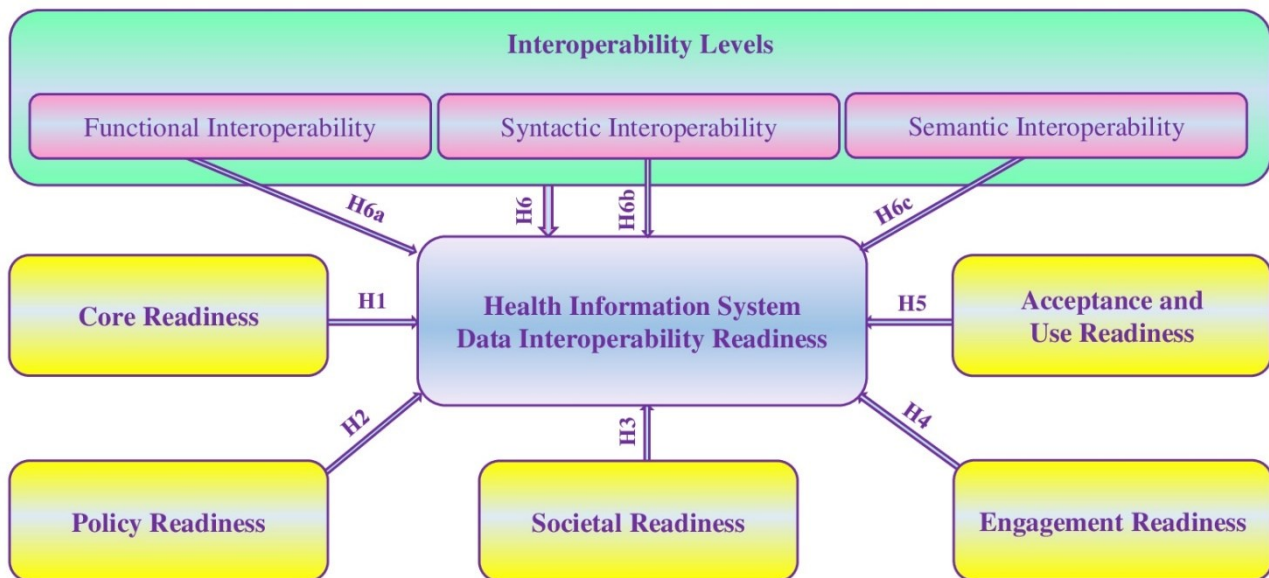
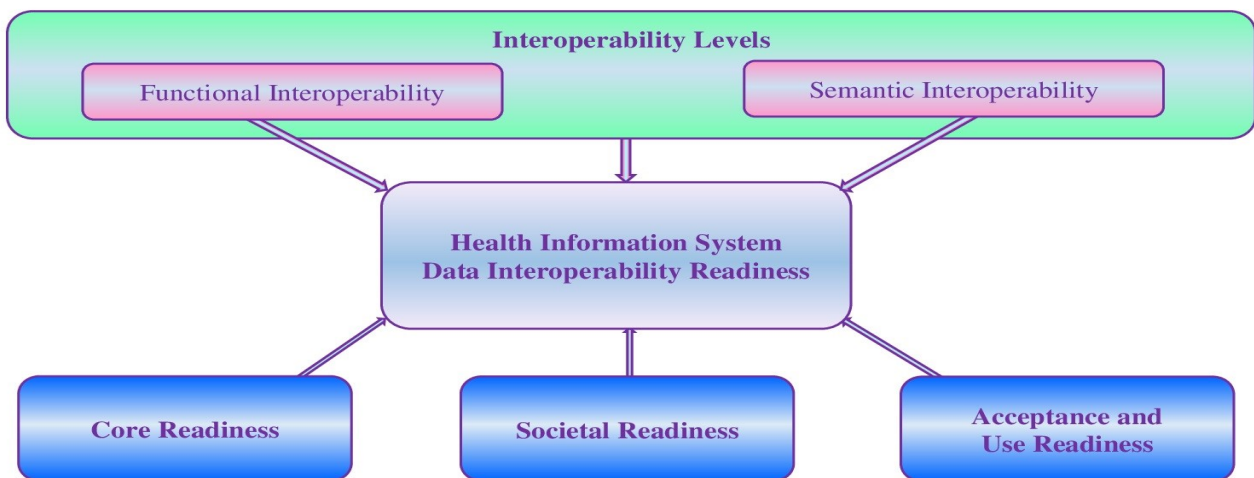


Figure 2

The Final Model for Data Interoperability Assessment Model for Health Information System in South African Public Healthcare



This study sought to assess interoperability readiness in South African public health. Interoperability plays a major role in today's interconnected world, as it enables health institutions to communicate and exchange data effectively and efficiently. With interoperability, health institutions may have improved data sharing and collaboration, enhanced data quality, increased efficiency, lower costs, improved user experience, and better security and privacy (Savage & Savage, 2020; Torab-Miandoab et al., 2023). To maximally benefit from interoperability, health institutions need to focus on creating a culture of collaboration and data sharing and investing in technology solutions that enable seamless data exchange between different systems and devices. This section discusses the results of the study in relation to the five hypotheses that were set to assess the

interoperability readiness in South African public hospitals.

The first hypothesis (H1) theorized that core readiness has a direct influence on HIS data interoperability readiness. This hypothesis was accepted. The acceptance of this hypothesis implies that with the increasing digitization it is almost becoming impossible for health institutions to operate without the use of technology. results of the study are in agreement with those of other researchers such as (Achieng & Ruhode, 2023; Khubone et al., 2020; van Heerden & Young, 2020) who indicated that digital solutions in health should be implemented with interoperability in mind to enable collaborations and information sharing especially in the resources constrained areas. Hence, they emphasized the role of core readiness in achieving interoperability readiness.



The second hypothesis (H2) predicted the influence of policy readiness on HIS data interoperability readiness. This hypothesis was rejected. Policy readiness which refers to government commitment regarding governance, standards, and legal infrastructure. The implementation of technology in healthcare is often frequently expected to raise the standard of healthcare services. The rejection of this hypothesis implies that policies are paramount for the implementation of HIS but may not have a role in the architecture and operation of the system as many policy makers are not actually the users of the system. The findings of this study don't align with those of other researchers such as (Achieng and Ruhode, 2023; Kgasi & Kalema, 2014; Tsegaye & Flowerday, 2021) who found policy significant and indicated that good policies should set standards that should be followed before. During and after the implementation of HIS.

The third hypothesis (H3) predicted the influence of societal readiness on HIS data interoperability readiness. This hypothesis was accepted. The acceptance of this hypothesis emphasizes the need to involve users when implementing a technological innovation. Such involvement is key for ensuring that high quality healthcare and reliable services are implemented to meet the users day to day needs. It also ensures trust, and confidence during use and the planning of the suitable training for the users. The findings of this study concur with those of previous researchers such as (Khubone et al., 2020; Robin et al., 2020; Udekwe et al., 2021) who found society readiness significant and indicated that technological systems may fail when they meet resistance originating from users' negative attitudes towards the technology especially when the users were not involved in the implementation process.

The fourth hypothesis (H4) predicted the direct influence of engagement readiness on HIS data interoperability readiness. This hypothesis was rejected. The rejection of this hypothesis implies that health institutions do not need to plan for engagement as it should be part and partial of the implementation process. When users are involved, engagement comes automatically as each user will feel that he/she is part of the whole process. The findings of this study concur with those of many other researchers such as (Udekwe et al., 2021; Villarreal et al., 2023) who also note that much as engagement readiness stimulates effective implementation planning that avoids financial losses, effort, time delays and, dissatisfaction among stakeholders. Its role may be reduced if users involvement is taken as part of the implementation process.

Hypothesis H5 theorized the influence of the acceptance and use readiness on HIS data interoperability readiness. This hypothesis was accepted. The acceptance of this hypothesis implies that any form of technology needs to be accepted, adapted, adopted and then used. Acceptance and use are very critical in the technology implementation journal regardless of what technology is being implemented. The findings of this study are in agreement with those other researchers such as (Achieng & Ruhode, 2023; Naidoo & Naidoo, 2021; Robin et al., 2020) who indicated that the use of HIS is influenced by

the level of system simplicity and user-friendliness. They indicated that, if the HIS is effectively used implementation of interoperability will be faster as users will be eager to share information and collaborate with others.

The interoperability levels were based on to hypothesize three relationships. H6a predicted that interoperability levels due to functional interoperability will influence HIS data interoperability readiness. This hypothesis was accepted. The acceptance of this hypothesis may imply that fragmented data fail to achieve the full potential of digital health, therefore today's world healthcare facilities do their best to deliver the best patient experience.

Without a proper interoperability structure, exchanging patient-related data becomes impossible in such cases. The foundational level is a basic level of exchange of data hence, the foundational level will assist in improving patient information. The findings of this study agree those of Rajkumar et al. (2022); Tsegaye and Flowerday (2021) who suggested that interoperability levels due to functional interoperability will influence the interoperability readiness of health information system data. This level of interoperability only ensures that information is transmitted and does not indicate anything about data representation.

Hypothesis H6b predicted the influence of interoperability levels due to syntactic interoperability to have an influence on HIS data interoperability readiness. This hypothesis was rejected. During sharing and collaboration, it is anticipated that there will be an exchange of information. These exchanged messages would need to be transmitted using a structure and syntax that are recognized by both the sender and the receiver systems. As a result, there must be an agreed on uniform data format for sharing and integrating different applications based on their respective structures (Lehne et al. 2019). The findings of this study are contrary to those of other researchers, such as Tsegaye and Flowerday (2021) and Rajkumar et al. (2022) who indicated that to achieve a meaningful exchange of health data, it is essential to have semantic and syntactic interoperability along with technical interoperability.

The last hypothesis H6c predicted the influence of semantic interoperability on HIS data interoperability readiness. This hypothesis was accepted. The acceptance of this hypothesis suggests that semantic interoperability is the foundation of healthcare and focuses on clear and unambiguous semantics and standardized medical terminologies.

Therefore, it is always better to use data with a clear and well-defined structure. To ensure the security of the exchanged data, semantic interaction is the best choice, as it allows interoperability at the highest level. The findings of this study are consistent with those of other researchers - such as Tsegaye and Flowerday (2021) who suggested that semantic interoperability levels will influence HIS data interoperability readiness since to allows the exchange of data among health institutions there is a need to ensure that data exchanged is interpreted correctly and does not miss its meaning.



Conclusions

Interoperability in the field of health care is still in its infancy and such has led to many legacy systems that worsens the already existing information silos and has consequently led to skyrocketing of healthcare costs, poor health service delivery due to delayed decision making. However, implementing interoperability in healthcare systems faces numerous challenges ranges from privacy and security Concerns to data quality and integrity. Overcoming the barriers health institutions need to leverage models like the one developed in this study to have a better understanding of how best interoperability could be implemented with minimal challenges.

More still, leveraging interoperable frameworks will enhance data accuracy, efficiency, and ultimately improve patient outcomes.

It is, therefore, important to note that interoperability serves as the backbone of a typical healthcare delivery system. Interoperability plays a crucial role in enhancing data accuracy, efficiency, and patient outcomes within the healthcare ecosystem. Improved interoperability in healthcare systems can have significant positive impacts on patient care, data security, and overall healthcare system efficiency.

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Ethical Approval

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ORIGINAL RESEARCH



A Persuasive Technology mHealth Self-Monitoring System for Intervention in Diabetic Patients Medical Adherence



Authors' Contribution:

- A – Study design;
- B – Data collection;
- C – Statistical analysis;
- D – Data interpretation;
- E – Manuscript preparation;
- F – Literature search;
- G – Funds collection

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Abstract

The prevalence of chronic diseases like diabetes has caused unmeasurable strain on many health systems especially in developing countries. Chronically ill patients are traumatised by their incurable illnesses, which adversely affects their adherence to their medical treatment, resulting in serious complications and even death. The aim of the study: to implement an intervention mobile health (mHealth) system by integrating persuasive technologies into mobile applications to empower diabetic patients to adhere to medical prescriptions.

Fogg Behaviour Model (FBM) was leveraged for the integration of mHealth and behaviour aspects. The system was developed with Kotlin programming using the Android Studio working integrated development environment (IDE). Tools including Firebase Real Time Database, Android Studio and Android Mobile Phone were used to afford a fully fledged mHealth self-monitoring system. The system was evaluated using descriptive statistics by medical personnel and social workers to determine the completeness, clarity, logical arrangement, correctness, reliability, usability, as well as content validity.

Findings indicated that the mHealth system meets a good degree of the measures that inform patients' self-monitoring for medicine adherence. The evaluation results also suggested that some functionality of the mHealth self-monitoring system requires an incremental improvement, to provide a seamless healthcare support. The artefact was descriptively evaluated on seven parameters: completeness that showed a mean of 3.75 with a standard deviation of 1.070; functionality with a mean of 4.05 and standard deviation of 0.945; accuracy with a mean of 3.70 and standard deviation of 1.031; reliability a mean of 3.90 and standard deviation of 0.945; consistence a mean of 4.00 and standard deviation of 0.968; performance a mean of 3.75 and standard deviation of 1.250, and usability with a mean of 3.55 and standard deviation of 0.999. The developed system is as effective as face-to-face consultations and personal visits to healthcare facilities. Diabetic patients need to adhere to medicine to avoid further complications that could lead to death.

diabetes, mHealth, self-monitoring, medical adherence, persuasive technology, chronic diseases, remote healthcare provision.

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Introduction

Adherence to medicines is the extent to which the patient's action matches the agreed recommendations by the healthcare provider. According to Franklin et al. (2020), non-adherence to medications can lead to hospitalizations and readmissions, increase mortality rates and adversely affect patients' quality of life. Non-adherence, both intentional and unintentional, limits medication benefits, resulting in health decline and high economic costs attributed not only to wasted medicine but also to knock-on costs arising from increased healthcare demands should health deteriorate (Lin et al., 2022). There are various reasons for patients having difficulty taking their medication. These include constant refills, the perception that medical treatments are improving, forgetfulness, or disinterest in taking medications, and non-availability of medication (Istepanian & Al-Anzi, 2018). Psychologically, patients experiencing comorbid illnesses who take regular medicine are more likely to neglect their medication due either to fatigue or stigmatization or both. It is essential that effort be made to improve patients' adherence to their medications. Such efforts should include support from both healthcare providers and relatives, social support from peers, leveraging of technological innovations, and digital products (Pypenko, 2019) where possible.

Globally, diabetes has been listed among the leading causes of death, with 1.5 million people in 2019 alone dying from this condition (Lin et al., 2022). According to the WHO (2023), in sub-Saharan Africa, South Africa has the second-largest population in this region of people with diabetes (12.7% of adults); and South Africa had 16.0% of the total deaths in 2016 attributed to diabetes and other non-communicable diseases (NCDs). The WHO (2023) emphasizes that diabetes pervasiveness is mainly attributed to lack of awareness of the disease, poor accessibility to proper healthcare, as well as poor adherence to medical prescriptions. Debon et al. (2019) allude to medical-taking inconsistencies have been the major cause of high mortality rates for people with chronic diseases. The above researchers note that routine and timeous taking of medication suppresses the symptoms and other ailments that could complicate diabetic conditions. Hence, failure to take medication regularly allows ailments and symptoms the opportunity to worsen the patient's condition, resulting from low levels of immunity.

Chronic diseases, which are persistent human health conditions, or diseases with long-lasting effects, contribute to various causes of death and disability worldwide (Debon et al., 2019). In both developing and developed countries, chronic diseases have a high prevalence; and are pervasive across all socio-economic classes (Lin et al., 2022; WHO, 2023). Chronic conditions require regular medication administration. The strain of living with conditions that cannot be cured normally leads to distress and depression among patients as a result of taking routine medicines. Such anxiety and depression in patients being aware of living with an incurable malignancy leads to psychological

distress, making drug regimen adherence a challenge (Kalema & Mosoma, 2019; Köhler et al., 2017). Diabetic patients need reminders to take care of their health by adhering to the prescribed medicine. This call has led to the development of various self-management reminder systems in which many have leveraged mobile health (mHealth) applications (Reidy et al., 2020).

Debon et al. (2019) note that many of the mHealth systems that have been developed to assist in healthcare monitoring of patients, lack the aspects that could trigger self-monitoring. These researchers indicate that the use of mHealth in the self-monitoring of diabetic patients should be coupled with persuasive technology that embraces both technology and behaviour change; as well as taking into consideration any aspects of cultural context. This paper reports on the development of a persuasive technology mHealth self-monitoring system to enhance adherence to medication among patients with diabetic conditions.

The prevalence of diabetes around the world poses a considerable burden on healthcare systems and patients suffering from this chronic condition. The rise in diabetes and other chronic diseases poses a particular challenge to low-income countries, many citizens lacking adequate medical equipment and clinics (Chang et al., 2022). As a result, nations, as well as healthcare providers, must ensure that four basic functions are provided to the citizens in order to ensure diversity and equality. Among these functions are financial management, provision of stewardship and development of resources, such as human resources, physical infrastructure, and knowledge dissemination (Bacelar-Silva et al., 2022). Additionally, Kendzerska et al. (2021) argue that enabling the effectiveness of these functions will improve the accessibility and responsiveness of the healthcare system. Regardless of the economic standing of a country, healthcare responsiveness is of paramount importance. Some researchers (Pypenko & Melnyk, 2021) argue that building the state economy on the principles of digitalisation will help solve these problems. According to Rensburg (2021), countries should find better ways of ensuring that health systems are equally accessible and available to all citizens, regardless of their geographical location. As part of this process, it is also necessary to bring healthcare closer to communities, especially in areas that are difficult for health workers to reach.

According to Achoki et al. (2022), improving accessibility to healthcare systems is one way of closing the gap between urban and rural settings with limited resources. A number of initiatives have been motivated by attempts to improve the accessibility and availability of healthcare systems. Utilization of technological innovations such as electronic health (e-health) and mobile health (mHealth) has been at the forefront (Arsenijevic et al., 2020; Shaw et al., 2020).

The proliferation of ICTs and the increasing use of mobile telephony continue to be leveraged as mediums of communication between healthcare providers and patients. Consequently, mobile devices such as



cellphones, PDAs, and other wireless devices have evolved into patient-monitoring devices. The rapid evolution of mobile technology platforms makes mHealth the fastest-growing segment of eHealth (Shaw et al., 2020). mHealth has played a major role in empowering patients with information, increasing access to health services, and improving real-time data management (Debon et al., 2019). Diabetic patients require continuous monitoring; yet specialists in this domain are few, and those available are overwhelmed by work. Hence remote health-monitoring emerges as a better alternative, preventing unnecessary complications (Istepanian & Al-Anzi, 2018). As a result, mHealth has become a popular tool for monitoring of patients with chronic conditions. Consequently, Chatterjee (2019) has emphasized that, for effective empowerment of patients with chronic conditions, it is essential to leverage persuasive technology that combines the use of technology with the patient's behaviour in responding to drug adherence.

With the advent of digital health technologies, healthcare has undergone a revolution, from the widespread use of computers to algorithms for the detection, treatment, and monitoring of diseases. The use of technology has been extended from robotic surgery to artificial intelligence, machine learning, computer-aided decision models, to mobile applications that help patients to manage their lives (Kgasi et al., 2023). From diseases to electronic medical records, digital health has experienced a revolution. As healthcare systems become more people-centred, the contribution of digital health technologies to preventive and diagnostic treatment, and self-monitoring capabilities becomes enormous. However, many technological interventions in healthcare have been more intended to facilitate the work of healthcare personnel than to facilitate patients managing their lives (Chatterjee, 2019). Researchers such as (Chatterjee, 2019; Debon et al., 2019; Kalema & Mosoma, 2019) argue that, in order to empower patients to self-monitor their health, technological interventions must be designed to incorporate motivational factors that are essential to trigger behaviour change. Earlier researchers such as (Fogg, 2002; Nass et al., 1996) recommended that self-monitoring can be effectively achieved by leveraging persuasive technology.

Fogg (2020) notes that persuasive technology involves the incorporation of psychological insights into the design of products such as mobile apps and wearables, to modify people's habits and beliefs. Therefore, Fogg (2020) believes that the designing process of persuasive technology should consider factors such as ability and motivation, where motivation arises from one's yearning for social connection. This implies that such an individual must have the ability easily to do what the app wants conducted. Therefore, the use of persuasive technology approaches have been widely designed with prompting features, such as reminder systems (Arsenijevic et al., 2020; Huzooree et al., 2019). Fogg (2002) indicated that human beings may respond to computers as though they were living beings. This is

mainly because social responses to certain computing systems are automatic and natural. The researcher notes that individuals are hardwired to respond to signals in the environment that seem alive in some way; and such responses are instinctive rather than rational. Additionally, computers can serve as persuasive social actors capable of rewarding individuals with positive feedback, modelling, and providing social support (Nass et al., 1996). When human beings perceive a social presence, they naturally respond in social ways that may include feeling empathy, being angry, or performing a social task (Fogg, 2020). This implies that social cues from computing products are essential. Such social cues trigger automatic responses in individuals whereby a given behaviour happens when motivation, ability, and a prompt come together simultaneously.

Chatterjee (2019) avers that, since human beings respond socially to computer products, the use of persuasive technology is of paramount importance for mHealth self-monitoring of patients with chronic diseases. In mHealth self-monitoring, the mobile device plays the role of persuasion dynamics described as social influence arising from social situations. Researchers such as (Fogg, 2002; Nass et al., 1996) observe that affiliation and social identity effects in human-computer interactions make human beings teaming up with computers behave similarly as they would on teams with other humans in terms of the physical, psychological, social dynamics, social roles, and language. In self-monitoring of diabetes patients, the changes in lifestyle with the use of mHealth is noteworthy in that the mobile apps facilitate the sending of simple messages and alerts aiding in adherence to treatment (Debon et al., 2019). More so, the possibility of providing direct communication by a multimodal content mHealth tool is crucial for higher adherence among patients to routine medicine taking (Arsenijevic et al., 2020).

A literature search was conducted using Litmaps by combining phrases and a combination of the words "mHealth", "mHealth self-monitoring systems", "mHealth self-monitoring systems for diabetic patients", and "mHealth self-management of chronic diseases". The search was filtered to include electronic databases for published articles and conference proceedings, online databases for theses, as well as reference lists of relevant reports and reviews for the years ranging from 2016 to 2023. The search revealed that Dobson et al.'s (2017) study on mHealth for self-management support was the most relevant; and has a wide impact on mHealth self-management research, hence it was used as the seed article. The Dobson et al. (2017) study investigated the use of mHealth in delivering self-management support to young people with Type 1 diabetes. The Dobson et al. (2017) study analysed clinical trials of using the text-message-based diabetes self-management support system in which the role of age in diabetes self-management was emphasized. Much as their study has been widely used, referenced, and extended, the study only analysed the moderating factors descriptively; and such limited the



prediction of patients' continuing usage of the intervening mHealth system.

In a systematic review and meta-analysis of mHealth and online health interventions for diabetes published before 2015, Larbi et al. (2019) identified and categorized several factors that influence the use of mHealth for diabetes self-monitoring. These factors included usability and suitability of the developed mobile apps and other online interventions, effect on clinical health measures, data protection, information needs, other external factors, support and access to services, coping, patient engagement and empowerment needs, and technological needs. Their study emphasized that in developing interventions for diabetes self-monitoring, the role that patients and their healthcare professionals play is significant in the development of tools and applications for such chronic diseases self-monitoring. To address this call, our current study developed its artefact based on the Kgasi et al. (2023) model that was quantitatively designed and validated for mHealth self-monitoring.

Reidy et al. (2020) based their study on the behaviour-change wheel and theoretical domains framework in investigating the effects of a facilitated web-based self-management tool for Type 1 diabetic patients using an insulin pump. The study by the above researchers leveraged the combination of contextualization of the healthcare intervention model, use of theory-driven intervention for healthcare self-monitoring, and the use of big sample size of participating patients in the application of the mHealth system. Findings of Reidy et al. (2020) indicated that successful self-management systems are situational and contextual, with time and life circumstances being major moderating factors. Much as their study bridged the gaps that had been presented by earlier researchers such as (Dobson et al., 2017; Larbi et al., 2019), the study fell short of addressing the psychosocial support factors, or their integration into the development of the intervention self-management models and systems.

The integration of psychosocial support into routine diabetes care has been cited as important in reducing challenges of distress, anxiety, depression, and sleep disorders, which are major antecedents of medicine adherence (Kgasi et al., 2023).

The World Health Organization (WHO) report on the uses of self-care interventions indicates that the classification of self-care interventions depends on the purpose of the intervention being developed (World Health Organization, 2021). The report indicates that these classifications include individual agencies that are advanced to promote awareness about self-care. Health information-seeking is recognized, with agencies intended to provide education for informed health decision-making, and social and community support. Such agencies are purposely developed for peer mentorship and counselling and personal health tracking designed to keeping home-based records of health and diagnostic data. Other purposes are self-diagnosis of health conditions intended for self-testing as well as self-management of health. One such developed by this

study supports a patient to carry out self-medication and treatment as well as reminding them to take their medicine as prescribed by medical personnel. Other researchers such as (Mueller et al., 2019) stress that, much as various self-management interventions have been developed, including individuals' links to health systems where patients share data with healthcare professionals (HCP), many such systems may be misleading due to poor development procedures. These studies recommended that developed interventions should be scientifically evaluated. The developed intervention system should be feasible, acceptable, usable, efficient, effective, including cost-effective while promoting safety in its implementation.

Lin et al. (2022), using a descriptive analysis approach evaluated Type 1 diabetes patients' accessibility and openness to receiving mHealth support. Their study observed that patients' perceptions of using mHealth as a tool for delivering information is dependent on the delivery style, nature of messages delivered, and the content that is delivered. Hence, the above researchers recommended the implementation of interactive voice response rather than SMS for the elderly chronic-disease patients. Additionally, their study emphasized the importance of leveraging a contextualized model in the development of mHealth interventions: an approach suitable for one population may not be appropriate for another. The current study leveraged the Kgasi et al. (2023) contextualized model in developing the persuasive technology intervention for mHealth self-monitoring.

The aim of the study. To implement an intervention mHealth system by integrating persuasive technologies into mobile applications to empower diabetic patients to adhere to medical prescriptions.

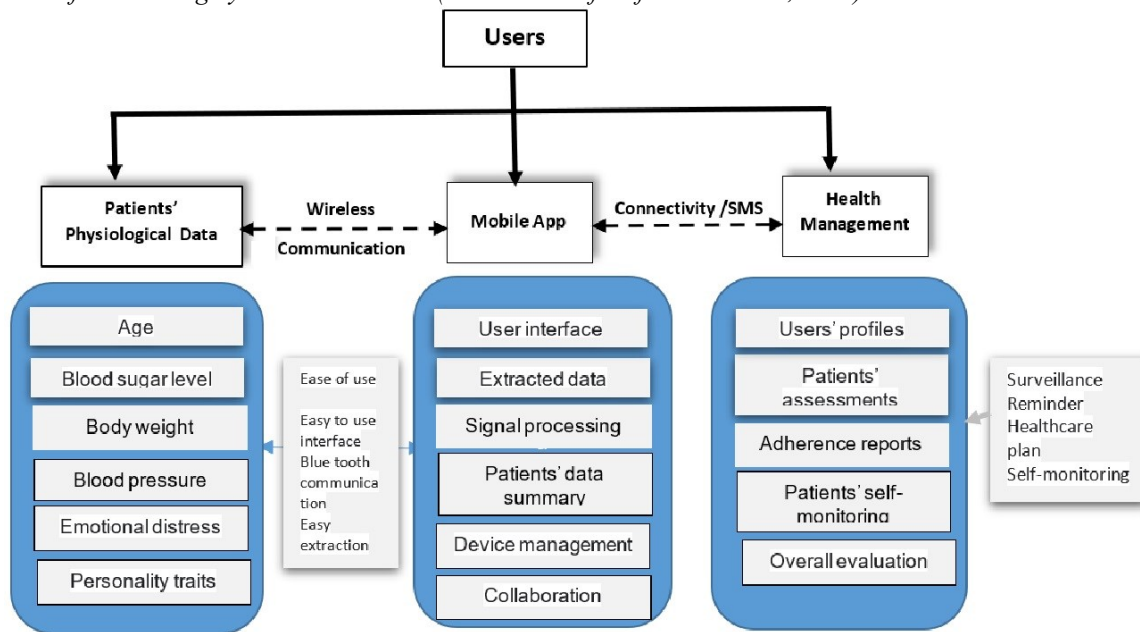
Materials and Methods

Researchers Lagan et al. (2021) argue that the proliferation of mobile health apps has made selecting the right one increasingly challenging for clinicians and patients. Despite the myriad of mobile health apps available, app evaluation frameworks can assist in sorting through them; however, the growing number of frameworks further complicates the process. With this understanding, this study set to develop a persuasive mHealth system based on previously validated models (Fogg, 2002; 2009; Kgasi et al., 2023). In persuasive technology, behavioural occurrence is seen as the goal achieved after aggregating other parameters that include motivation, ability, and a prompt (Fogg, 2002). Hence, the general architecture consists of devices connecting the patients' physiological information, implanted systems for signal processing, and wireless communication as demonstrated in Figure 1.

As illustrated in Figure 1, the patients' physiological data and the mobile application components interact directly and are supported by the ease-of-use design principles. Similarly, the persuasive technology characteristics such as assessment, self-monitoring, patients' adherence, as well as evaluation form the components of the health-management system.

Figure 1

mHealth Self-Monitoring System Architecture (Source: Modified from Jia et al., 2015)



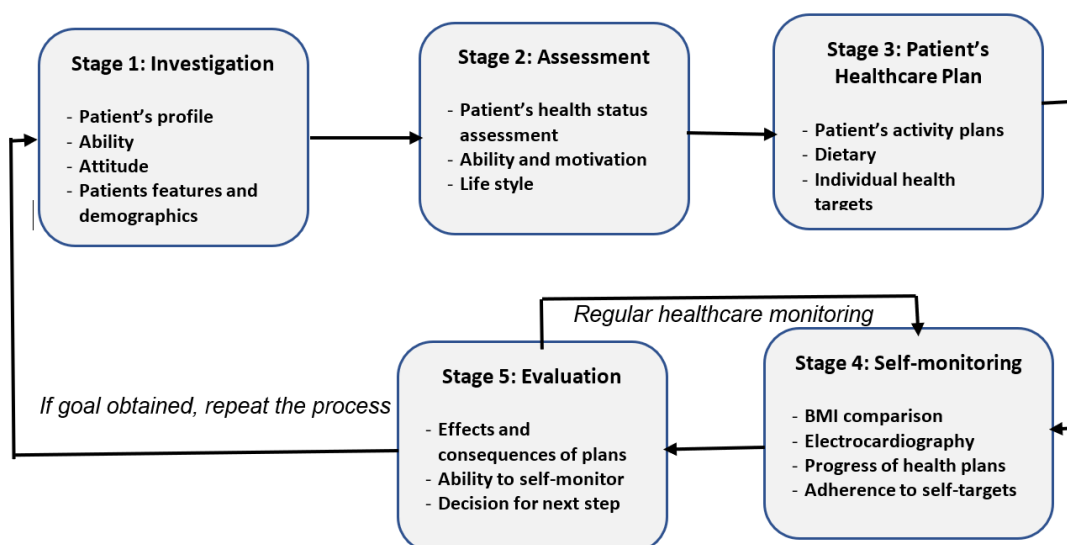
System Functionalities and Integration with Persuasive Technology

The mHealth self-monitoring system functionalities that describe how well it should operate were identified to include productivity, access to information, training, access to diabetes national programmes, security, trust, and scalability (Lagan et al., 2021). On the other hand, for self-monitoring of the system's features, descriptions, dependencies, and functions needed to include registration, patient verification, and push notification, connection to social accounts, utility, news feed, product and services, contacts, messages,

dashboard, reports, as well as home screen. The design process considered these functionalities along with Fogg's (2009) five persuasive strategies, namely, investigation, assessment, patient's health plan, self-monitoring, and evaluation. These features were incorporated into the system to enhance patients' execution ability and adherence. Based on these parameters, the design process then followed an iterative approach incorporating patients' feedback and medical personnel evaluation of how the patients have behaved towards the system's triggers as demonstrated in Figure 2.

Figure 2

Integration of Persuasive Technology for Self-Monitoring (Modified from Fogg, 2009; Jia et al., 2015)



Physical Design and Coding of the System

The designed mHealth self-monitoring system is an android application designed with Kotlin programming using the Android Studio working integrated

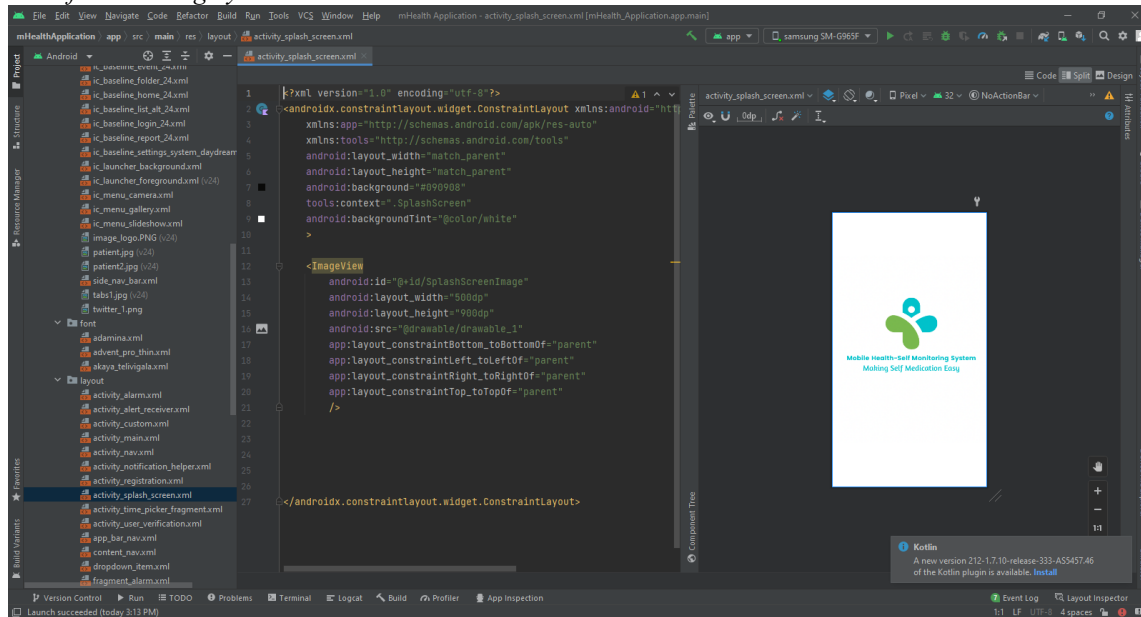
development environment (IDE). Kotlin programming language ensures code safety and developer's satisfaction for professional android developers. The following tools were used:

- Firebase real time database, a cloud (online) NoSQL database, that stores and syncs data between users in realtime. This helped to store information about the registered patients on the mHealth system.
- Android Studio an integrated working environment (IDE) designed specifically for android development. This helped in the utilization of the android studio chipmunk that allows the inspection and debugging of the animations features built in a composable preview.
- Android Mobile Phone was used to run the application.

Coding and Graphical Interfaces

The developed frontend and backend were deployed on the android phone to enable the displaying of the output on the graphical interface. A sample of coding of the frontend is demonstrated in Figure 3. Each functionality was developed with both the frontend and backend. The frontend illustrated the patient's interface of interaction with the system; while the backend illustrates the exact occurrence within the system when a function or command is issued.

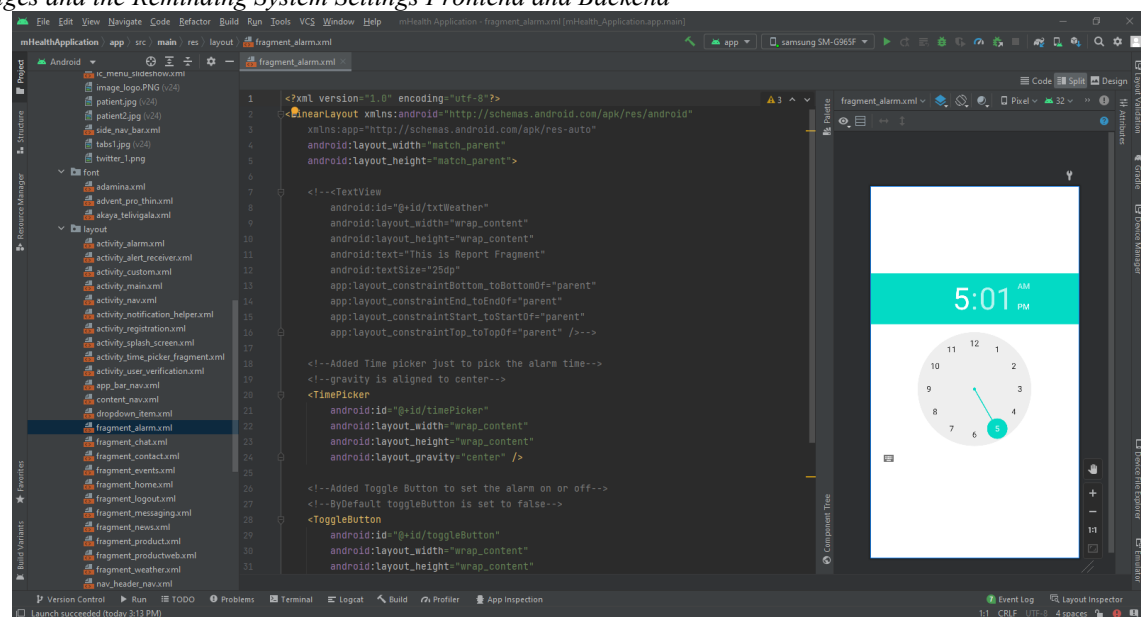
Figure 3
mHealth Self-Monitoring System's Frontend



Since the objective of the mHealth self-monitoring system is to remind a patient to adhere to the medical prescription at the time recommended by the medical personnel or social worker, the system was designed in such way that it takes two approaches to reminding the patient. It first sends a message to alert the patient at the

exact time set for medicine-taking; then an alarm automatically goes on. Figures 4 illustrates the messages and the reminding frontend and backend coding. The system also enables a patient to schedule and create personal alarm notifications on the App by setting the ring notification time.

Figure 4
Messages and the Reminding System Settings Frontend and Backend





While on the system, the patient may navigate to perform other tasks such as reading the latest news, setting appointments, browsing the nearest pharmacy, as well as viewing his or her individual report in responding to the system. The “Exit App” button helps the patients to exit the application and resets the system to the “Get Started” page of the App. Additionally, the system was designed in such a way that it allows medical personnel at the facility where the patient is registered to view and produce a report of the patient’s performance. Based on these reports, an evaluation of the patient’s adherence to the system’s triggers, and responses to drug adherence, are recorded including the frequency of the patient’s interaction with the system. Adherence is then confirmed by observing the patient’s replenishing of the required medicine on time.

Evaluation of MHealth Self-monitoring System

Several methods of testing an artefact may be used to confirm its operability. These may include, inter alia functional and structural testing, testing using experimental methods such as those conducted in the field and laboratories, statistical testing including descriptive and inferential methods, as well as analytical and architectural analysis (Hevner, 2007). Data was

collected from medical experts by using a close-ended questionnaire and was analysed descriptively. The artefact was evaluated on the attributes of completeness, functionality, accuracy, reliability, consistency, performance, and usability. Because data was to be analysed descriptively, a small sample of about 20 respondents was deemed sufficient. The judgment-sampling technique was used to select the respondents. The experts sought were healthcare professionals, both medical and social workers, with relevant experience of working with diabetic patients. The artefact was deployed on these experts’ cellphones and the experts were asked to practise with it for a period of two weeks. The questionnaire was distributed in person; and experts were allowed three days for its completion.

Results

Respondents were asked to evaluate the artefact based on the seven attributes of completeness, functionality, accuracy, reliability, consistency, performance, and usability. Results presented in Table 1 demonstrate the respondents’ evaluation of how best the mHealth self-monitoring system design conforms to the expected criteria in terms of the seven tested attributes.

Table 1

Descriptive Analysis of Artefact Evaluation Parameters

Parameters	N Statistic	Min. Statistic	Max. Statistic	Mean Statistic	Std. Dev. Statistic	Variance Statistic	Skewness	
							Statistic	Std. Error
Completeness	20	2	5	3.75	1.070	1.145	-0.304	0.512
Functionality	20	2	5	4.05	0.945	0.892	-0.524	0.512
Accuracy	20	2	5	3.70	1.031	1.063	-0.282	0.512
Reliability	20	2	5	3.90	0.968	0.937	-0.170	0.512
Consistency	20	3	5	4.00	0.795	0.632	0.000	0.512
Performance	20	2	5	3.75	1.251	1.566	-0.548	0.512
Usability	20	2	5	3.55	0.999	0.997	0.024	0.512
Valid N (listwise)	20	—	—	—	—	—	—	—

Implications of Findings

Completeness: This aspect evaluated whether the artefact’s components were sufficiently complete to enable patients and medical personnel to interact with the systems, as well as being in a position to receive and share information. Findings indicate that the minimum and maximum responses are 2 and 5; with a mean of 3.75, and standard deviation of 1.07. This implies that most responses were skewed towards agreeing that the system is complete and could be used for monitoring patients’ adherence to medicine.

Functionality: This aspect tested the artefact’s usefulness; and how best it reminds the patients to adhere to the medical prescriptions. Functionality was tested in terms of the system’s input, processing, storage, as well as the output, including the extracted reports by the medical personnel. Results demonstrated in Table 1 indicate that responses had a minimum of 2 and a maximum of 5, with a mean of 4.05 and a standard deviation of 0.945. The implication of these findings is that experts considered the system to be performing averagely, as expected.

Accuracy: This aspect evaluated the degree of closeness of the artefact to perform self-monitoring. This was in

terms of the level of quality and precision, stability and security, and providing solutions without confusion. As demonstrated in Table 1, the minimum and maximum responses were 2 and 5, respectively, with a mean of 3.70 and a standard deviation of 1.031. The findings of the study imply that many respondents were skewed towards agreeing that the artefact accurately gives the expected results.

Reliability: This aspect assessed the probability that the artefact performs correctly regardless of the time and location, and is performing adequately according to predefined specifications and requirements. Results demonstrated in Table 1 indicate that experts’ responses were more skewed towards agreeing that the system is reliable, and performs according to stated functional and non-functional requirements. Reliability is essential for event-based reporting that occurs on a daily basis; hence this confirms that the system will perform to expectations.

Consistency: This aspect evaluated the system’s capability of producing a solution as intended. In the case of this study, consistency refers to whether the mHealth self-monitoring system could support patients in self-managing their health. Results demonstrated in Table 1



indicate that experts' evaluations were a minimum of 2 and a maximum of 5 with a mean of 3.90 and standard deviation of 0.968. This confirms that accuracy and consistency of mHealth self-monitoring are important in assessing and understanding predictive validity. Such includes the ability to detect events or pattern changes and for the intervention of the application.

Performance: The system was evaluated in terms of how well it does the reminding of the patients; and whether it accurately sends the messages as and when needed. Results demonstrated in Table 1 indicate that the majority of the respondents 70% (n=14) agreed that the system performs to expectations. The implication of this findings is that self-monitoring strategies are essential in helping patients maintain adherence to medical prescription for their own progress toward controlling complications that could be caused by the diabetic conditions.

Usability: As demonstrated in Figure 1, the mHealth self-monitoring system architecture emphasized that the system be developed with ease-of-use features. This implies that both the patients and healthcare workers should be able to navigate and use the system with ease. Results demonstrated in Table 1 indicate that responses were a minimum of 2 and a maximum of 5, with a mean of 3.55 and standard deviation of 0.999, with a positive skewedness of 0.024. Therefore, most responses were towards "agree" and "strongly agree". The implication of this finding is that usability plays a key role in engagement and behaviour changes.

By interacting with the system, a high-usability mHealth self-monitoring system should increase engagement and result in positive behaviour change.

Discussion

This paper presents a designed artefact that can be implemented into a fully-fledged mHealth self-monitoring system to assist diabetic patients to adhere to medical prescriptions. The designed artefact was evaluated by healthcare personnel in terms of its completeness, functionality, accuracy, reliability, consistency, performance, and usability. Results indicated that the artefact meets a good measure of patients' self-monitoring of their health. The evaluation results also suggested that some functionality of the mHealth self-monitoring system requires an incremental improvement, so as to provide a seamless healthcare support. Preventing NCDs is crucial to enabling better healthcare so as reduce long-term care costs while harnessing the potential of economic growth.

It is vital that better disease-management strategies, systems, and innovative tools are implemented to support the already overburdened healthcare systems, especially in low-income countries (Yagiz & Goderis, 2022). In this regard, new tools and integrated care models such as self-monitoring systems are required to support primary, community, and home-based healthcare, as well as long-term care.

Due to experiences of COVID-19 that introduced travel restrictions and social distancing, accessibility to medical facilities was limited; and such emphasized the need for electronic medical care systems. As a result, mHealth

self-monitoring systems are regarded as effective tools for fostering physical well-being and quality of life for patients (Chifu et al., 2022; Cruz-Ramos et al., 2022; Prioleau, 2021).

Other technologies could also be used in the same manner; and these include assistive technologies to monitor nutrition and physical activity, awareness campaigns to promote health, and digitally accessible community-based and integrated-care models to improve access to healthcare services.

As the prevalence of diabetes increases worldwide, it places a considerable burden on countries' healthcare systems as well as on the economic conditions of patients suffering from these chronic conditions. Therefore, leveraging technological innovations such as the mHealth self-monitoring system could save diabetic patients from the challenges of resource constraints and give these patients an added advantage of enhanced self-care.

The mHealth self-monitoring system architecture presented in Figure 1 indicated that the system should be developed with ease-of-use features; and should be beneficial to the intended users. These two technological aspects are essential in that, because diabetic conditions are prevalent in both youth and adults, the developed system should be accessible to all age groups. The system should be easy to use and at the same time patients should appreciate its usefulness. As Jia et al. (2015) note, failure to make the mHealth system easy to use will imply usage limited to only younger age patients, leaving the elderly ones socially isolated. Enhancing positive social support network is generally crucial to a patient's well-being, irrespective of chronic diseases complications, as this improves their positive motivation towards adherence, leading to better recovery. Additionally, social support for patients increases resilience to stress, hence lessening effects of trauma and depression (Fogg, 2020; World Health Organization, 2023).

Due to the stigmatization of having incurable health conditions, chronic-disease patients sometimes become reserved when interacting with peers, leading to low self-esteem (Kalema & Mosoma, 2019; Köhler et al., 2017). Hence, healthcare intervention programmes should not be limited to building the capacity of individual patients as well as their family members, in managing the chronic disease effectively. Programmes should also emphasize the use of technological innovations such as the mHealth self-monitoring system. Additionally, individuals with chronic physical illness are at increased risk of negative psychological sequelae; hence self-monitoring systems act as an intermediary innovative approach intended to reduce these negative effects and increase quality of life in such individuals (de Leeuw et al., 2022).

The fact that the persuasive mHealth self-monitoring system embraces the integration of patients' behaviour with technology is a good alternative to human medical personnel when dealing with patients with chronic illness. Delivering a smartphone intervention system is feasible as it meets the desired criteria of availability, demand, acceptability, and limited-efficacy testing (Huberty et al., 2019).



Limitations and Recommendations

The use of persuasive technology involves the incorporation of technological aspects of mobile-technology software and hardware, along with the users' individual characteristics and other triggering factors such as environment, institutional support, social, as well as cultural aspects, to cause behaviour change. The development of the artefact was based on the pre-tested model (Kgasi et al., 2023) that had been developed with consideration of patients' demographics and situational variables to moderate behavioural change. However, the evaluation of the artefact was based on the system's parameters, namely, completeness, functionality, accuracy, reliability, consistency, performance, and usability, without considering the evaluators' demographic variables. Furthermore, the evaluation was conducted at one time only, yet system usage behaviour may change over time (Chang et al., 2022; Fogg, 2009; Kalema & Mosoma, 2019). Therefore, this study recommends that future research use longitudinal data collection in which data on the effectiveness of the system is collected at different intervals after usage. This will help to identify those parameters that have ceased to be significant, together with those that have become salient.

The increasing globalization and urbanization is seeing a number of chronic diseases both communicable and non-communicable becoming more prevalent (Huberty et al., 2019; World Health Organization, 2023). As the number of citizens with chronic disease increases, healthcare systems become overwhelmed with the many patients who require routine healthcare. Technological innovations such as mHealth self-monitoring become key players in improving patients' self-management of their health. The mHealth self-monitoring system developed for this study goes beyond simply providing health information and SMSs, to include a reminder system and printing of the patient's reports on interaction with the system. The reminder system was developed in such a way that the time for the alarm to go on and the sending of messages are set manually either by the patient or a healthcare worker. This implies that the system is not intelligent enough to detect from the patient's condition that the alarm or reminder should sound. This study therefore recommends that future research should develop the mHealth self-monitoring that is intelligent enough to automatically detect patient's triggers for reminders before the alarm goes on. Patients' reports on the healthcare personnel's site should be based on real-time responses to allow immediate actions by the medical personnel. Such real-time interventions will help to ease the work of the healthcare personnel due to increasing numbers of patients.

This study was concerned with the development of a self-monitoring system for medicine adherence only, with no intervention for influencing health outcomes. However, there are also various other ways by which diabetic patients may be monitored, such as rate of physical activity, weight gain or loss, and blood-glucose levels. These other health-monitoring facilities were out of the scope of this study. Future research could develop

mHealth systems that combine all these health conditions that should be monitored, into one integrated system. Furthermore, due to increasing numbers of patients suffering from chronic conditions, data storage, as well as network stability, may become an impediment for effective use of the mHealth self-monitoring system. This study therefore recommends that future mHealth system and device integration be developed, supported by a more comprehensive, cloud-based system. Cloud-based solutions will provide various benefits, including stability, availability, and security, in addition to healthcare personnel being in a position to analyse patients' data from a central platform.

Conclusions

The pervasiveness of the use of technological innovations into the healthcare domain, and the increase of disease burdens, has made mHealth a much sought-after tool in the healthcare sectors of many countries. mHealth has been widely applied to the various aspects of healthcare management, especially to chronic complications that require routine monitoring, making adherence a challenge (Huberty et al., 2019; Leeuwert et al., 2022). mHealth systems such as the one developed in this study not only work as a reminder system for patients, but also allow healthcare professionals to collect quantitative information related to patients' health and behaviour towards medicine adherence; and such helps personnel to make meaningful decisions.

Through the data generated, stored, and disseminated by the mHealth systems, healthcare providers will be capable of gathering patients' related data and making decisions such as patients' risk prediction, need for physical monitoring, or admission to intensive care. On the other hand, the integration of patients' electronic health records, their behaviour and wearable technologies through the use of mHealth self-monitoring is essential for patient self-monitoring of their chronic conditions. Hence, an understanding of how to use the data generated from patients suffering from chronic conditions such as diabetes could lead to better treatment. Such could also lead to effective monitoring and control of other related complications that may arise from worsened conditions of chronic diseases due to poor adherence to medicine (Shaw et al., 2020). This is essential especially for diabetes where related complications leads to increased the risk heart problems such as heart attack, stroke and narrowing of arteries that may lead to death.

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Ethical Approval

The study obtained ethical clearance from the Ethics Committee of University of South Africa, UNISA (No. 2022/CAES_HREC/105 from 6/06/2022).



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