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'INCREASING THE VISIBILITY OF TRUSTED GREY RESOURCES'

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The Grey Journal

An International Journal on Grey Literature

COLOPHON

About TGJ

The Grey Journal is a flagship journal for the international grey literature community. It crosses continents, disciplines, and sectors both public and private.
The Grey Journal not only deals with the topic of grey literature but is itself a document type classified as grey literature. It is akin to other grey serial publications, such as conference proceedings, reports, working papers, etc.

The Grey Journal is geared to Colleges and Schools of Library and Information Studies, as well as, information professionals, who produce, publish, process, manage, disseminate, and use grey literature e.g. researchers, editors, librarians, documentalists, archivists, journalists, intermediaries, etc.

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About GreyNet

The Grey Literature Network Services was established in order to facilitate dialog, research, and communication between persons and organizations in the field of grey literature. GreyNet further seeks to identify and distribute information on and about grey literature in networked environments. Its main activities include the International Conference Series on Grey Literature, the creation and maintenance of web-based resources, a Global Distribution List and Social Media, and The Grey Journal. GreyNet is also engaged in the development of distance learning courses for graduate and post-graduate students, as well as workshops and seminars for practitioners.

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EDITOR'S NOTE

By drawing public awareness to grey literature without at the same time incorporating the results of studies over the past thirty years would be counterproductive. A campaign of public awareness with a new focus on grey literature is required. However, such an initiative can only be achieved in collaboration with the many grey literature stakeholders led by the publishers in grey literature, who are on the forefront of research and innovation in their specific domains of science and technology. GreyNet International owing to the support of its associate members has over the past three decades sought to promote and undertake research, publication, open access, education, and public awareness of grey literature by organizing the International Conference Series on Grey Literature.

For GreyNet, emphasis on the supply side of grey literature was always its starting point from which the field could confront the problems voiced by the demand side and adequately address them.

Speaking on behalf of GreyNet's community of practice, I maintain that by formalizing a consortium of grey literature publishers – online, openly accessible via the PUBGREY Registry – can such an initiative meet with success. If your organization publishes grey literature, enter your record today.

Dominic Farace
Journal Editor

The contribution of grey literature on a pathway to sustainable fisheries: Case studies from Cambodia, Indonesia, Philippines and Viet Nam [*]

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Daryl L. Superio, Northern Iloilo State University, Philippines

Abstract

During 2022, FAO and SEAFDEC completed a project to identify, record and analyse research under the scope of Sustainable Development Goal (SDG) indicator 14.4.1 – proportion of fish stocks within biologically sustainable levels. Research and data on the status of stocks is essential for their sustainable management and in ensuring they contribute to food security, employment and trade. The challenge of assessing and sustainably managing a country's national stocks is even more critical in the context of climate change given changes to the marine environment. Focusing on four countries in southeast Asia, (Cambodia, Indonesia, Philippines and Viet Nam), this project sought to increase the visibility of research and data sets previously only available at local and national levels. The research and data identified during the project would be analysed to identify knowledge strengths and gaps in the region, therefore contributing to the sustainable management of marine fisheries in the region. At the start of the project, a search methodology was agreed and used to search the ASFA database. Fifteen participants from four countries were recruited with access to, and knowledge of, their institution's holdings, research and data on stock assessments and marine fisheries. Training on the search methodology was given to participants who recorded relevant results on OpenASFA. The project resulted in 1,047 resources being recorded by participants which are now freely searchable on the FAO Fisheries and Aquaculture website. This compares to only 350 results identified using ASFA database- demonstrating the need for efforts to be made to improve the accessibility of research produced in the region. Many of the results recorded by participants could be classed as grey literature which can suffer from a lack of resources to adequately catalogue and make findable, preventing the research and data from informing further research and policy making decisions. Barriers in to sharing data in particular were raised by participants and further work is needed to implement open data policies whilst ensuring adequate protection of data rights, for example by ensuring credit is given to the collecting institute/ researcher. To meet the global challenge of climate change and SDG target 14.4 on sustainable fishing, the capacity to store, share and access research and data on fish stocks is required at local, national and international levels. Whilst improving the visibility of research and data from the region, the project has also highlighted the challenges of ensuring data and information is made FAIR on an ongoing basis.

Introduction

For over fifty years, the Aquatic Science and Fisheries Abstracts (ASFA) partnership has worked to promote the world's research on aquatic environments, with a particular focus on grey literature. The ASFA partnership model, which as of 2023 involves over 100 institutions worldwide, ensures the participation of producers of grey literature, who are themselves best placed to catalogue resources for inclusion on the ASFA database. Having made efforts in recent years to update its technologies and business model, notably with the launch of OpenASFA in 2021, ASFA is able to openly share its records (Castillo, 2023). OpenASFA is a Virtual Research Environment (VRE) for the creation, storage and publication of abstracting and indexing records related to all aspects of aquatic sciences, fisheries and aquaculture. From OpenASFA, records are shared with different information products, including a search interface on the FAO website, (where records are available as JSON-LD), and the full ASFA database which is hosted by ProQuest and available to subscribers only. Since its launch in 2021, OpenASFA has made further updates including the coverage of datasets and the option to deposit the full text. Although registration is required to deposit records and full text, there is no financial cost to using OpenASFA and all records can be freely searched, without registration, on the FAO Fisheries and Aquaculture website.

[*] First published in the GL25 Conference Proceedings, February 2024

Having undergone rapid technological advances, ASFA sought to understand the impact of OpenASFA by conducting a project to meet a specific information need. Following discussions with the Southeast Asia Fisheries Development Center (SEAFDEC) Secretariat, a project was formulated to identify and analyse research and data related to Sustainable Development Goal indicator 14.4.1 – the proportion of fish stocks within biologically sustainable levels. The SEAFDEC is an autonomous inter-governmental body in the regional fishery field with a long history of working closely with the fishery sections of its member countries. As the SEAFDEC works to promote sustainable fisheries in the region through the meetings, training courses, workshops, etc., SEAFDEC was the best supporting organization for ASFA to work with in establishing the connection between FAO and member countries of the region to collect all the research and data, particularly grey literature which requires local knowledge to locate and catalogue.

For a region such as Southeast Asia, reliant on fish and seafood as the primary source of animal protein (FAO and OECD, 2017), adapting to the challenges of climate change is essential in achieving and maintaining food security. In order to sustainably manage fisheries and implement science-based advice, research and data on the status of stocks is needed. However, many stocks in the region have an unknown status due to insufficient data (Sharma, 2021). The project would therefore assess whether research and data on stocks in the region existed; how such research and data is managed; and what role, if any, a service such as ASFA could play in improving the visibility of these resources. Therefore, the project had two goals:

(1) identifying and analysing the research and data being produced in Southeast Asia of relevance to SDG 14.4.1;

(2) identifying strengths and gaps in knowledge, as well as making recommendations for enhancing the availability of research and data.

Methodology

The project was split into three stages, each of which are discussed in detail below.

1. Development of project scope and search strategies
2. Identifying and recording research and datasets held in local and national collections
3. Quality control and analysis of results

Stage one: Development of project scope and search strategies

To ensure the focus of the project on SDG indicator 14.4.1, a detailed search strategy was developed that encompassed the geographic, taxonomic and subject keywords that would be used to identify and index relevant resources. Developing the search strategy resulted in a number of additions to the ASFA thesaurus under the theme of stock assessment. Furthermore, a list of 53 taxonomic terms of commercial interest was compiled that participants would be asked to prioritise seeking research and data for. The full search strategy and list of taxonomic terms of commercial interest is contained in the project report: *Identifying research and data related to Sustainable Development Goal (SDG) Indicator 14.4.1. Case studies from Cambodia, Indonesia, the Philippines and Viet Nam.*

Once developed, the search strategy was tested on the ASFA database, hosted on the ProQuest platform, which resulted in just 350 relevant results being identified. These 350 results were shared with participants to give an idea of the kind of resources that were within the scope of the project.

Stage two: Identifying and recording research and datasets held in local and national collections

This stage involved working with fifteen participants, listed in table 1, who were recruited from Cambodia, Indonesia, Philippines or Viet Nam, each with experience in information management or stock assessments. The participants were provided with training on the search methodology and how to identify relevant resources, as well as how to record results on OpenASFA. Participants spent a total of 10 days for training and recording their results, with a total of 1,047 records being created in total.

Name	Institution	Country
Suy Serywath	Marine Fisheries Research and Development Institute (MaFReDI)	Cambodia
Tan Sokhom	Faculty of Fisheries, Royal University of Agriculture (RUA)	Cambodia
Madiareni Sulaiman	BRIN - National Research and Innovation Agency	Indonesia
Ria Ariani	BRIN - National Research and Innovation Agency	Indonesia
Pamela Damayanti	Ministry of Marine Affairs and Fisheries	Indonesia
Duranta Kembaren	Research Institute of Marine Fisheries	Indonesia
Tirtadanu	Research Institute of Marine Fisheries	Indonesia
Ledhyane Ika Harlyan	University of Brawijawa	Indonesia
Martin F Floro	Capiz State University	Philippines
Ethelyn Magdaong Abaday	Mindanao State University – Naawan Campus	Philippines
Joy Geromiano	SEAFDEC/AQD	Philippines
Mary Grace Oliveros	SEAFDEC/AQD	Philippines
Sean Hoang	Fisheries Protection and Development Department Viet Nam Directorate of Fisheries	Viet Nam
To Van Phuong	Nha Trang University	Viet Nam
Hai Yen	Viet Nam Institute of Oceanography	Viet Nam

Table 1 List of participants in FAO-SEAFDEC project

Stage three: Quality control and analysis of results

All records submitted by participants were verified by the project team to ensure they were relevant to SDG 14.4.1 and correctly catalogued. Any duplicates were also removed at this stage. Following this review, a total of 1397 relevant records was identified, whose metadata was exported to Excel to conduct analyses.

A broad analysis of records created by participants and those available on the ASFA database was conducted, followed by a more specific analysis of the taxonomic keywords assigned to records. The analysis is presented in full in the recently published report (Superio et al, 2023), however a summary is presented below.

Of the total 1,397 records identified as part of this project, just under 75 percent came from participants with the rest coming from the ASFA database hosted by ProQuest. This indicates that many resources are missing from ASFA's database and further efforts should be taken to increase the volume of research being recorded on ASFA's database.

Just over half of the records were journal articles (702 references or 50.3 percent). Many journals were published by universities or research institutions in the countries and therefore not always easily findable online (see table 2). Dataset was the least recorded type with just under 10 percent (139 references). Datasets were recorded only by participants and not covered on the ASFA database on ProQuest. Despite the project's focus on the importance of data, many participants struggled to identify and record datasets.

Type	Frequency	Percentage
Journal articles	702	50.3
Books	447	32
Book chapters	109	7.8
Datasets	139	9.9
Total	**1397**	**100**

Table 2 Distribution of the Gathered Publications and Datasets per Type

Each of the references was assigned one of the subcategories described in table three. Stock information and stock assessment ranked as the most recorded subcategories, indicating high compliance with the search strategy.

Subcategory	Frequency	Percentage
Fishing vessels	31	2.2
Environmental impacts	33	2.4
Catch history	73	5.2
Biological parameters	227	16.2
Fishing gear	252	18
Stock assessment	369	26.4
Stock information	412	29.5
Total	**1397**	**100**

Table 3 Distribution of the Gathered Publications and Datasets per Subcategory

All references were assessed as to their online availability. A reference was considered to be available online if the full text was accessible online without subscription or cost. This revealed that 71.6 percent of references were available online, with 873 of these references being recorded by participants and 127 coming from ProQuest. Of the 174 references recorded by participants that were unavailable online, the reason was often due to lack of repository to store the resource, rather than protection due to commercial reasons. Participants requested the option to store the full text of the resource on OpenASFA, which was implemented at the end of the project.

Source	Frequency	Percentage
Available online	1000	71.6
Unavailable online	397	28.4
Total	**1397**	**100**

Table 4 Distribution of the Gathered Publications and Datasets per availability

Source	Format	
	Available online	**Unavailable online**
Participants	873 (87.3%)	174 (43.8%)
ProQuest	127 (12.7%)	223 (56.2%)
Total	**1000 (100%)**	**397 (100%)**

Table 5 Distribution of the Gathered Publications and Datasets Grouped according to Source and Format of Publication

An analysis of the taxonomic keywords was undertaken to understand the volume of research and data that could contribute to understanding the status of stocks in the region, particularly for species of commercial interest. The dataset used to perform the taxonomic analysis can be downloaded from here: https://data.d4science.net/CW4s.

The 1397 records identified during this project had a combined total of 6720 taxonomic keywords, giving an average of 4.8 taxonomic keywords per record. Of the 6720 taxonomic keywords, 1556 were for unique names. These high numbers are testament to the care participants took to create detailed metadata to describe the resources.

Despite the high level of taxonomic indexing, analysis revealed a concentration on a small number of species with the top ten most recorded taxonomic terms aggregating 63 percent of all references, which increased slightly to 64 percent of references when looking only at the subcategory stock assessment. Whilst only one species of commercial interest was not assigned as a keyword to any references, when looking only at the subcategory stock assessment, 11 species were not recorded, indicating research efforts are concentrated on a small number of taxa.

Discussion and conclusion

This project provided a snapshot of the research and data available under the scope of SDG indicator 14.4.1 in Southeast Asia. Each participant indicated further resources were available however were unable to record them in the 10 days allotted to this project. The relatively high proportion of materials, just under 30 percent, which were not available online; the number of resources not recorded due to time constraints; and the diverse platforms which resources are stored on, indicates the need for maintaining the OpenASFA collection on SDG indicator 14.4.1.

A common barrier to sharing research is the lack of planning and resources to ensure their long-term accessibility. Many reports are published only on a website, available for a short period of time before they disappear or become lost. OpenASFA therefore presents a single and stable platform on which to share research and data. However, whilst creating a record for a resource on OpenASFA is a short task and there is no financial cost to usage, an institution must support the work and ensure sufficient time and resources are allocated to performing this task. A shift in attitudes towards information management is needed to persuade institutions to give the necessary time and resources to making their research and data findable, accessible, interoperable and reusable (FAIR) in the long term. This is required in particular for data, with project participants expressing difficulty in gaining permission to share even the metadata for a dataset due to concerns over ownership.

Describing the benefits of FAIR research and data is critical to achieving this shift and ASFA shall work with its partners to produce materials to highlight the individual and institutional benefits of OpenASFA in promoting and sharing research and data. Whilst libraries have transitioned to digital for many years, the appearance of full text online is in danger of being perceived as a substitute for the traditional library skills of cataloguing and classification, which are vital in ensuring a resource is findable. Making the case for investment in the cataloguing and indexing of a resource as a necessary component of document management needs to take place.

Recommendations for future work and conclusion

To ensure the work of the project is not lost, ASFA formulated four recommendations for future work based on lessons learned:

1. Understand and overcome barriers to sharing data: further work is needed to give institutions the confidence, incentives and technologies to share data. The project recommended compiling best practices for data sharing related specifically to fisheries data.
2. Ensure online accessibility of materials: in addition to digitizing print only materials, producers of grey literature require an information management plan to ensure their publications and data are stored on a sustainable repository and accessible online.
3. Improve the visibility of Doctoral / Master Theses: the project uncovered a high volume of dissertations/ these that are relevant to performing stock assessments. Particular attention is needed to ensure resources are FAIR due to potential language barriers and difficulty of searching and accessing individual university repositories.
4. Maintain and update the OpenASFA collection: ten days was an insufficient time period to record all relevant resources and, in order for the collection to remain useful, regular deposits and records are needed. Ongoing, voluntary contributions from project participants and ASFA partners in the region are needed to ensure the collection remains of use to understanding the status of stocks in the region.

In summary, the project met its goals of identifying and analysing the research and data being produced in Southeast Asia of relevance to SDG 14.4.1 and identifying the strengths and gaps in knowledge, as well as making recommendations for enhancing the availability of research and data. The 1047 records created by participants, compared to the 350 records identified on the ASFA database, reveals the breadth of resources that are not being captured on the ASFA database without projects such as these, and the 28 percent of materials that are not available online, indicates the risk of this research and data being lost. ASFA looks forward to building on the lessons learned as part of this project and working with the authors, producers and publishers of research and data to ensure it is findable and accessible online.

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Charcoal Burning in Zambia: User Narratives for Successful and Equitable Information Services [*]

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Abstract

The International Nuclear Information System (INIS) is a repository managed by the International Atomic Energy Agenfcy that provides bibliographic information and full-text documents related to nuclear science and technology. This repository is an open platform that receives contributions of grey literature from its member states and is accessible to the public through the INIS Repository Search website.

Site administrators use Google Search Console to track the queries that led users to specific documents or bibliographic references within the repository. Administrators have observed that certain queries recur dozens to hundreds of times in a matter of a few days, then disappear. The queries use an identical phrase or slight variations and come from a single country. Examples include, "How is Carbon 13 used in medicine?", or "What are methods for detecting heavy metals in water", or "What is the environmental effect of charcoal burning in Zambia."

Through the data gathered from these queries, it is possible to construct user narratives to determine if the repository is meeting the needs of its various audiences. A user narrative is an extended description of the user, their circumstances, and their wants, which is distinct from a user story – a more formal and short description of a user's needs used in system design.

As an example, consider the query related to charcoal burning in Zambia. Based on the frequent queries related to this topic, it can be inferred that the user is likely a student researching a school assignment. Additionally, it is possible that the user is accessing the repository from a mobile device or school computer and is seeking authoritative and user-friendly information that answers their specific question. By accessing the repository as the described user, we can understand their experience and identify areas where the repository could be improved.

In a repository, success can be defined as meeting the user's needs and providing information in a user-friendly manner. By conducting this exercise for underrepresented or non-represented groups and addressing the problems identified, the repository can increase its success, equity, and opportunity. Overall, constructing user narratives based on actual queries can provide valuable insights into how to improve information services and make them more equitable and accessible.

Keywords: *Repositories; Grey Literature Resources; System Design; User Narratives*

Background

The International Nuclear Information System (INIS) has existed since 1970. It provides grey literature and bibliographic records to the public through the INIS Collection Search website. Approximately 435,000 PDFs are available to the public, and in 2023 there were over 15 million downloads through this open platform. In all, 4.7 million knowledge products (both full text and bibliographic-only) are available. The content is either provided to INIS by member states or is harvested from online publishers.

For bibliographic records, approximately 84% of sessions are the result of a Google search, including on Google Scholar. A user has searched for a topic by typing in a keyword or series of keywords. A record in INIS has appeared as a result, and the user has clicked on the result, sending them to an HTML page or PDF in INIS.

Google Search Console provides website administrators with reports on queries that led to a particular page on the subject website. Using this, administrators can monitor trends, and derive cumulative statistics on site usage. Another commonly used tool is Google Analytics. However, direct PDF downloads are not easily tracked, so the Search Console is used.

[*] First published in the GL25 Conference Proceedings, February 2024

In Search Console, administrators noticed that there were sometimes identical long textual queries, all happening within a day or two, and all from the same country. Table 1 lists some of the queries, the countries where users accessed the site, and the page linked by Google. The Table also lists, only for general interest, the contributing country of each item.

Query	User Country	Linked Page	Contributing Country
What is the history of nuclear power in Asia	India	Nuclear Power in Asia: Experience and Plans	Rep. of Korea
How can we provide dry season feeding of ruminants in Africa	Nigeria	Some Tools to Combat Dry Season Nutritional Stress in Ruminants Under African Conditions	United Kingdom
How is Carbon 13 used in medicine	United Kingdom	C 13 Application in Medical Diagnostics	Uzbekistan
What are methods for detecting heavy metals in water	Nigeria, India	A Laboratory Manual for The Determination of Metals in Water and Wastewater By Atomic Absorption Spectrophotometry	South Africa
How long does it take to build a nuclear power plant	United States	Construction time of PWRs	Brazil
What is the environmental effect of charcoal burning on the environment in Zambia	Zambia	Environmental Impact Assessment of The Charcoal Production and Utilization System in Central Zambia	Sweden

Table 1: Selected Queries and Resulting Pages

Taking one or all the examples, we can construct “user narratives” to see what the user experience is like in interacting with the system. More importantly, we can determine if the system is meeting the needs of the user, or if the system needs to be improved.

User Narratives

User narratives are a way to visualize or imagine the experience of a user going through their usage of a product or website. Developers and administrators have natural biases and their own preferred ways of using information technology products. The result is that a product most closely matches and meets the needs of the developer, and not necessarily other audiences of users. User narratives are a way to break out of the developers own experiences through an empathetic journey of a disparate group’s usage of the product.

As Kelly Payne (2016) writes, “A user narrative describes a particular person’s (i.e. persona’s) fictionalized journey through the use of your intended product. Aptly named, it reads more like a short story. Most user narratives are between 500 and 1,500 words."

Jack Dorsey (2011), the founder of Twitter, is also a great advocate of user narratives writing, “If you do that story well, then all of the prioritization, all of the product, all of the design, and all of the coordination that you need to do with these products just falls out naturally.”

Charcoal Burning in Zambia

Taking the last query as an example, a user narrative can then be built to assess whether the repository is meeting the needs of the user. First, it could be supposed that the identical wording, timing, and length of the phrase, indicates that the searches were done as part of a school assignment. All queries came from Zambia, so we can begin to construct the user narrative as below:

I am a 14-year-old student in Zambia. I was given an assignment at school, to write a one-page paper on "the effects of charcoal burning on the environment in Zambia." I used my…

At this point, some research may be required. Did the student use a mobile phone or a computer? Looking at International Telecommunications Union statistics on mobile phone uptake in Zambia, it shows that there are over 100 mobile subscriptions per 100 people.

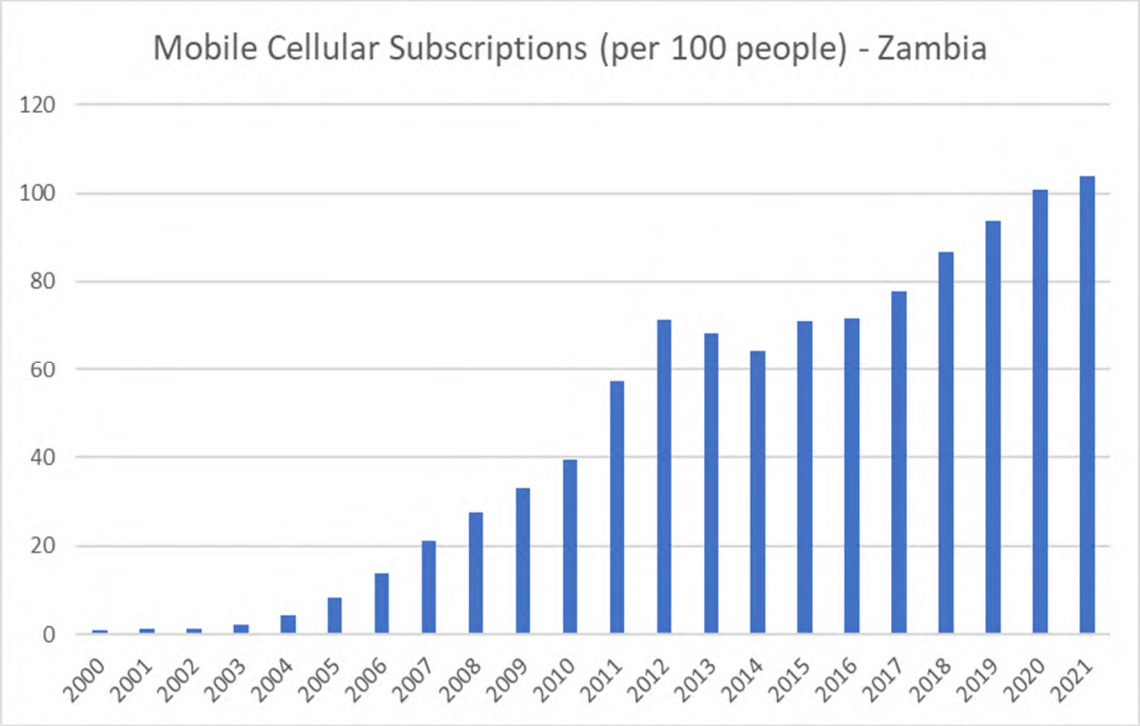

Figure 1: International Telecommunications Union, CC BY-4.0 https://creativecommons.org/licenses/by/4.0 , via World Bank

It can be supposed, therefore, that the student was likely to use a mobile phone, or perhaps a school computer, to do the research. The narrative is now:

I am a 14-year-old student in Zambia. I was given an assignment at school, to write a one-page paper on "the effects of charcoal burning on the environment in Zambia." I used my mobile phone to search for that phrase in Google. I clicked on one of the links and it took me to a PDF on the INIS Repository.

Trying the Narrative

With the user narrative created, site administrators can put themselves in the place of a user and experience the repository as they would. Using a mobile browser, an identical search can be performed, "the effects of charcoal burning on the environment in Zambia". The search produces the result in figure 2.

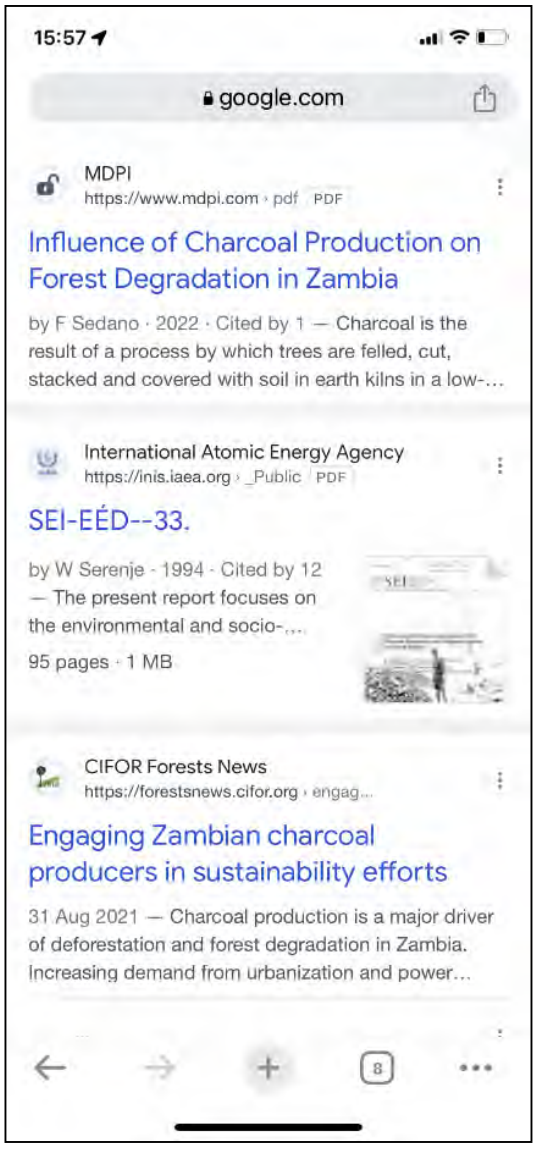

Figure 2: Result of the Google Search

Figure 3: PDF viewed on a mobile phone

The result in Google is unsatisfactory from the user perspective. First, the PDF from INIS (the second result) has an odd title, "SEI-EED—33". This comes from the PDF metadata and represents the report number. It is not descriptive for the user.

Clicking on the link provided, the user is presented with a PDF of 95 pages. The document, which is a detailed study of the practice of charcoal burning and its environmental impacts, does not give a straightforward answer to the question posed. The student doing research would have to sift through the document, scanning for an answer. For this audience, the PDF provided is also unsatisfactory. For such a user, it would be preferable to be able to pose a question, and receive a citable, authoritative, yet concise answer.

Potential Improvements

Having looked at the user experience and determined that the current configuration does not meet the needs of the audience, solutions can be proposed. One quick improvement would be to edit PDF metadata to match the title given for each record. This would eventually improve the entries on the Google search.

One possibility for improving the overall user experience would be to provide a wiki with pages on various topics. The pages could be developed and edited by experts. This could serve for a limited number of topics. However, for the example topic – that of charcoal burning in Zambia – it is very specific and on the edge of topicality for the organization. It is unlikely that a wiki could meet all such needs.

One possible solution would be the use of Large Language Models (LLMs) such as ChatGPT. Such models are conversational in nature and can provide condensed and direct answers to questions. However, as Irons et. al. (2023) write, "the well-known limitations of LLMs, particularly their ability to 'hallucinate' (create factually incorrect information), may make them ill-suited for science work." Among other problems, such as biases caused by materials used in training, LLMs fabricate references and facts so that their products cannot be trusted or cited. It is to be hoped that this problem will be addressed in coming years.

Conclusion

User narratives can be helpful in designing grey literature repositories, so that other user perspectives are considered. In the selected case, the repository does not currently meet the needs of the audience. Some small improvements can be made. However, there is not currently a satisfactory technical solution. It is hoped that future enhancements to artificial intelligence will make further improvement possible.

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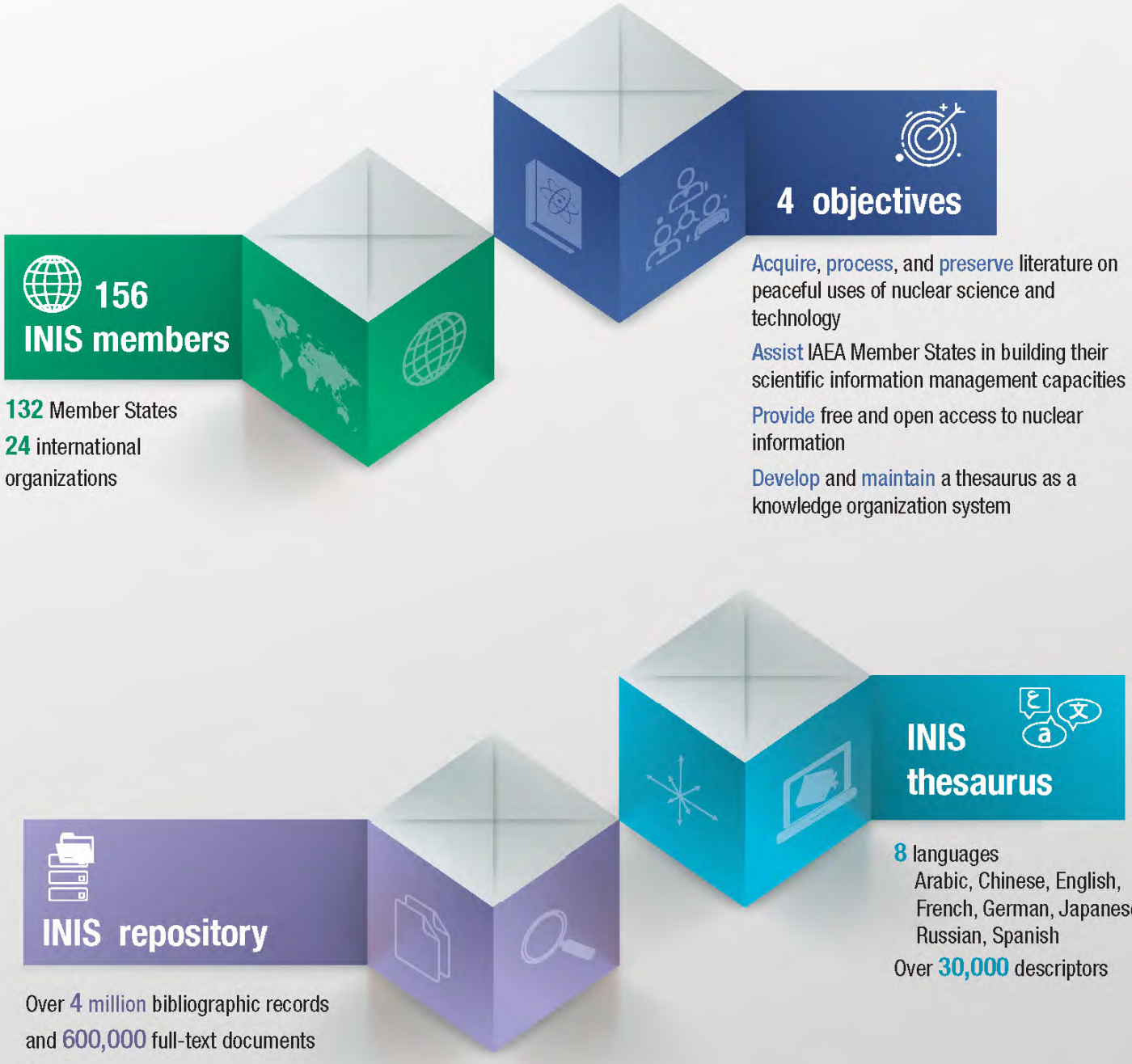
International Telecommunications Union (2023), ITU Datahub, Zambia Mobile-cellular Subscriptions https://datahub.itu.int/data/?e=ZMB&i=178&u=per+100+people

Irons, J., Mason, C., Cooper, P., Sidra, S., Reeson, A., & Paris, C. (2023, July 13). Exploring the Impacts of ChatGPT on Future Scientific Work. https://doi.org/10.31235/osf.io/j2u9x

International Nuclear Information System – INIS

Organizing the world's nuclear information and making it universally accessible



156 INIS members

132 Member States

24 international organizations

4 objectives

Acquire, **process**, and **preserve** literature on peaceful uses of nuclear science and technology

Assist IAEA Member States in building their scientific information management capacities

Provide free and open access to nuclear information

Develop and **maintain** a thesaurus as a knowledge organization system

INIS thesaurus

8 languages
Arabic, Chinese, English, French, German, Japanese, Russian, Spanish

Over **30,000** descriptors

INIS repository

Over **4 million** bibliographic records and **600,000** full-text documents

3 million web page views

2 million unique searches

1 million unique visitors

IAEA | International Nuclear Information System INIS

www.iaea.org/inis

February 2019
19-00898

Grey literature on climate change studies at the International Nuclear Information System *

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Abstract

Established in 1970 by the International Atomic Energy Agency (IAEA), the International Nuclear Information System (INIS) has since served as a major subject repository in all areas related to nuclear science and technology. Despite its name, INIS has also made significant efforts in harvesting, categorizing, and publishing records on subjects of broader interests like energy in general or climate change studies. As a result, more than 4.5 million bibliographic records are now stored and made publicly online by INIS with topics ranging from like general studies of nuclear reactors, instrumentation related to nuclear science and technology, to energy planning, policy, and economy, or environmental science. This paper will present an analysis on the grey literature on climate change-related subjects that have been harvested by INIS, as well as the interest of INIS users on these subjects. For example, 50% of records in the INIS repository mentioning climate change in their abstracts can be considered grey literature, or according to the categorizing system of INIS (the INIS Thesaurus), the repository has 1656 reports on "climate change", 685 on "greenhouse effect", and 24 on the Paris Agreement. On the other hand, INIS users have showed their increasing interest in climate change-related subjects via the more prominent appearance of search terms like "climate change" or "climate change and nuclear power". The analysis results show that INIS has become a useful bibliography bridge for users to connect their interest in topics directly related to nuclear energy, and in studies on climate change. As INIS currently receives about 150,000 unique searches every month with users coming from all over the world, especially from developing countries with lesser access to credible studies on climate change or other energy-related topics, INIS can play an important role in bringing grey literature on climate change closer to the public, and thus support in raising better public awareness on this timely and important topic.

Introduction of INIS

In 1957, the International Atomic Energy Agency (IAEA) was established to "accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world"[1]. To carry out this objectives, seven functions of the IAEA have been outlined by its Statute, of which the third and fourth directly focus on the exchange of scientific and technical information on the peaceful use of nuclear energy. These functions of the IAEA are further emphasized in Article VIII of the Statute on exchange of information, namely the Agency "shall take positive steps to encourage the exchange among its members of information relating to the nature and peaceful uses of atomic energy and shall serve as an intermediary among its members for this purpose". Accordingly, the creation of the International Nuclear Information System (INIS) under the auspice of the IAEA was authorized by its Board of Governors in February 1969, which had its first product – the monthly bulletin "INIS Atomindex" Vol. 1, No. 1 in May 1970.[2] After decades of exclusivity of usage among INIS Member States, the database of INIS was opened to public on a free, open, and web-based access via its Repository[3] in April 2009 and it has been since become one of the largest custodians on the Internet of conventional and non-conventional literature published in the nuclear field.

As of 2023, the INIS Repository hosts more than 4.5 million bibliographic records, about 2 million of which are full-text records with 600,000 full-text PDFs stored by the Repository itself. This significant reserve of nuclear-related literature has been expanded years with more than

* First published in the GL25 Conference Proceedings, February 2024

[1] IAEA, The Statute of the IAEA, url: https://www.iaea.org/about/statute

[2] C. Todeschini, "The International Nuclear Information System (INIS): The First Forty Years 1970-2010", International Atomic Energy Agency, October 2010.

[3] INIS Repository, url: https://inis.iaea.org/search/

100,000 new records thanks to the collaborative effort between INIS, its 132 Member States, and 17 organizations, which pool decentralized inputs from scientific publishers, national and international institutions, or relevant entities into one centralized storage that is the INIS Repository for further processing and public dissemination. The number of inputs to the INIS Repository is provided in Figure 1.

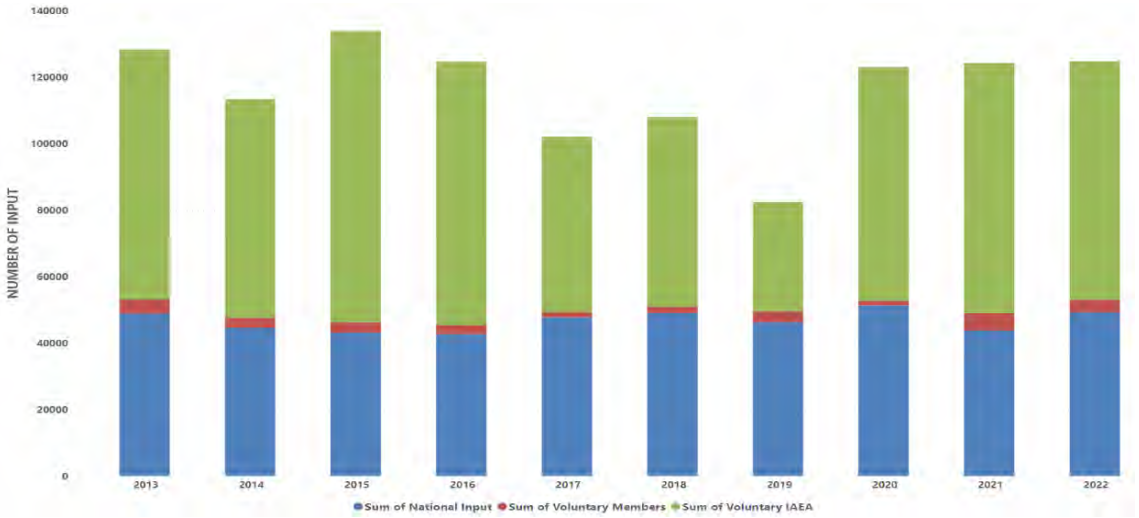


Figure 1. Number of inputs to the INIS Repository, 2013 – 2022.

Climate change, scientific publication, and grey literature

In recent decades, climate change has gradually become one of the most important issues with global impact that receives significant attention not only from the scientific community but also policy makers and the public, especially since the more and more negative effects of climate change could be observed in every country, especially ones with long coastlines and/or close to the Equator. For example, all the countries most affected by extreme weather events in the period between 2000 and 2019 as identified by the Global Climate Risk Index are ones with large maritime interfaces and mostly of developing economic status, namely Puerto Rico, Myanmar, Haiti, the Philippines, Mozambique, the Bahamas, Bangladesh, Pakistan, Thailand, and Vietnam.[4]

Recently, the link between scientific findings and policy making, especially with regards to emerging issues that require a high level of science and technology inputs like climate change, has been emphasized by policy makers, media outlets, and the public in general.[5] Thus, one might assume that there would be a causal relation between a country's level of exposure to climate change and its interest in climate change studies and consequently its scientific output in climate change research, namely climate change-related peer-reviewed papers or books. However, this is not the case as most publishing countries on climate change have also been the traditional powerhouses in scientific publication like the United States, United Kingdom, China, Australia, Germany, Canada, France, the Netherlands, Spain, and India, all of which are not among the most vulnerable countries affected by extreme weather.[6]

To explain such a significant discrepancy between the need and interest in climate change research and actual scientific output in this field, one should recognize the pressing nature of the climate change issue, which sometimes requires a more rapid and unconventional format of publication for timelier communication among the scientific community, policy makers, and the public via channels like social media or grey literature.[7] According to the Grey Literature

[4] D. Eckstein et al., Global Climate Risk Index 2021, Germanwatch e.V. 2021.

[5] P. Callow, "Storylistening's role in policy advice", Science vol. 379, iss. 6638, p. 1198 (2023); N. Light et al., "Knowledge overconfidence is associated with anti-consensus views on controversial scientific issues", Science Advances vol. 8, iss. 29 (2022).

[6] D. Klingelhöfer et al., "Climate change: Does international research fulfill global demands and necessities?", Environmental Sciences Europe vol. 32, 137 (2020).

[7] A. Lawrence, "Influence seekers: The production of grey literature for policy and practice", Information Services & Use, vol. 37, no. 4, pp. 389-403 (2017).

International Steering Committee, grey literature is "information produced on all levels of government, academics, business and industry in electronic and print formats not controlled by commercial publishing".[8] Thus, by investigating the production and usage of grey literature on climate change via records like government policies, dissertations and theses, conference proceedings, technical reports, or think tank materials, we could achieve a more accurate picture on the interest in climate change research from countries highly vulnerable to this global emergency.

Climate change grey literature in INIS Repository

Although INIS was established first and foremost as a channel for IAEA Member States to exchange scientific and technical information in the nuclear field, IAEA in general and INIS in particular have for a long time recognized the close linkage between such nuclear energy and climate change, as well the need for INIS to broaden its scope to climate-related subjects. For example, IAEA Director General Rafael Mariano Grossi in 2021 stated that "governments, industries and international organizations have important roles to play in supporting innovation and the early deployment of all clean energy technologies. This is particularly critical because almost half of the emissions reductions needed to reach net zero by 2050 will have to come from new low carbon technologies, including advanced nuclear reactors. Clearly nuclear must have a seat at the table anytime energy and climate policies are discussed".[9] Beyond its power application for electricity generation, other non-power applications of nuclear technologies have also been recognized for their important roles in sustainable development, from sustainable agriculture, water desalination, to fighting cancer and diseases, and biodiversity support.[10]

Thus, among the 49 one-level broad subject categories of the scope of INIS, many have direct or indirect links to climate change, including the most assigned subject areas and citation rate of peer-reviewed papers identified by the Web of Science platform, including environmental sciences and ecology, biodiversity and conservation, meteorology and atmospheric sciences, geology, physical geography, water resources, or agriculture[11]. These relevant subject categories are presented in Figure 2.[12]

Besides subject categories, the link between a record in the INIS Repository and climate change can also be identified by the descriptors assigned to this record by INIS, namely the technical terms from the controlled terminology of the INIS Thesaurus that were used to represent the information content of the aforementioned record.[13] As a result, more than 30,000 records in the INIS Repository are identified to be directly related to climate change, of which 45% are journal articles, 11% are books, 22% are reports, and the rest could be categorized as grey literature, including conference proceedings, thesis, numerical data, progress report, legislative material, preprint, software, multimedia, and audio-visual files. The addition of these records to the INIS Repository is presented in Figure 3.

[8] Grey Literature International Steering Committee (GLLISC), "Guidelines for the production of scientific and technical reports: how to write and distribute grey literature" (Nancy style), Version 1.0, March 2006, url: http://eprints.rclis.org/7469/2/index.html.

[9] IAEA, "Nuclear Energy for a Net Zero World", International Atomic Energy Agency, September 2021, url: https://www.iaea.org/sites/default/files/21/10/nuclear-energy-for-a-net-zero-world.pdf.

[10] UNECE, "Application of the United Nations Framework Classification for Resources and the United Nations Resource Management System: Use of Nuclear Fuel Resources for Sustainable Development - Entry Pathways", United Nations Economic Commission for Europe (UNECE), March 2021, url: https://unece.org/sustainable-energy/publications/nuclear-entry-pathways.

[11] Klingelhöfer et al., idem.

[12] IAEA, "Subject Categories and Scope Descriptions", INIS/ETDE Joint Reference Series No. 2 (Rev. 1), International Atomic Energy Agency, January 2021, url: https://inis.iaea.org/search/subject-categories/.

[13] IAEA, "INIS/ETDE Manual for Subject Analysis", INIS/ETDE Joint Reference Series No. IAEA-INIS/ETDE-03, International Atomic Energy Agency, August 2012, url: https://www.iaea.org/sites/default/files/manual-subject-analysis.pdf.

Figure 2. Subject categories within the INIS Scope and its relations to climate change-related subjects.

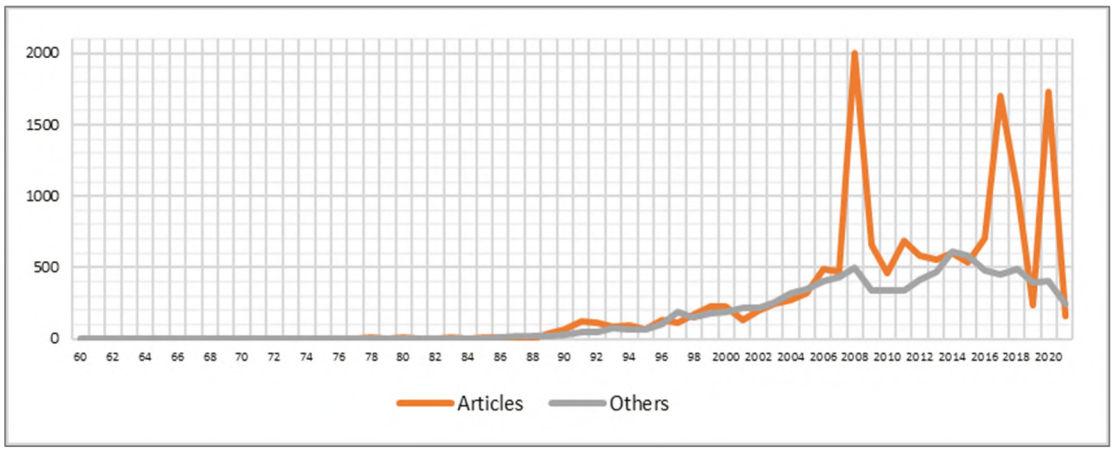


Figure 3. INIS Repository records directly related to climate change of the journal article "Articles" type, and of "Others" type, namely grey literature.

Since the main goals of grey literature are to provide evidence for policy making, to communicate with the public on policy and practice, and to translate scientific knowledge into more accessible information for the public,[14] it is also necessary to examine the link between the climate change grey literature hosted by INIS and subjects of great interests by the public. On this aspect, research done by Haunschild et al. in 2019 used instances of climate change papers being mentioned on the Twitter (now X) platform to identify the recurrent terms and themes related to climate change that attract public attention, including keywords like "climate", "climate change", "adaptation", "diversity", "sustaina-bility".[15] As presented in Figure 4, although records indexed with similar descriptors by INIS are still largely journal articles, grey literature also contributes to some extent, especially on major keywords/descriptors like "climate change", "greenhouse gases", "sustainability", or "greenhouse effect".

[14] Lawrence, idem.

[15] R. Haunschild et al., "Does the public discuss other topics on climate change than researchers? A comparison of explorative networks based on author keywords and hashtags", Journal of Informetrics, vol. 13, iss. 2, pp. 695-707 (2019).

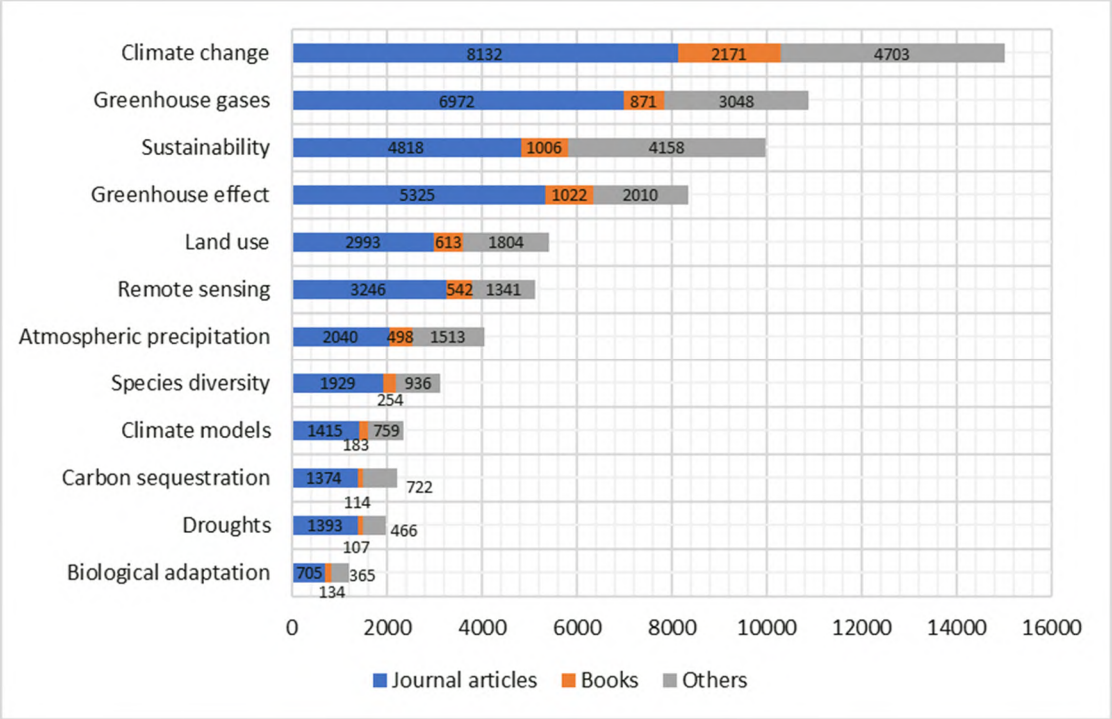


Figure 4. Climate change-related INIS Descriptors sorted by number of INIS Repository records.

Conclusions

The analysis in this paper showed that INIS has made significant effort to harvest climate change-related scientific knowledge to its Repository, including grey literature on this subject. Such effort has received positive response from public users, as two among INIS subject categories with most unique searches from 2020 to 2023 are directly related to climate change, namely Environmental Sciences (S54) and Energy Planning, Policy and Economy (S29). In addition, 25% among the top 50 INIS Repository records with most unique searches from 2020 to 2023 are climate change-related records, including not only journal articles but also grey literature pieces like conference papers or reports, on a variety of subjects like soil moisture, cow dung, waste management, burning spilled oil, or the comparison between nuclear energy and other types of clean energy.

Recently, the significant disadvantages for non-native English speakers to conduct and publish in environmental sciences were highlighted in a study done by Amano et al.[16] This might be one of root causes for the interest-publication output discrepancy mentioned earlier in this paper. Therefore, despite its initial success in gaining public interest in climate change via grey literature, INIS should harvest more and in a timelier manner grey literature in languages other than English, and from lesser-exposed institutions and sources, particularly from countries heavily affected by climate change. Such approach will provide INIS with a chance to further communicate and highlight with the importance and urgency of climate change, of the linkage between nuclear energy and sustainable development, and of the role grey literature can play in scientific information exchange and climate change mitigation.

[16] T. Amano et al., "The manifold costs of being a non-native English speaker in science", PLoS Biol, vol. 21, iss. 7, e3002184.

Drops in a bucket: contributions of the IAEA Lise Meitner Library to the INIS database*

Nicolas Rucks, Nuclear Information Section; Division of Planning, Information and Knowledge Management Department of Nuclear Energy; IAEA Lise Meitner Library, Austria

Abstract

No library can have it all. It is the job of the Inter Library Loan/Document Delivery Service to get elsewhere what is not in a Library's collection. That is also the case in the IAEA Lise Meitner Library (ILML). Most of the topics the ILML deals with are nuclear related (albeit not only), and so are the "known" or specific items requested to the ILL/DD Service.

The ILML is therefore a heavy user of the INIS database, among other nuclear related databases. Many relevant documents are to be found there. In any case, it is a source that must be checked. Then again, it also happens that a given item is not in INIS. Realizing that, the ILML ILL/DD service took the initiative to report those "missing drops" to the INIS proverbial bucket. (ILML and INIS are two different units within IAEA's Nuclear Information Section).

One may wonder if a drop in a bucket is worth it. It is in this case because INIS, as other topical databases/repositories, aims for the wider possible coverage within its topical scope. Since 1972, records in INIS come from member states contributions, IAEA contributions, and yet, some documents escape the coverage, something learned by the experience of looking for requested materials like old conference papers, unpublished thesis, reports from nuclear agencies and institutions, etc.

As a relatively cheap by-product of the search of an item, every month or so, a report in RIS format with items found elsewhere than INIS is sent to INIS, including basic bibliographic information, report ID, searches performed in INIS (not finding it), and location of the material: URL of a site, library catalogue, publisher, or agency. Occasionally, a reported item may lead to the inclusion of many others, a conference paper to the proceedings, a chapter to a book, a paper to a journal, etc.

The reporting is easily replicable: any other library that stumbles upon an item not covered by INIS is welcome to inform about it.

These are items that escaped prior systematic coverage, added to INIS because some user needed it, and ILL/DD located it elsewhere. Reporting to INIS is a way of compensating the relatively high cost of looking for a specific item, hopefully avoiding others looking for it again, but finding it in INIS.

The IAEA Lise Meitner Library

The IAEA Lise Meitner Library is the IAEA (International Atomic Energy Agency) library. It has recently been named after Lise Meitner, the Austrian/Swedish physicist.

The library orients its services mainly to IAEA Staff, and therefore covers mainly Nuclear Science and Technology but also many other topical areas, such as Management, Diplomacy, Computer Science.

It can be said that it has an important collection on Nuclear related topics, including both non-grey and grey literature.

The Inter Library Loan/Document Delivery (ILL/DD) Service

Then again, regardless of its size and scope, no library can have it all; therefore, it is the job of the Inter Library Loan/Document Delivery (ILL/DD) Service to search/locate/obtain elsewhere the items requested by its users that are not in a Library's collection. That is also the case in the IAEA Lise Meitner Library (ILML). Most of the topics the ILML deals with are nuclear related (albeit not only), and so are the "known" or rather specific items requested to the ILL/DD Service.

* First published in the GL25 Conference Proceedings, February 2024

Many of the documents requested come in some shade of grey: conference papers, thesis, reports. Others are more commercially available, like books and parts of books, as well as journal papers. It is probably interesting to note that the time-span of the publications requested is very wide and can go as far back as the 40s and 50s…

In order to provide the document to the user, the library's own collection is naturally checked first, as sometimes the items requested are, after all, already in the collection; otherwise, other resources are used, like catalogues of other libraries and different kinds of databases, depending on the item requested, and its subject.

The INIS database

In the nuclear field, the INIS database is unavoidable, close to mandatory. Let us just highlight here that INIS is a repository that constitutes the world's largest collections of published information on the peaceful uses of nuclear science and technology, with over 4 million records[1], which may include the full-text, and brings useful referential information.

Within that context, for nuclear related topics, the ILML is a natural heavy user of the INIS database, among other nuclear related databases. Many relevant documents are to be found there. In any case, it is a source that must be checked. Then again, it also happens that a given item is not in INIS. Realizing that, the ILML ILL/DD service took the initiative to report those "missing drops" to the INIS proverbial bucket. (ILML and INIS are two different units within IAEA's Nuclear Information Section).

The Reports

After one year of working at the ILML, that is, starting November 2019, it has been realised that some of the items requested were actually not included in INIS (whether full-text or referential), but found elsewhere.

It was asked to Brian Bales, Head of INIS, if some kind of report of those cases would be of interest and/or useful.

Note that the IAEA Library and the INIS database are two separate things, but both are under the same organizational Head of Section, hence closely related.

The first report was sent to INIS October 2020, with a rather loose textual format, and a kind of alert to INIS established as a by-product of actual requests for specific materials.

Examples

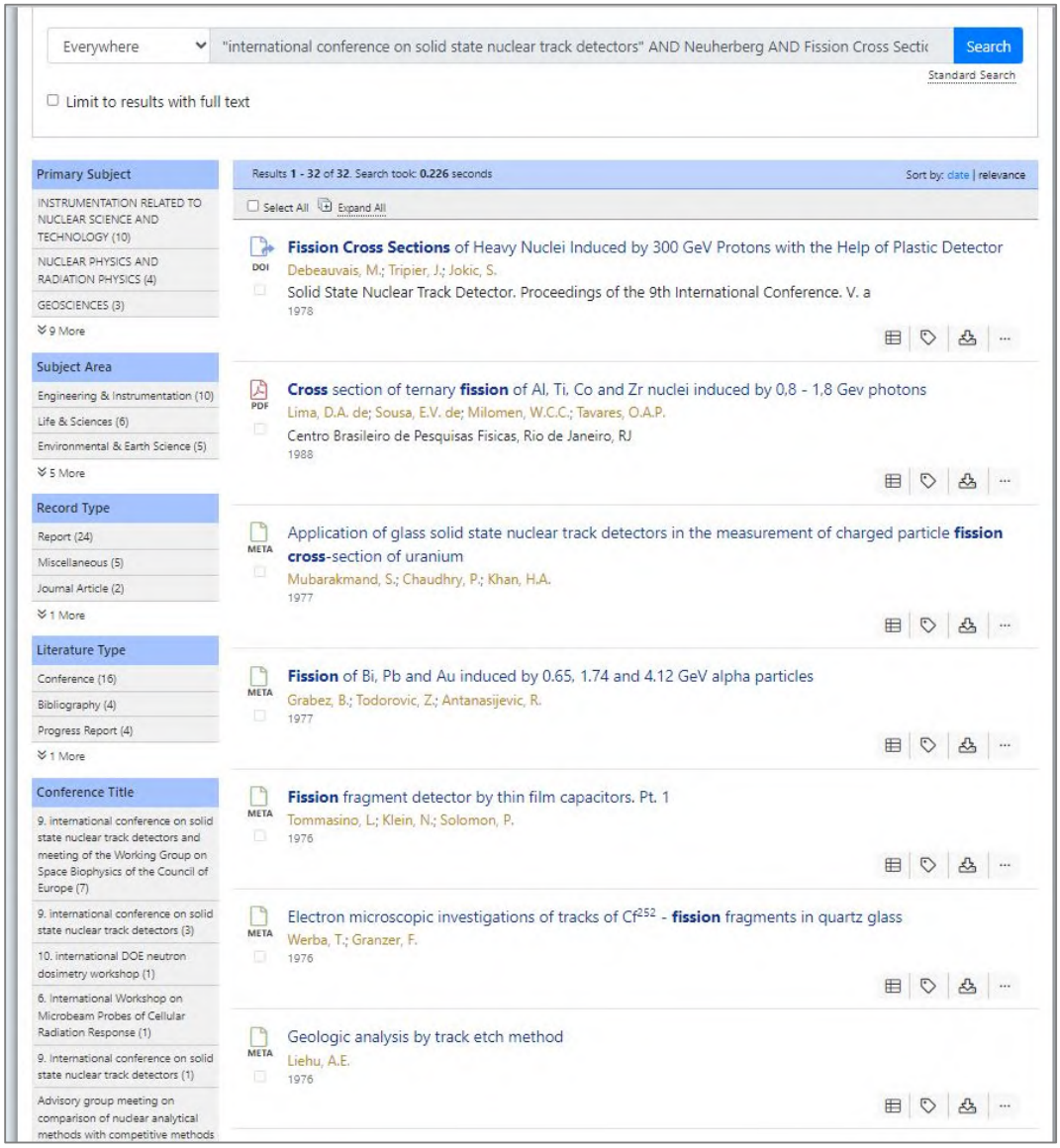
The following are **some examples** of items requested by users to the ILML, that were not found in the INIS database, but located in the IAEA Library or elsewhere, afterwards reported to INIS, and finally added to the INIS database (that is, the bibliographic reference, and a link to the source). All of them falling within the scope of INIS, peaceful uses of nuclear science and technology.

Occasionally, a reported item may also lead to the inclusion of many others, a conference paper to the proceedings, a chapter to a book, a paper to a journal, etc.

Example A

Debeauvais, M., Tripier, J., & Jokic, S. Schopper, E. (Ed.). (1978). Fission Cross Sections of Heavy Nuclei Induced by 300 GeV Protons with the Help of Plastic Detector. United Kingdom: PERGAMON PRESS.

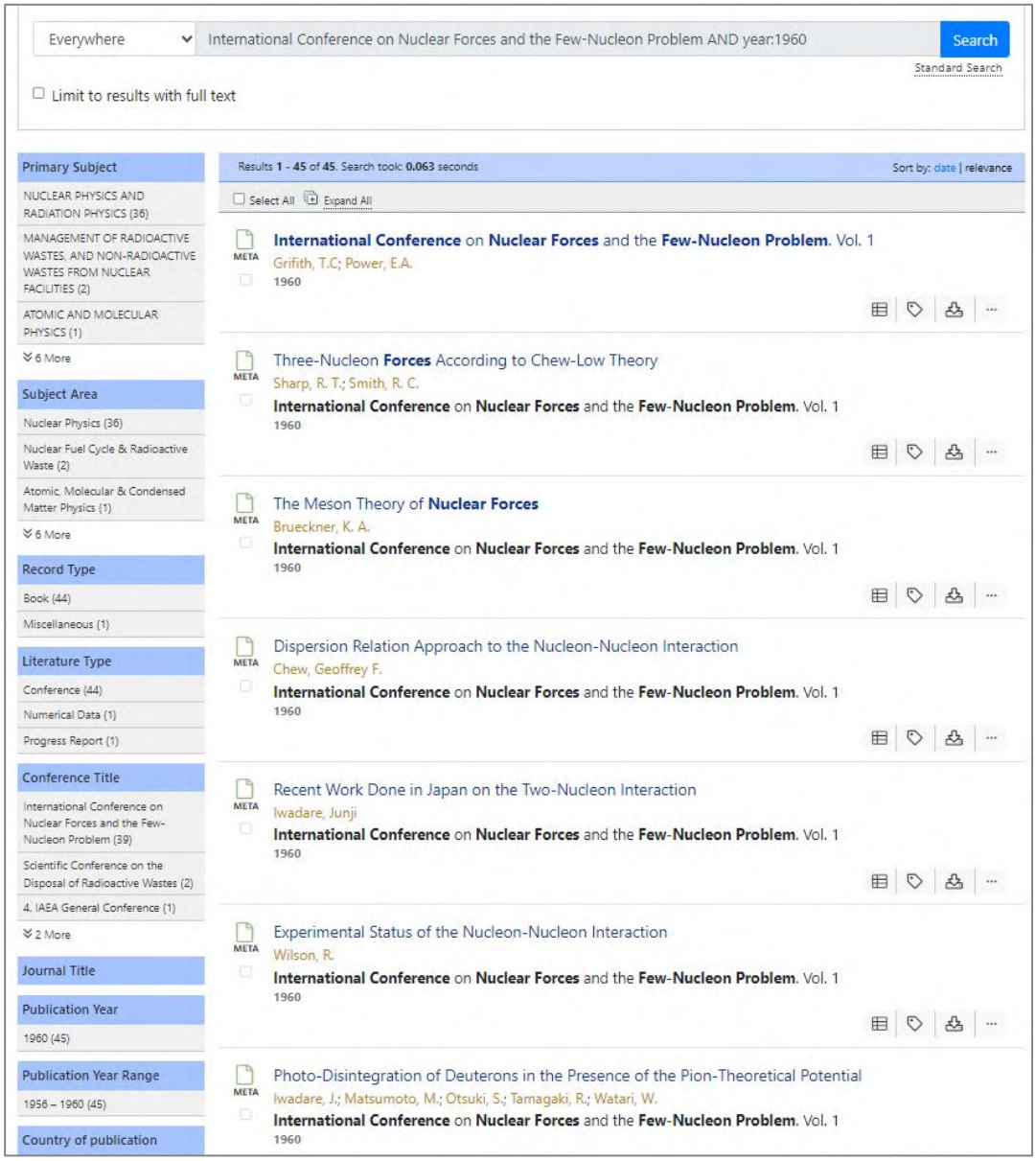
This is a paper from a 1978 conference; fortunately, the proceedings were in the library. Actually, the conference was partially covered by INIS, but this particular paper was not.
https://inis.iaea.org/search/search.aspx?orig_q=RN:53113349



Example B

Bowen, P.H., Cox, G.C., Huxtable, G., Langsford, A., Scanlon, J.P., Stafford, G., & Thresher, J.J. Power, E.A. (Ed.). (1960). Neutron-Proton Angular Distributions and Polarization Measurements in the Energy Range 20 To 120 MeV. United Kingdom: The Whitefriars Pres Ltd. In : Grifith, T.C Power, E.A. (Ed.). (1960). International Conference on Nuclear Forces and the Few-Nucleon Problem Vol 1. United Kingdom: The Whitefriars Pres Ltd.

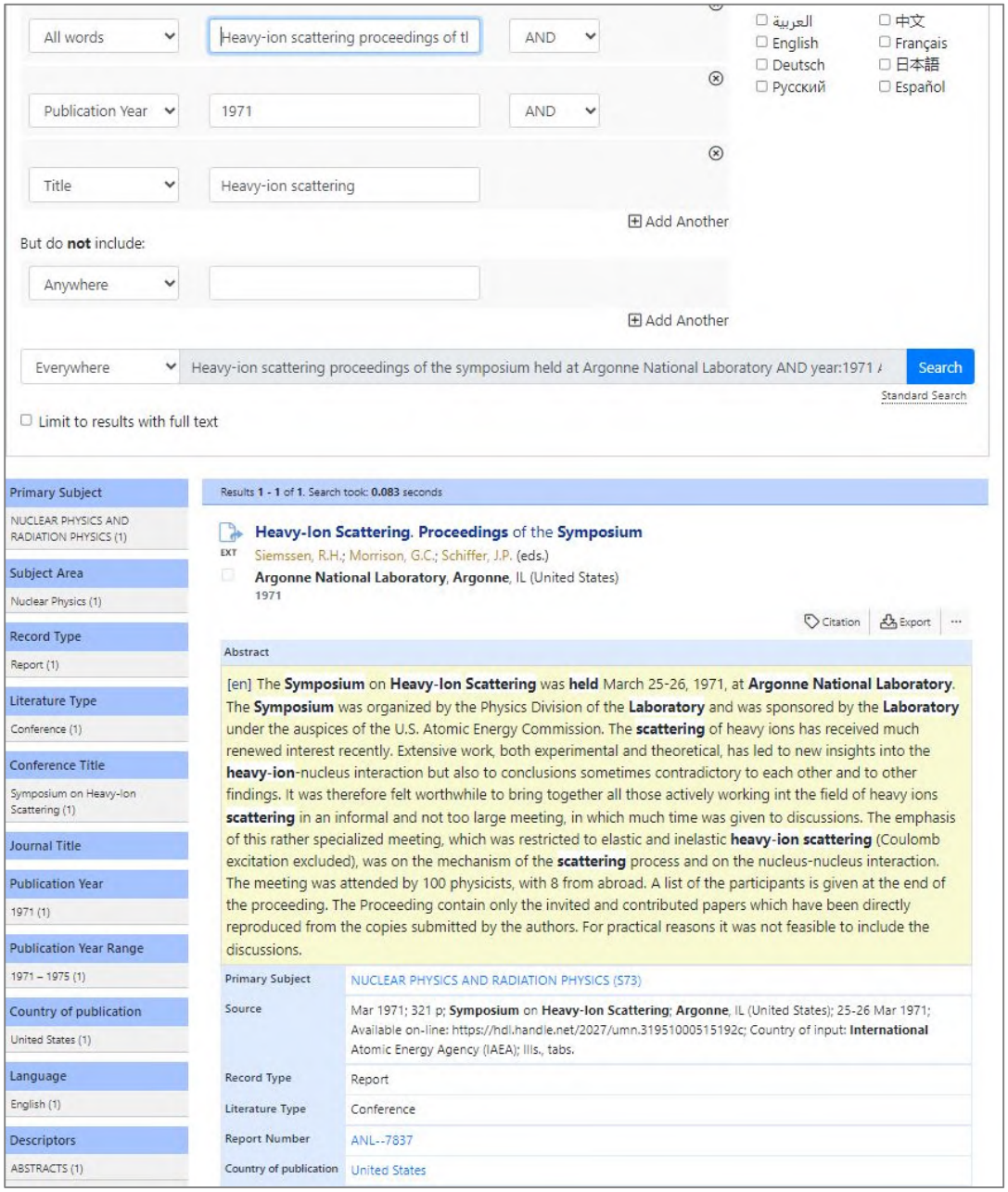
This is a paper in a conference held in 1959: Nuclear Forces and the Few-Nucleon Problem. Which was also in the library's collection. What is interesting here is that the request of one paper led to the inclusion of all the papers of the conference into INIS.
https://inis.iaea.org/search/search.aspx?orig_q=RN:54028539



Example C

Argonne National Laboratory report ANL-7837.
Siemssen, R.H., & Morrison, G.C. (1971). Heavy-Ion Scattering Proceedings of the Symposium (ANL--7837). Schiffer, J.P. (Ed.). United States.

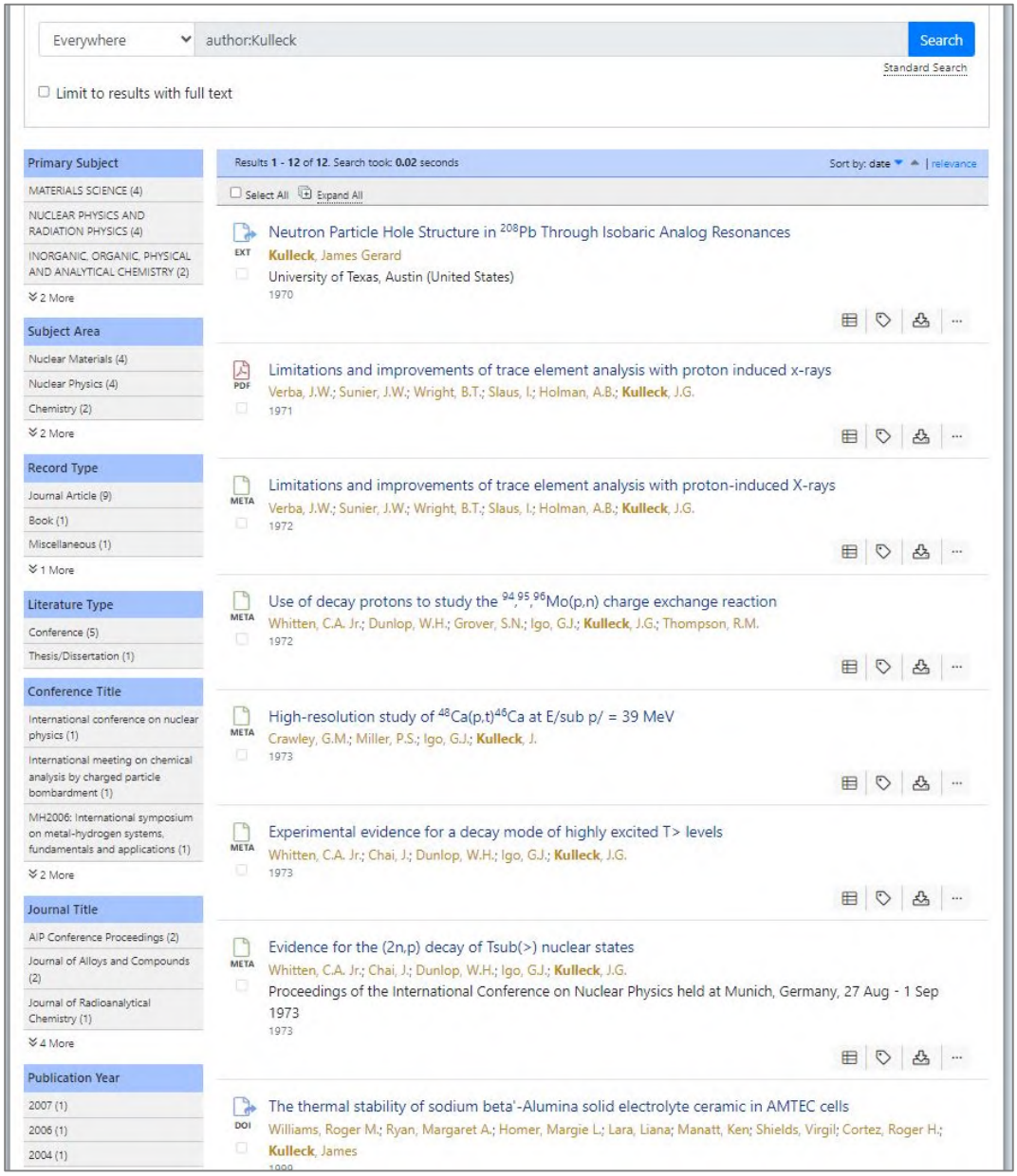
This conference proceedings identified as a report was digitized by Google from an original made available by University of Minnesota. Now it also has its record in INIS. Papers inside were also included separately. https://inis.iaea.org/search/search.aspx?orig_q=RN:53109178



Example D

Kulleck, James Gerard. Neutron Particle Hole Structure in 2°8Pb through Isobaric Analog Resonances. Thesis (Ph. D.)--University of Texas at Austin, 1970.

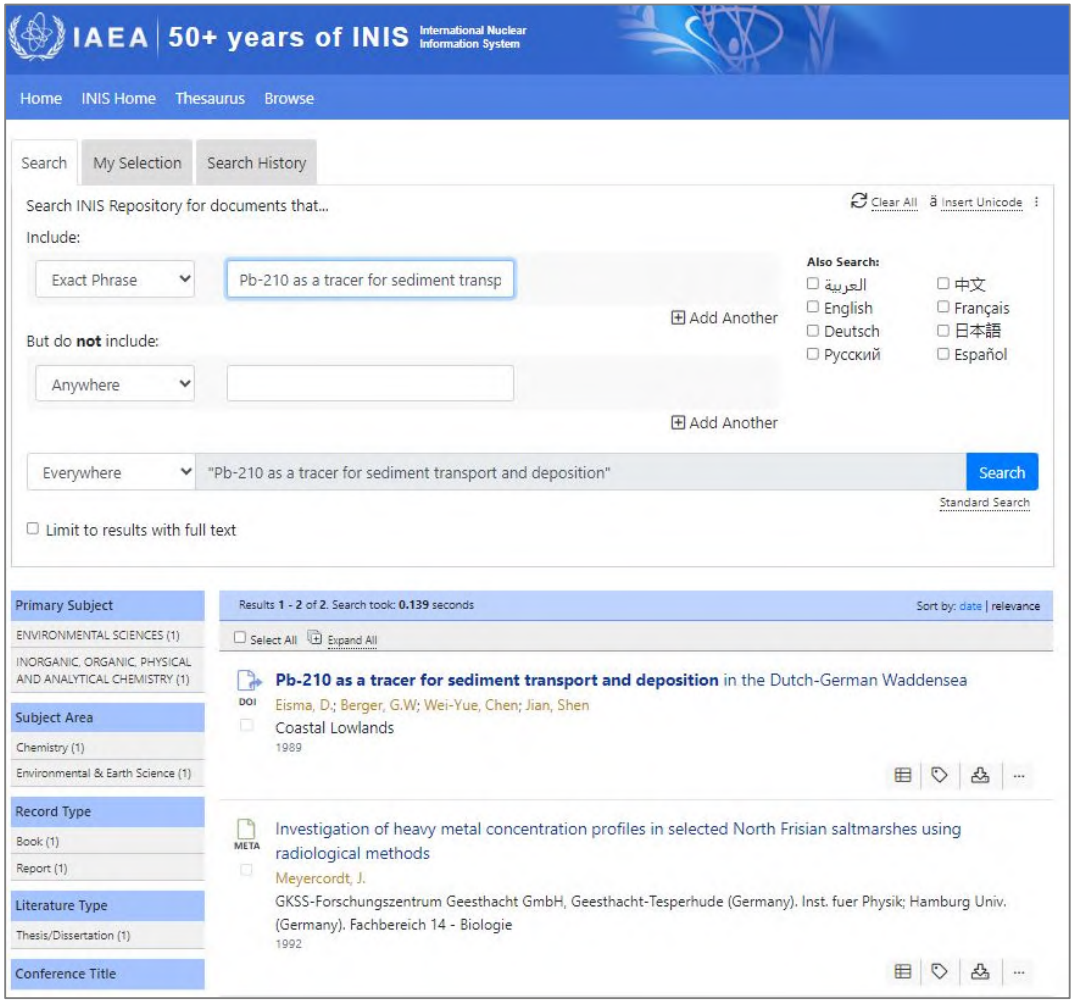
The dissertation/thesis of Mr Kulleck, presented at the University of Texas Austin in 1970, which has its record in the University of Texas Library catalog, now has its record is in INIS too. https://inis.iaea.org/search/search.aspx?orig_q=RN:53114381



Example E

Eisma, D., Berger, G.W., Wei-Yue, C., Jian, S. (1989). Pb-210 as a tracer for sediment transport and deposition in the Dutch-German Waddensea. In: van der Linden, W.J.M., Cloetingh, S.A.P.L., Kaasschieter, J.P.K., van de Graaff, W.J.E., Vandenberghe, J., van der Gun, J.A.M. (eds) Coastal Lowlands. Springer, Dordrecht

This is a chapter of a book on Coastal Lowlands Geology. Only the on chapter on Pb-210 as a tracer is relevant to the INIS database.
https://inis.iaea.org/search/search.aspx?orig_q=RN:53101900



The reports to INIS include the following information:

- Identifying bibliographic data, Just what is necessary to clearly identify the item, not a full citation nor cataloguing record
- Searches performed in INIS showing that the item was NOT FOUND in the database
- The source where the item and/or its bibliographic data was found (URL, Library or call numer for the ILML)
- In August 2022 this was more formalized, adopting an implementation of the text based RIS format.

Examples of provided records

```
TY  - THES
AN  - 7511
TI  - Neutron Particle Hole Structure in 208Pb Through Isobaric Analog Resonances
AU  - Kulleck, James Gerard
PP  - University of Texas, Austin
PY  - 1970
C1  -
    https://inis.iaea.org/search/search.aspx?num=10&orig_q=author%3aKulleck&lang=en-US&login=false&user=External&src=
    ics&search-option=Everywhere&sort=date%3AD%3AS%3Ad1&sortorder=ascending
C2  - author:Kulleck
UR  - https://search.lib.utexas.edu/permalink/01UTAU_INST/9e1640/alma991036205999706011
ER  -
```

```
TY  - CONF
AN  - 7530
TI  - International Conference on Nuclear Forces and the Few-Nucleon Problem
bA  - 8-11 July 1959
PP  - Physics Department, University College, London
C1  -
    https://inis.iaea.org/search/search.aspx?search-option=bibliographicOnly&orig_q=%22Nuclear%20Forces%20and%20the%20Few-Nucleon
    %20Problem%22&mode=Advanced&translateTo=
C2  - "Nuclear Forces and the Few-Nucleon Problem"
C1  -
    https://inis.iaea.org/search/search.aspx?num=10&orig_q=International+Conference+on+Nuclear+Forces+and+the+Few-Nucleon+Problem
    &lang=en-US&login=false&user=External&src=ics&search-option=Everywhere&sort=date%3AD%3AS%3Ad1&sortorder=ascending
C2  - "International Conference on Nuclear Forces and the Few-Nucleon Problem"
C1  - *
    https://inis.iaea.org/search/search.aspx?search-option=everywhere&orig_q=International%20Conference%20on%20Nuclear%20Forces%2
    0and%20the%20Few-Nucleon%20Problem%20AND%20year%3A1960&mode=Advanced&translateTo=
C2  - International Conference on Nuclear Forces and the Few-Nucleon Problem AND year:1960
N1  - Search for specific paper with title Light Particle Reactions. by J. M. LeBlanc
C1  -
    https://inis.iaea.org/search/search.aspx?num=10&orig_q=Light+Particle+Reactions+AND+author%3aLeBlanc&lang=en-US&login=false&u
    ser=External&src=ics&search-option=Everywhere&sort=date%3AD%3AS%3Ad1&sortorder=ascending
C2  - Light Particle Reactions AND author:LeBlanc
CN  - IAEA Circulation 539.141 I615 v.1 and v.2
UR  -
    http://libenc.iaea.org/iii/encore/record/C__Rb1168702__SNuclear%20Forces%20and%20the%20Few-nucleon%20Problem__Orightresult__U
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How many drops in the proverbial bucket? Is it worth?

During 2022, after several reports, **55 citations in total** were contributed to INIS by the ILML This raised concerns as to whether this was useful at all, with the feeling of dropping drops in a bucket, and just a few.

For the sake of the illustration, let's put this figure of speech into numbers, and have a quick look at the proverbial drop in a bucket...

How many drops there are in a bucket depends of course on the size of the drops and the size of the bucket. Supposing a 20 Litter bucket, and a drop of 0.05 ml, this makes 400.000 drops in a bucket.

20.000 mL / 0.05 ml/drop = 400.000 drops in a bucket

So how does the IMLM reports to INIS compare to that? In year 2022, INIS added almost 125.000 new records[2], so that's 55 contributions within the 125.000 new records in INIS in year 2022. That would be equivalent to 175 drops if in a bucket of 400.000 drops. Considerably more than "just 1 drop" in a bucket. In other words, quite decent... if compared to the drop in the bucket. But actually, to be fair, it is a participation of 0.044% compared to the annual INIS bucket of new records.

So that is not completely reassuring.

Modest, but worth it

On the reassuring side, though, let's keep in mind that this is a by-product of searches in the library. Not a harvesting, nor a collection development policy. Therefore, from the library's point of view, it is not that expensive, since searches have to be performed anyway. It is also a token of relevancy to the items searched, since they were requested.

More important, following the drop in a bucket figure of speech, each drop here has a title. If considered solely as a contributed numbers for a bigger total, then it's drops in a bucket. But if you put a title on each drop, then you get one step closer to "Yet another customer satisfied". But this is a given document identified and located for a given reader. Consider also that if somebody had done this before, documents requested would have been found in INIS to begin with. Now that they have been found maybe the searching burden is sparing to others, avoiding some duplication of efforts. These little searching efforts are being capitalized.
Since 1972, records in INIS come from member states contributions, IAEA contributions, and yet, some documents escape the coverage, something learned by the experience of looking for requested materials like old conference papers, unpublished thesis, reports from nuclear agencies and institutions, etc.

As stated by Brian Bales, head of INIS, in a presentation in 2022 ... among several principles a Repository should aim to, one of them is comprehensiveness (or completeness): <<Characteristics, such as timeliness, openness, user-friendliness, accuracy, and completeness, are proposed as those which meet user and institutional needs and define the degree of development for a given repository. [...] Finally, **completeness** describes how well a repository encompasses its scope.>>[3]
The contributions of the IAEA Lise Meitner Library to the INIS database are, therefore, tiny steps towards completeness.

Finally, it is worth mentioning that the reporting is easily replicable: any other library that stumbles upon an item not covered by INIS is welcome to inform about it, contributing to completeness too.

Conclusion

These reports to INIS are a relatively cheap by-product of searches for requested items that can be capitalized. Modest as it may be, it still is a useful contribution that aims for comprehensiveness and avoiding duplication of efforts. Within the Nuclear Science and Technology community, other librarians may face a similar situation. It would be useful for if those extra efforts were collected and information included in INIS, as this is probably easy to replicate by other Nuclear-related libraries that likely already use or recommend using INIS.

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Accelerating Millennials' Leadership Development Program – A Proposal for New Guidelines

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Abstract
The imperative need to nurture leadership skills among millennials has gained prominence as organizations seek sustainable growth. In developing nations like Indonesia, leadership development programs offer significant support to corporate growth strategies. The effectiveness of these programs is crucial for maximizing their impact. The purpose of this paper is to propose new guidelines for the acceleration of the millennials' leadership development programs. The research included primary data collection using a qualitative review approach. In-depth interviews were conducted with Human Resources directors from five prominent companies participating in Indonesia Millennials' Leadership Development programs. The data were processed using cross-sectional content analysis of the interviews and descriptive analysis of the completed questions to ascertain the opinions of all the parties involved in the millennials' LD programs. The results show three themes and subthemes to accelerate millennials' Leadership Development programs: 1. the program perspective (program approach, age, program duration), 2. the ecosystem (ecosystem framework, support system, meeting environment), and 3. the program subject (lesson complexity, particular lesson, exposure opportunity). The insights from this study have relevance across diverse industries and offer valuable guidance for organizations seeking to optimize millennials' leadership development programs.

1. Overview

More than $60 billion is spent annually on leadership development programs by worldwide organizations. However, it is not always obvious how beneficial these investments are for leaders and their teams (Ayse et al., 2023). According to recent studies, leadership development in the twenty-first century goes beyond the standard components of academic and occupational education. (Day et al., 2021; McCauley & Palus, 2021). Executives must increase their professional networks while expanding their knowledge and skill sets via leadership development to build institutional values for their companies(Day et al., 2021). Studies of leadership training programs often examine how well they prepare their participants to lead and what kinds of transferable skills and knowledge they acquire (Kean, 2020).

Furthermore, the baby boomer generation is either already retired or heading that way. At the same time, as there are many unfilled leadership roles, there is a dearth of qualified candidates to fill them (Harrison, 2015; Nye, 2018). As a result, a lot of attention has been paid to Millennials in leadership development and training programs. Numerous organizations struggle to prepare for future leadership (Al-Asfour & Lettau, 2014; Caldwell, 2015; Campione, 2015). There is, however, a lingering concern about how best to administer a leadership development program for today's youth. The literature on training effectiveness and the essential aspects contributing to this kind of leadership program is lacking.

Then, companies in the United States spend $1,252 per worker on training, most of which goes toward leadership development programs. Employers consistently report a shortage of leadership skills and abilities despite leadership development being a top priority (Lacerenza et al., 2017). As a result, the median age of Americans participating in leadership training programs is 42 (American Society of Training and Development, 2012). While there has been a rise in leadership development programs and millennial-specific training in recent years, the results have fallen short of expectations in many cases (PWC, 2011). This worldwide movement may also be seen in Indonesia. While millennials make up 61% of the total workforce at Unilever Indonesia, the country's largest and oldest FMCG company, they only make up 11% of its top management (Singodimejo, 2019). However, millennials make up 61.6% of PT. Telkom's workforce across the country (Setiawan, 2019) is absent from the company's executive ranks.

65.5% of millennials work at Gudang Garam, a significant participant in Indonesia's tobacco sector, yet none are directors or top-tier executives (Muliono, 2019).

Leadership development programs in developing nations like Indonesia may support corporate growth in many ways. First, individuals may acquire the necessary skills and information to become successful leaders via leadership development programs. This encompasses abilities like strategic thinking, problem-solving, communication, and decision-making. Businesses in Indonesia may overcome obstacles, make wise choices, and promote development by cultivating great executives. Second, within a company, leadership development programs may aid in spotting and fostering bright employees. Businesses may create a strong pipeline of future leaders by investing in their development. This guarantees continuity and stability in leadership roles, which is essential for the long-term success of an organization. Third, fostering innovation and adaptation leadership development programs often strongly emphasize encouraging innovation and adaptation. Leaders must think creatively, accept new ideas, and adjust to changing market circumstances in a company environment that is changing quickly. Businesses in Indonesia can maintain their competitiveness and capture new possibilities by acquiring these skills. Fourth, leadership development initiatives show a promising effect on the growth and development of the workers. The feeling of worth and support for one's professional advancement may improve employee engagement and happiness. Engaged staff members are more likely to remain with the company, which lowers turnover and preserves key talent. Last, leadership development programs are essential for producing influential leaders, creating a talent pipeline, encouraging innovation, raising employee morale, and influencing corporate culture. These elements promote growth, stability, and competitiveness, which in turn contribute to the general development of business in emerging nations like Indonesia.

Leadership development programs have been extensively implemented across various domains, encompassing higher education (Eich, 2008; Reyes et al., 2019), under-resourced communities (Holtzhausen & Botha, 2019), the tourism industry (Fang & Whitelaw, 2020), and healthcare (McAlearney, 2008; McDonald, 2014; Mustafa et al., 2019). Previous research suggests that these programs effectively enhance leadership skills and improve team performance outcomes (Holtzhausen & Botha, 2019; Reyes et al., 2019). However, few studies have taken an integrative approach to address the challenge of enhancing the effectiveness of leadership development programs. Coates (2013) researched the effectiveness of the Integrated Leadership Development Programme, but the study was limited to the UK context. Therefore, there is a pressing need for more rigorous evaluation studies that address endogeneity concerns and identify the most effective strategies for leadership development (Fang, 2018). Consequently, this research aims to address this research gap by taking an integrative approach to improving the effectiveness of leadership development programs, particularly from the perspective of the human resources department. This investigation seeks to contribute value to leadership development by exploring how these programs can drive business development in developing countries like Indonesia through comprehensive and tailored strategies.

2. Literature Review

There are various discussions about leadership development programs and factors affecting the program's success (Kean, 2020). The primary study focus is the efficacy of leadership development programs and the breadth of the leaders' new abilities (Day et al., 2014). Effective and efficient leadership development is of relevance to most companies. However, research shows that insufficient companies provide their future leaders with the essential skills to succeed (Lacerenza et al., 2017). An area of considerable apprehension pertains to the readiness of younger cohorts, specifically millennials, to assume forthcoming leadership positions. The proposition of implementing leadership development programs specifically designed for millennials has emerged as a prospective remedy for the scarcity of qualified individuals in leadership positions. Despite engaging in a multitude of leadership development initiatives, individuals belonging to the millennial generation frequently experience a sense of stagnation in terms of their professional advancement (Kammien, 2016). Despite participating in various

leadership training programs, millennials feel they are not progressing in their careers (Santillo, 2017).

There has not been nearly as much research done on the theory and its particular applicability to millennial participants (Konczak & Foster, 2009)). Leadership development programs may fail millennials because ideas reflecting their values are not integrated into the overall development process. Whether or not millennials find value in leadership development programs determines whether or not they will internalize and use the skills and knowledge they acquire (Seldon, 2014).

Furthermore, millennials aren't going into leadership positions because they don't feel prepared (Nye, 2018), according to studies showing that they lack the soft skills essential to lead (Deloitte, 2017). Current leadership development solutions do not adequately prepare millennials for future leadership roles (Schwabel, 2012). Millennials are interested in work projects and opportunities that will allow them to make a difference in the world and shape how businesses operate, how people interact, and where the nation is heading (Deloitte, 2017). Organizational leaders may aid millennials in pursuing professional success in three ways (Ferri-Reed, 2012). These include providing the broad picture, helping them discover me in the team, and mentoring them on career-building habits. A future study (Harrison, 2015) suggests focusing on how this idea can be used in leadership development, specifically by determining which program methods are the most successful and how millennial leaders' growth will affect future organizations' requirements.

Moreover, 63% of Millennials surveyed said they lacked the necessary leadership abilities to advance in their current positions (Deloitte, 2017). The surveyed millennials were asked to rank the leadership qualities and competencies they found most admirable in their companies. According to the findings, the millennial generation values leadership the most. It is clear that millennials want to feel as though they are in control of their professional development; furthermore, 71% of millennials reported the likelihood of leaving their organizations in the next 24 months due to dissatisfaction with developing their leadership skills (Davies et al., 2016). Despite millennials' apparent interest in personal growth, only 20% of leadership development initiatives target them. In particular, academics lack knowledge on improving the effectiveness of leadership development programs aimed at millennials (Lacerenza et al., 2017). To close the gap between Millennials' self-perception and the realities of organizational leadership roles, we must first investigate its causes (Nye, 2018).

The latest research found the results of the search for literature on the antecedent factors that affect the success of leadership development. Leader support, a conducive learning atmosphere, and enough educational resources are the three main components of every effective leadership development program (Dewanto et al., 2022).

Organizational leaders can offer millennials a more comprehensive outlook, aiding them in exploring their roles within the organization to facilitate their professional advancement. The cultivation of effective leadership is imperative for organizations to achieve success. Organizations can enhance the likelihood of their leaders achieving success by implementing comprehensive and strategic leadership development programs that aim to cultivate the requisite abilities and competencies. Organizations can develop resilient and capable leaders to catalyze their continued prosperity by implementing comprehensive and strategic leadership development initiatives. Organizations can ensure the competence and aptitude of their leaders by evaluating their efficacy, integrating continuous learning and action research, fostering both exploratory and exploitative behaviors, considering the global landscape, and embracing a systematic approach. Organizations can assess the degree to which their leadership development programs accomplish their intended goals by evaluating their effectiveness. This procedure may involve gathering participant feedback, tracking performance metrics, and executing exquisite modifications (Solansky, 2010).

Integrating lifelong learning and action research into leadership development programs can significantly improve leaders' skills and ensure their adherence to contemporary trends and best practices. The concept of lifelong learning, characterized by the ongoing acquisition of knowledge and skills throughout an individual's lifetime, has yielded favorable outcomes

regarding personal life satisfaction. Additionally, it can serve as a means for leaders to explore and engage in personal interests and passions beyond their occupational obligations (Fletcher et al., 2010). In contrast, action research is a systematic procedure that entails self-reflection and enhancing an individual's professional behavior. This approach has the potential to aid leaders in the recognition of their competencies and the identification of areas that necessitate additional development. Integrating exploration and exploitation behavior within management teams has been found to substantially impact organizational performance, as it facilitates innovation and enhances decision-making processes. One approach to fostering the development of leaders' skill sets involves offering them novel challenges and opportunities (Kjellström et al., 2022).

Considering the global context is paramount when designing leadership development programs to guarantee their efficacy in diverse cultural and business settings. International leadership development programs have the potential to assist organizations in nurturing leaders who possess the essential competencies required for effective leadership in a global organizational environment (Hruby et al., 2022). Adopting a systemic approach to leadership development is imperative for effectively incorporating programs within the broader corporate strategy and culture. This may entail offering leaders a range of developmental schemes, including mentoring, coaching, and feedback-oriented methodologies (Douglas et al., 2022). The significance of effective communication within leadership development programs lies in its ability to cultivate interpersonal relationships, facilitate constructive feedback delivery, and enhance knowledge acquisition(Kjellström et al., 2020).

3. Method

Given the exploratory nature of this research, a qualitative approach was utilized, with the primary data source being interviewed (Jain, 2021). This study used purposive sampling to select project management academics (Suri, 2011). Purposive sampling allows researchers to intentionally choose participants based on specific criteria relevant to the research (Andrade, 2020). Eligibility for inclusion in the study necessitated that participants were actively engaged in a leadership development program and held a full-time position with a minimum of five years of managerial experience. Five human resource departments from premier organizations in Indonesia that met these specifications were extended invitations to partake in the study.

The study focused on leadership development, particularly in the context of the millennial generation, with Human Resources (HR) Directors and top-tier executives from five distinguished Indonesian companies serving as the primary sources of information. These companies had extensive operational scales and assets and held prominent market positions within their respective industries, including financial services, e-commerce, manufacturing and technology, and Fast-Moving Consumer Goods (FMCG).

Five human resource departments agreed to participate, contributing comprehensive interview data from ten individuals. These interviews, conducted in 2021-2023, were recorded and transcribed using Google Meet. All automated transcriptions were manually reviewed to ensure accuracy. Data saturation was achieved after conducting ten semi-structured interviews. To protect participant confidentiality, individual interviews were assigned anonymous labels from P1 to P10 (Table 1).

Interviewee	Company	Industry	Role of Participants
P1	Company 1	Banking	Assistant Vice President
P2	Company 1	Banking	Senior Manager People Analytics
P3	Company 2	E-commerce	Chief People Officer
P4	Company 2	E-commerce	People Development Senior Lead
P5	Company 3	FMCG	Human Resource Vice President
P6	Company 3	FMCG	Head of Human Resource

Interviewee	Company	Industry	Role of Participants
P7	Company 4	Insurance	Chief HR Officer
P8	Company 4	Insurance	Head of HRBP
P9	Company 5	Manufacturing	Country HR Lead
P10	Company 5	Manufacturing	Rewards & Service Delivery Lead

Table 1. Participants List

The interview data were analyzed using thematic analysis with a thematic deductive approach involving a six-stage analysis process. This process encompassed familiarization, initial code generation, theme searching, theme evaluation, and definitive theme identification, culminating in presenting findings (Braun & Clarke, 2006). Thematic analysis was chosen for its ability to systematically code qualitative data and identify patterns or themes within the text, ranging from simple observations to interpreting phenomena (Boyatzis, 1998). This approach ensured the production of comprehensive and reliable results.

Trustworthiness is paramount in qualitative research (Byrne, 2022; Kiger & Varpio, 2020; Thompson, 2022). This encompasses essential dimensions such as credibility, confirmability, and representativeness (Megheirkouni & Moir, 2023). To achieve this, researchers conducted multiple interviews with participants from diverse companies, ensuring the richness and diversity of insights related to the research question. Additionally, engaging in peer debriefing further bolstered the trustworthiness of research findings.

4. Findings

The themes and subthemes that emerged from the interviews are displayed in Table 2. The first theme is "Program Perspective," which consists of three subthemes: Program Approach, Age, and Program Duration. "Program Approach" was mentioned by sources P2, P6, and P7, while "Age" was mentioned by sources P1, P5, and P8, and "Program Duration" was mentioned by sources P1 and P4. The second theme is "Ecosystem, " subdivided into Ecosystem Framework, Support Systems, and Meeting Environment. The subtheme "Ecosystem Framework" was brought up by P1, P4, and P9. "Support System" was cited by P3 and P1, whereas "Meeting Environment" was mentioned by P4, P3, and P10. The third theme is "Program Subject," which encompasses Course Difficulty, Particular Lessons, and Exposure Opportunities. "Learning Complexity" was mentioned by P1 and P6, "Special Learning" was mentioned by P2, P4, and P8, and "Exposure Opportunities" was mentioned by P1, P3, and P7. This table provides an organized and plain view of the interview findings, facilitating further analysis of the data obtained.

No	Themes	Sub-themes	Sources
1	The program perspective	Program Approach	P2, P6, P7
		Age	P1, P5, P8
		Program Duration	P1, P4
2	The ecosystem	Ecosystem Framework	P1, P4, P9
		Support System	P3, P1
		Meeting Environment	P4, P3, P10
3	The program subject	Lesson Complexity	P1, P6
		Special Lesson	P2, P4, P8
		Exposure Opportunity	P1, P3, P7

Table 2. Themes and Sub-themes Emerged from the Interview

4.1 Program Perspective

4.1.1 Program Approach

Multiple respondents stressed the importance of balancing the bottom-up approach of a leadership program. Since millennials are unique, the leadership program should be specified based on their characters. Program organizers should create meaningful leadership development based on the future of the work. One respondent, identified as P6, articulated this viewpoint, asserting:

> *"In my opinion, first, don't put millennials to everyone. That's really important. So, millennial as a label, what's it called, you can't equate all of them because earlier the distance was too far, sir. So, that's what I think we should clarify first. The second is that each generation they have different traits. Well, that's all different. Well, the third one is from a leadership perspective. If I see what's really needed... I'll look at this, I mean this... Maybe feedback to millennials is just like that, sir, not feedback to us as a charge, but feedback to millennials is for I am a millennial that needs to be taught, especially the true ones, and approaching Z that life is tough like that, hand challenge-adversity is something that we need to enjoy, that we need to embrace and believe me it will shape you to be a better person that you are will become in the next few years. And finally, what I want to share is a career in your own hands, actually. So, you need to pursue whatever dream you have."* (P6).

Furthermore, another participant denoted as P2, highlighted:

> "*And there is a mechanism in place here... We have a plan in place, sir. Therefore, it is up to each individual to make his own success.*" (P2)

These perspectives underscore the need for a nuanced and individualized understanding of millennials, emphasizing that they cannot be broadly labeled or generalized. Feedback and guidance for millennials should be tailored to their specific needs and characteristics. Additionally, it highlights the idea that while there may be existing systems or plans to support individuals, the ultimate responsibility for success lies with each individual. In light of the unique attributes of millennials and the changing nature of work, there is a critical need to adapt and align leadership development programs to be both adaptable and relevant, as emphasized by the statement of P7:

> "*The significance of harmonizing a leadership program's bottom-up approach. Given the distinct characteristics of millennials, leadership programs must be adapted to their specific traits. Program planners must design leadership training that is relevant to the future of work*." (P7)

4.1.2 Age

In addition, participants of the interview stated that if the program could be given to millennial employees who wish to take part in leadership development, they could start earlier so that participants could accelerate to a higher level. As articulated by P1:

> *"The point is that the program leader. The point is this is for this company's top talent but specifically millennials. It has an age. Not even millennials who are 40 years and under, no, but 30 years and under. So here we go again. It's getting lower. These people are given special education, so some sort of combined education is indeed to be prepared so that they can accelerate to become Board of Director -1."* (P1).

P1 underscores the critical importance of investing in and nurturing young talent within the organization, providing them with specialized education and training tailored to their needs. This strategic approach can empower these individuals to ascend to higher positions within the company. Furthermore, P5 emphasized the importance of fostering a diverse and inclusive

workplace where individuals are treated equitably and have equal access to opportunities for growth and advancement.

> *"In fact, because of the inclusivity of our values, we must make sure that everyone is given the same opportunities and rights. So, there are no gender restrictions or age restrictions"* (P5)

Additionally, P8 sheds light on the proactive aspirations of millennial workers in their pursuit of leadership roles:

> *"Millennial workers have expressed a desire to begin their leadership journeys earlier. They hoped that by beginning leadership development programs earlier, they would be able to enhance their leadership competencies and skills more rapidly, allowing them to advance to higher leadership positions in a shorter amount of time"* (P8)

Therefore, early access to leadership development programs enables millennial workers to accelerate their growth and ascend to higher leadership levels.

4.1.3 Program Duration

Several interview participants mentioned that the program's duration greatly influenced millennial preferences for the program. Leadership development is now shorter than in the past**.** Notably, the duration of leadership development has been shortened compared to the past, as emphasized by P1:

> *"Now the duration of the leadership program is six months, sir. Previously, the duration of the program was one year."* (P1).

This shift towards a shorter program duration indicates a strategic effort to make leadership training more efficient and accessible, possibly in response to evolving organizational needs or the preferences of program participants.

> *"So, that has also affected the way we learn. you don't need to sit for two hours or an hour like that, all you have to do is watch a video for half an hour or maybe even 15 minutes, and they can do it right away. So, they prefer a more actionable learning style. Just go ahead, don't take long. The point is maybe the main difference between the learning style of Generation Y and the Millennial generation is the value of the process. So, maybe people in our Generation Y still value the process. We still value the process. For people in the millennial generation, they value the results more, so they want to go straight to the results."* (P4).

This shows different generations' evolving preferences and characteristics concerning their learning and skill acquisition approaches. It underscores the need for organizations to adapt their training methods to cater to the distinct preferences of millennial learners, who place a high value on efficiency and results-driven learning experiences.

4.2 The Ecosystem

4.2.1. The Ecosystem Framework

Multiple respondents stressed the importance of the framework of the ecosystem toward a sustainable leadership development impact. Effective leadership development necessitates numerous resources. Program organizers should create an ecosystem leadership development framework comprising all sources required. P1's statement further elaborates on this:

> *"because it turns out that HR programs at this firm, including leadership, diverge from the company's reforms. This is a fantastic breakthrough for the business world. As a result, the difficulty has shifted. The question then becomes how the corporation can also play the role of ecosystem orchestrator. How can we attract and retain the appropriate people? People in developing countries must also adapt, and this transformation. Therefore, the process of transformation occurs as a single, unified entity."* (P1).

It underscores the evolving role of HR and stresses the importance of aligning HR programs with broader corporate reforms and transformation efforts in the modern business environment. In line with this perspective, P4 highlights:

> *"So, that's why we created a coaching ecosystem."* (P4)

This statement emphasizes the organization's commitment to providing coaching as a valuable resource and support mechanism for its employees. P9 also reinforces the significance of an ecosystem framework:

> "*The importance of an ecosystem framework for sustainable leadership development impact. Conducting effective leadership development requires many resources. We believe that program organizers must create an ecosystem leadership development framework that includes all necessary resources.*" (P9)

Therefore, as highlighted by P9, achieving success in leadership development programs requires program organizers to adopt a comprehensive and holistic approach by creating an ecosystem framework.

4.2.2 The Support System

In addition, interview participants stated that the program could be given to millennial employees as a support system that supports it. For example, P3 sheds light on the challenges of predicting staffing needs in a rapidly evolving tech environment:

> *"For me, first of all, it's demand and supply that I tidy up first. Which is is a bit difficult for technology companies. Because like, if I ask, we are proactive. In the next year, what role do we need? That's what they'll say. I can only tell you in the next three months, okay? A year from now, maybe not. Well, if, for example, we already have a rather long-term plan, right, with more maturity, it should be longer, then the demand will be discovered. Well, so, we can prepare the supply. That's what I think is the key. And the demand and supply system, which until now should have analytics, in my opinion. So, for example, we have to attrition by when we will have a vacancy at that level, right? If, for example, there is a blank, who will move? Well, that algorithm like that system doesn't exist, to be honest, now. That's what I think we can really do. So, with that, let's make a pipelining program, right? Well, the pipelining is still on the tech bench, in my opinion. There is a landed job that we have identified well when it will be created, and this talent has already been prepared. So, follow the tech bench, take this course, take that course, right, one-on-one mentoring, and all this thing. So, by the time the job opens, it's ready. Well, that's what I really want to create, the ecosystem anyway. So, conceptually, in my opinion, the current tech bench is a successful experiment." (P3).*

It underscores the necessity of establishing an ecosystem where talent development and readiness closely align with the evolving organizational needs. This perspective is further reinforced by P1, who acknowledges the significant challenge of creating an integrated talent management system:

> *"So, it's a challenge. And how to create an integrated talent management system."* (P1)

Therefore, organizations should prioritize investing in talent management systems that carefully synchronize supply and demand for talent. This approach can enable organizations to address evolving staffing requirements more effectively and efficiently.

4.2.3 The Meeting Environment

Several interview participants mentioned that the meeting environment is also essential to facilitate communication between the participants and mentor or other actors involved in leadership development. For instance, P4 highlighted:

> *"The unique thing about millennials is that they like to hear stories, success stories. So, if we look at the success story, what kind of appeal is that? Usually, that is their journey to becoming a leader. As I said earlier, they sometimes have already been appointed as a leader when they are not ready yet. So, listen to people talk about their leadership experiences, not only the good ones but also the bad ones too. That kind of success story actually has an exponential impact, you know, it's not only inspiring but also gives an image of "Oh, yes, leaders are human too. They can make mistakes." But the difference is there are leaders who make mistakes, and they immediately feel sad, right? In the end, they don't perform and leave. These leaders are still willing to learn and try to grow them, and they can still stay. Well, this is the inspiration for them. Indeed, everyone's success parameters are different, so we are not trying to highlight where their success is, but what we are highlighting is the story or the journey of these leaders. Because of advocacy stories. So, for myself and what I apply, I think it needs to be made in a meeting environment."* (P4).

It emphasizes the power of leadership stories in motivating and guiding millennials in their leadership journeys. Furthermore, P3 stated:

> "*I will help to make sure we facilitate the discussion properly and correctly, isn't that right?"* (P3)

This statement signifies their commitment to contributing to the effective and accurate facilitation of discussions, highlighting their active engagement in ensuring the quality of the conversation. This sentiment is reinforced by P10's statement which:

> "*Many of us believe that true learning comes from open dialogue and discussion, where we can freely share experiences and challenges. Hearing from those who have gone through their own leadership journeys provides invaluable insight and inspiration. Ultimately, we all want grow and develop, and a supportive and collaborative meeting environment is key to achieving that.*" (P10)

It underscores the value of open dialogue, discussion, and shared experiences in the context of learning and personal growth, particularly in the realm of leadership development.

4.3 The Program Subject

4.3.1 Lesson Complexity

Multiple respondents stressed the importance of the complexity of the lesson on leadership development. Through challenging experiences, the participants will gain high-quality lesson learning. Program organizers should create high-quality content with a high impact on the participants. For instance, P1 pointed out:

> *"big project experience, and maybe experience... Not a failure, but a big potential for failure. Because he will study again, study again. Well, I see that actually. So, how can these people be given a much higher challenge, if necessary... So, not a comfortable one, not just an ordinary job, what might be that is... Will it be assigned to a children's company like that? , but... To manage new things, like for example... Or manage changes that many people might not even like. So, for unpopular projects like that. Well, if I think it's true. So more challenges. So, if the project is popular, it's mediocre. So, many people can do it. It doesn't take more effort to do a normal project." (P1)*

P1's perspective underscores that individuals learn and grow most effectively when they confront significant challenges and potential failures in their work. This viewpoint is reinforced by P6, who highlighted:

> *"Especially millennials or Gen Z to speed things up. But it can't be just any program, sir. Because I know I also have friends like that in a number of companies like that, but they don't accelerate, they don't challenge, they don't give rewards like that, so the result is*

podo wae like that, sir. So, I think if I can look back, those three years were very, very important for my career. Well, the second one, in my opinion, is what it's called challenge and adversity." (P6)

Therefore, it is crucial to push individuals out of their comfort zones and place them in roles or tasks that require them to navigate new and challenging situations. This approach effectively fosters personal and professional growth.

4.3.2. Special Lesson

In addition, interview participants stated that the program should be specific to construct unique competency for millennial employees. P2 pointed out:

"When the course is what I'm going to do, what's the name, improvisation, like detailed identification of the participants, sir. Then, from the start, we have also identified this before giving development, in fact, the most gaps are where the competence is like that. Don't let the program be hammered out like that, okay, so in general. It's straightforward... Because if I see it, millennials are more specialists, sir, you can see that. So, if he really has a gap where it's not a general thing, he should be able to do everything, but what exactly does he want to develop? So that when development is going to be carried out it is really specific, not in general." (P2)

It highlights the importance of personalizing and targeting development programs to maximize effectiveness, especially for millennials with specialized interests and needs. This perspective aligns with P4, who mentioned:

"Well, they have to do what used to be called an individual development plan. Now the future fit plan. Why future fit plans? The principle is the same though. Namely where do you want to go, what do you want to do, what is your purpose, so that there is a gap and a development plan is created that will be worked on." (P4)

This underscores the enduring importance of individual development planning, focusing on aligning personal goals and aspirations with a structured plan for skill development and career advancement. In line with this, P8 emphasizes:

"To truly understand and improve areas that need development, we must have a clear picture of individual competencies and where the gaps lie." (P8)

This emphasizes that to enhance one's skills and capabilities, it is crucial to have a comprehensive and individualized assessment of competencies. This serves as a foundation for targeted development efforts and personal growth.

4.3.3. Exposure Opportunity

Several interview participants mentioned the crucial role of the opportunity to be exposed to more enormous opportunities, such as learning from the board of directors and having a chance to accelerate to a higher position within an organization. P1 articulated:

"I mean, that person will be successful if they have a lot more exposure. If they have a lot of exposure. They have the opportunity to be exposed to, close to, or get a special mentor from the Board of Directors." (P1)

This emphasizes that success often hinges on the extent of one's exposure and the quality of mentorship they receive. Access to diverse experiences and influential mentors can significantly contribute to professional growth and achievement. P3 further elaborated on this:

"So, if, for example, you want to be mentored, don't mentor just one level above. Yes, you have to skip the level. So, skip the mentoring level that we use because the mindset is very different. Because if it's just that, well, in the end, you can at most get an aha moment like two or three times. But if you skip a level, suddenly you're like, "oh, yeah, yeah." (P3)

Seeking mentors from higher levels of the hierarchy can provide a more profound and enlightening mentorship experience, leading to more frequent and profound moments of insight and understanding. P7 also echoes this perspective:

> *"Allowing millennial employees to see and learn from different aspects and levels of an organization is key to helping them understand the big picture and see how they can contribute more effectively"* (P7)

Hence, it is essential to provide millennial employees with opportunities to explore various facets and levels within the organization, enabling them to gain a holistic understanding of the company.

5. Discussion

This research seeks for the procedure to accelerate millennial leadership development. The results of this study are encapsulated in Figure 1, which outlines three key themes that facilitate the acceleration of leadership development programs.

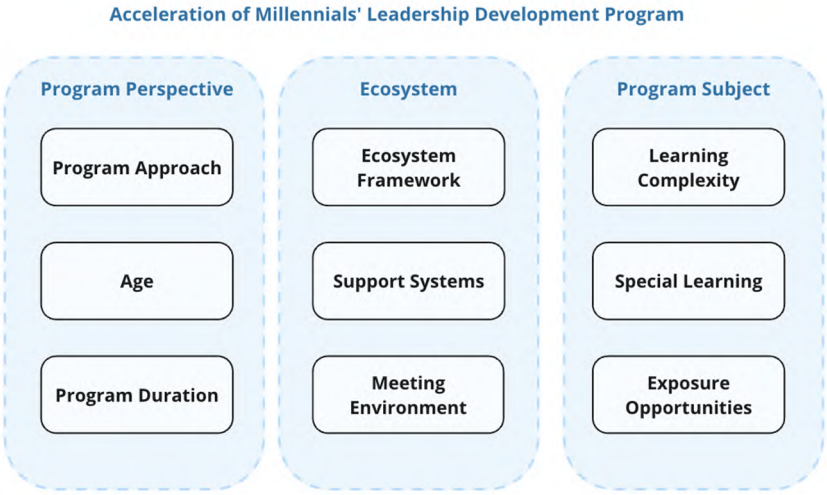

Figure 1. Acceleration of the leadership development program

First, the findings of the themes program perspectives aligned with the previous research discussing the program approach, participants' age, and the program duration (Cacioppe, 1998; Duguay et al., 2016; Straus et al., 2013). Striking a balance between top-down and bottom-up leadership development strategies is essential to equip leaders for present and future challenges. Top-down leadership entails senior executives setting the tone and guiding the organization from the rear. In contrast, bottom-up leadership encourages and supports front-line workers in leadership roles. Both methods are essential for managers and their direct reports to achieve organizational objectives. Leaders who practice bottom-up leadership can trust their followers' expertise, experience, and discretion. It is crucial to balance top-down and bottom-up leadership development methods for a more flattering organizational structure in which people are encouraged to take on leadership positions. (Bush, 2011). Due to the proportion of millennials within companies, ensuring the millennials' existence and ideas that influence the organization's success is urgent. Their representatives affect the organization's diversity, leading to its success (Glenn Llopis, 2011).

Numerous experts discussed the correlation between age and leader behavior. There have been a few relevant results from prior research (Walter & Scheibe, 2013). It has been observed that younger and older leaders are equally successful in task-oriented conduct or getting things done. A leader's initiative, ability to give orders, and ability to create incentives do not seem to decline with age. However, a leader's receptivity to change declines with age. There is a noticeable reduction in the willingness and inclination of older leaders to embrace change and foster creativity. For example, previous research has shown that more senior executives invest less in R&D than their younger counterparts (Barker & Mueller, 2002). The

millennial representative within companies will benefit business growth because millennials focus on the future, such as investing more in R&D than older employees.

The search results do not give a definitive solution to how long a leadership program should be, as they vary depending on the demand (Corell Sarpy & Stachowski, 2019). However, ensuring the program lasts long enough to achieve the company's goals is essential. According to Gentry et al. (2013), for a leadership development program to be successful, it must be tailored to both the company's overall plan and the specific needs of its participants. Participant, manager, and team member involvement, as well as that of the CEO, all contribute to the program's overall impact and success. Besides, since the millennials are fast learners, the program should not be too long, affecting the cost of leadership development.

Second, the ecosystem themes' findings aligned with the previous research discussing the ecosystem framework, support system, and meeting environment (Umble et al., 2011; Winters et al., 2022). Instead of giving courses and programs in isolation, an ecosystem framework takes a holistic view of leadership development by including elements from the whole learning continuum. Cultivating future leaders creates a setting that allows for and even encourages high levels of productivity and growth (Fuller et al., 2019). The framework comprises guiding principles that specify the behaviors necessary to define, simplify, and inspire leadership at any level. Applying a conceptual framework, scaffolding development-oriented approaches, catering to different stages of adult development, integrating diverse perspectives, interweaving theory, practice, and competency acquisition, and ensuring consistency of leadership training approaches across institutions and programs are all possible principles of an ecosystem framework. The support of the HR, CEO, and other employees benefits the millennial leadership development program.

Evidence indicates that participating in a millennial leadership development program may help employees grow as leaders. Employees who aspire to management positions may benefit from leadership development programs, which help them acquire the knowledge, character strengths, and practical abilities necessary to take charge of teams, expand the organization, and overcome obstacles. Leadership commitment and support can explain the program's objective and methods to all levels of the business, which is crucial for the success of a workplace health program. A leadership development framework may direct and compel the cultivation of the leadership skills necessary to meet the problems of the here and now and the foreseeable future. Mentoring relationships may also facilitate learning, developing, and actively engaging leaders (Nyberg et al., 2009).

Regular group meetings are a crucial part of any leadership training course. For the program to be successful, it must provide participants with a compelling picture of how the abilities they are developing in the program relate to the company's leadership roadmap. Lines of sight must be unobstructed to map corporate priorities onto how leaders must alter or hone their abilities to realize those aims. To educate managers on training their employees to participate in a leadership development program, astute program owners organize orientation calls for them. Owners of the programs also provide training sessions for managers to ensure they are correctly modeling the relevant abilities. Building a memorable brand that resonates with students is essential for the millennials due to their character and appreciation of direct feedback.

Third, the program subject's findings aligned with the previous research discussing the lesson complexity, particular lesson, and exposure opportunity (Brue & Brue, 2016; Dunn & Pope, 2001). Learning Industry compiles the best content providers for executive education. The list is carefully curated based on a broad set of criteria that cover everything from learning industry innovation to customer retention rates. The best leadership content suppliers have the courses and tactics to develop exceptional talent and fundamental leadership abilities. The millennial program subject could be more complex, involving the e-learning method or a more technological approach such as AI.

Based on the data gathered, many topics may be covered in leadership development programs. The many definitions and meanings of leadership development call for more investigation. High-quality material is essential for all leadership development programs since it

may target particular talents and contribute to creating a consistent approach to leadership across an organization. Some facets of leadership are crucial, no matter how much authority is exercised. Expertise in leadership development may be broken down into several subfields, including but not limited to leadership evaluation and development, 360-degree feedback, job analysis, competence modeling, employee selection, and promotion (Coates, 2013). There has never been a more pressing need for leadership development, as businesses of all stripes are beginning to understand that to thrive in today's VUCA world, they need new leadership skills and organizational abilities (Claus, 2021; Weisfeld-Spolter et al., 2018). One of the most important aspects of training future leaders is considering their current and desired levels of knowledge and expertise. The millennials could be taught a particular subject of study to have specialty expertise rather than general knowledge.

The search returns various suggestions on how to go about finding a mentor for leadership training. For instance, one may seek mentors from established thought leaders who can guide individuals in developing their leadership stances. Excellent thought leadership may be found by looking for renowned individuals they appreciate and asking others about their impact. Another option is to join a leadership program that provides its students with mentors. If someone wishes to grow professionally but is already employed, they can look for mentors to assist them. Mentors may be found at networking events, within professional organizations, and through online forums. Lastly, top leaders in their business may take on more prominent positions, such as mentors, seminar leaders, feedback providers, etc., to aid in leader development and offer mentoring opportunities. Millennial employees get used to mentoring because they can get insight from their supervisor or get direct feedback rather than reading leadership material. Finally, based on the findings, this research proposes recommendations to accelerate millennials' leadership development.

6. Conclusion

Based on the findings, this research proposes five recommendations to accelerate millennials' leadership development. First, to ensure the whole-department transformation. The business world is a place of intense competition. Problems with organizations include finding a good leader when there's so much competition. Therefore, from this point of view, the change is the whole company itself. Therefore, let's talk about everything, not only human resources. It transforms one continuous operation. Our findings support the literature's contention that every department in an organization is responsible for developing future leaders. Additionally, our results reveal that other departments are not geared toward leadership development, making it challenging for the organization to give sufficient training. In light of what we discovered, we propose a four-pronged approach to educating future professionals: the target population's culture, the Human Capital system, the developing individuals, and the system as a whole. In particular, our findings indicate that applying the transformation to the whole object at once yields the most outstanding results. The findings suggest that evaluating the growth potential of millennial leaders is crucial to the success of leadership development initiatives. Accelerating the millennial employee through a millennial leadership development program needs support from all departments due to the final impact of the leadership program and other support. The final goal is business growth. This finding aligns with the previous research (Fletcher et al., 2010).

Second, to ensure the organization's communication runs effectively. The search results indicate a tight relationship between successful corporate communication and leadership training. When a firm's employees can collaborate well, it directly results from their ability to communicate well. It is impossible to be a great leader without mastering the art of organizational communication, which improves business results and workers' lives. Strong leadership is the foundation of a compelling corporate communication strategy since the leaders set the tone for the team. How well its executives communicate with their staff may impact an organization's culture, morale, and productivity. Furthermore, leaders can benefit from effective communication in handling challenging situations, resolving conflicts, and overseeing broad horizons. Great leaders use various communication techniques to motivate and inspire their followers, such as articulating their vision clearly and concisely, actively listening to others, and

adjusting to their audience's preferred mode of expression. The results of this study support the idea that teaching people how to communicate effectively inside their organizations is essential for producing the kind of leader society needs. Besides, effective communication is crucial to ensure support from all parties involved in the millennial's leadership development based on their role in the company. This finding aligns with the (Kjellström et al., 2020). The search results indicate that effective communication is vital for successful leadership and organizational effectiveness. The efficacy of a business is contingent upon proficient communication, while inadequate communication can result in diminished employee morale, unmet performance objectives, and decreased sales. Effective communication is crucial for leaders as it allows them to effectively mobilize their team towards a common goal, empower their employees, foster trust, and successfully navigate through periods of organizational change. Individuals must acquire proficiency in corporate communication to become exceptional leaders. The study posits that practical communication skills within organizational contexts are imperative for cultivating leaders who meet societal demands. The importance of effective communication cannot be overstated in securing the necessary support from all stakeholders involved in the leadership development of millennials, taking into account their respective positions within the organization. The search results indicate that leadership communication courses have the potential to enhance leaders' cognitive abilities, improve their ability to articulate thoughts, and enhance their proficiency in disseminating information to diverse audiences. Effective communication plays a crucial role in developing leadership programs, as it facilitates the cultivation of leaders who can inspire and motivate individuals, establish a compelling vision, and foster an environment that promotes ongoing learning and advancement.

Third, shorten the duration of millennials' leadership development program. Our research revealed, among other things, that sometimes, shorter sessions resulted in massive gains. We discovered that a half-year intensive may be just as effective as a full-year program. Certain situations can even lead to knowledge gains comparable to those shown following a leadership development intervention. Since a shorter, more intensive program may achieve better results using less time and financial resources, program developers and participants may benefit from exploring ways to condense these initiatives. The millennials are quick learners who can absorb the material fast.

Fourth, to give millennials specific lessons. Every worker has a unique strategy for personal development. Our study revealed, in particular, that millennials are distinctive in their own right. Those of their personalities striving for work-life harmony value a good workplace environment. Because millennials are so different from previous generations, businesses must help millennials choose programs to help them achieve their individual learning goals. In addition, it is generally helpful to develop a growth attitude before beginning a new leadership development program. Ultimately, our findings suggest that program participants will have varying characteristics to alter and that some may need more assistance than others to reap the program's full benefits. This research is in line with the previous study.

Fifth, to evaluate the millennial's leadership development program periodically. This study's findings suggest that the positive effects of a single leadership development experience tend to dissipate over time. People may change as soon as they use what they've learned, but this isn't always true. Even in our studies, we saw this same dynamic play out: gains in leadership knowledge tended to evaporate in the months after the conclusion of a training course. Organizations should thus distinguish between fleeting success and long-term effects and check that their development initiatives will last. While it may be simpler to track short-term gains, the most successful programs work to sustain participants' new behaviors through regular reminders and other interventions. A periodic evaluation should be conducted to ensure the level of changes toward millennial employees. The search results indicate that conducting regular assessments of the leadership development program for millennials is essential to ascertain the program's enduring impact. The long-term effect of a solitary leadership development encounter tends to diminish over time, necessitating organizations to differentiate between transient achievements and enduring consequences. The most effective programs aim to maintain the adoption of new behaviors among participants by implementing regular

reminders and additional interventions. It is imperative to conduct periodic evaluations to assess the extent of changes occurring among millennial employees. The search results additionally propose that mentorship programs possess significant potential in cultivating leadership qualities among employees while establishing connections and engaging in networking activities, which hold considerable importance for individuals belonging to the millennial generation. Organizations must address the developmental requirements of their high-potential millennial employees to secure the future success of their leadership team. Establishing effective communication is paramount to ensuring the backing of all stakeholders engaged in the leadership development of millennials, taking into account their respective positions within the organization. The search results indicate that the successful implementation of leadership development programs necessitates their integration into an organization's daily operations. Furthermore, these programs should adapt to professionals' preferences to enhance existing practices and align with a dynamic environment. This finding aligns with the research (Solansky, 2010), highlighting the critical role of evaluation.

The current article took an integrated approach to improve the entire design of the millennial leadership development program to make them fit for purpose with real-world situations and prepare for future trends. This was accomplished through interviews with human resources department managers and directors. According to the study, the millennial leadership development program can be improved by highlighting the program perspective, ecosystem, and subject. The study results might be used to develop recommendations, policies, or support resources for accelerating millennial leadership development.

7. Limitations

The present study possesses certain limitations that provide avenues for future research. Firstly, this study is rooted in the experiences of human resource professionals from a country in the Global South, specifically those overseeing a millennial leadership training program. This geographical context may limit the global applicability of the findings. Future research could explore the influence of socioeconomic and political factors in the Global North on leadership development planning and implementation, potentially unearthing diverse insights and perspectives.

Secondly, the research predominantly highlights the perspectives of selected leadership development organizers, focusing on their interactions with millennial workers. This concentration might not encapsulate other generational cohorts' diverse experiences and perspectives. Subsequent studies could broaden the scope to include various generational groups, offering a more holistic understanding of leadership development across different age demographics.

Thirdly, while the findings offer insights relevant to multiple industries such as financial services, e-commerce, manufacturing and technology, and FMCG, their generalizability to other sectors remains uncertain. Future research endeavors might consider delving into other industrial domains to examine the consistency of these observations and conclusions.

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Critical Success Factors and Agile Transformation Framework in Oil and Gas Company Operations

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Abstract
In recent years, agile methodology has gained favor as a management strategy for delivering performance and converting enterprises into organizations that are faster, more flexible, and more responsive. Nevertheless, the use of agile methodology in the oil and gas business can pose problems if the necessary adaptations are not made correctly. In this research, a conceptual framework for agile transformation in the operations of oil and gas companies has been proposed. A comprehensive literature assessment of 22 publications taken from respectable journals and centered on the success criteria and frameworks for agile transformation serves as the first step in the research. The McKinsey 7S Framework is utilized to further categorize the aforementioned body of work. The results of semi-structured interviews that were performed with top transformative executives in the oil and gas industry are then given to address the potential afforded by agile transformation as well as the obstacles it poses. The study proposes a conceptual framework that is comprised of several clusters, including strategy and structure; people, processes, and culture; agile organization capability; employee engagement; sustainable performance; and, lastly, dynamic market and shareholder expectations. The literature review and the interviews were used to compile the data for this study. The framework offers a point of view on the application of agile principles to business operations in the oil and gas industry. This research makes a significant contribution to the current understanding of agile transformation in the oil and gas business by determining success criteria and frameworks for agile transformation and presenting a conceptual framework for adopting agile methodology within this industry. The framework that has been provided can be of assistance to oil and gas firms in their efforts to adjust to the dynamic business environment, which will allow these companies to become more responsive and adaptable as organizations.

1. Introduction

The use of an agile methodology for the delivery of performance has seen tremendous popularity growth over the course of the past decade. Because of the observation that the rate of business change was rapidly surpassing the ability of traditional manufacturing organizations to adapt, the word "agile" was developed as a response to this discovery. According to Harraf et al. (2015), modern corporate competition is defined by a high-intensity rivalry that takes place in an environment that is unpredictable and uncertain. In this context, businesses that are able to adjust rapidly and effectively to changes in the environment enjoy a major advantage. According to Hormozi (2001), organizations that fail to take advantage of possibilities and fail to adapt to changing situations may not be able to survive.

According to Power et al. (2001), the impetus behind the focus on agility is rooted in the imperative for organizations to enhance their responsiveness to evolving customer demands, shifting competitive landscapes, and escalating environmental volatility. Organizations that adopt agile methodologies are able to flourish in dynamic and constantly changing environments as a result of their ability to quickly respond and adapt to new circumstances. Goldman et al. (1995) assert that the paradigm is concerned with the capacity of enterprises to adjust to unforeseen changes, endure unparalleled business risks, and capitalize on emerging prospects. According to Zhang and Sharifi (2007), organizational agility is a fundamental aspect of competitiveness and considered the prevailing mode of competition and business paradigm in the 21st century.

Zhang and Sharifi (2007) have identified several fundamental capabilities that agile organizations exhibit, which include responsiveness, competency, flexibility, and speed. Responsiveness pertains to the capacity to identify and respond to alterations, whether foreseen or unforeseen and to adapt to novel situations. The concept of competency pertains to the ability to attain the

objectives of an organization through the demonstration of efficiency, productivity, and effectiveness. Flexibility is the ability to utilize a set of resources to accomplish diverse tasks and attain multiple objectives. Speed is as the capacity to execute tasks and operations within the minimum amount of time required. Conclusively, the capacity to exhibit agility is imperative for enterprises seeking to thrive in the current dynamic commercial landscape.

The process of agile transformation involves a shift in organizational culture that fosters greater networking and flexibility, facilitates more rapid achievement of desired outcomes, and enhances responsiveness to change. The implementation of an agility-based organizational transformation would necessitate a significant alteration in both cultural and business operational aspects (Mkoba & Marnewick, 2022). Empirical evidence suggests that throughout history, about 66% of change initiatives have been deemed ineffective, irrespective of the change approach utilized (Naslund & Kale, 2020). Oil and gas corporations aim to transform into integrated, agile, and highly responsive entities to effectively tackle forthcoming business obstacles. The aforementioned entities aspire to transition into agile enterprises (*Bp Annual Report and Form 20-F*, 2022). The agility of an organization, while advantageous in terms of speed and adaptability, may pose a potential hazard in ensuring the safety, reliability, and compliance of its operations. According to an empirical study, the implementation of agility may not be appropriate for all organizations and situations. Dühring and Zerfass (2021) assert that a high-hazard organization places great importance on establishing unambiguous chains of command within a high-risk setting. The study demonstrates that businesses can reap the many advantages of agility while preserving effective risk management and compliance, especially in regulated industries (Bickford et al., 2020).

The current body of literature exhibits a dearth of studies indicating the customization of agile transformation methodologies for the oil and gas sector. The objective of this research is to examine the factors that contribute to the successful implementation of agile transformation in industry operations. The proposed solution involves adopting a system-thinking approach to ensure that organizational factors are aligned with the agile journey. The application of systems thinking in the process of change involves the consideration of the "whole" from various perspectives concurrently. The examination of strategic, cultural, structural, and behavioral change aspects is approached through four distinct discourses, resulting in a comprehensive understanding that surpasses the limitations of one-dimensional models. Moreover, adopting a systemic thinking approach towards change facilitates a comprehensive viewpoint, in contrast to the often excessively reductionist techniques (Jackson, 2001). The systemic approach is based on a pair of fundamental principles. Initially, it is imperative to note that any alteration within a system inevitably affects all its constituent parts. According to Maes and Hootegem (2019), it is observed that any alteration made to a single component of a system has an impact on all the other components.

This study will investigate the critical success factors for agile transformation and build a conceptual framework to transform into agile organization in the oil and gas industry. This study will address the following questions: (1) What are the essential elements for successful implementation and the obstacles encountered during the process of transitioning to an agile methodology, as emphasized in prior scholarly investigations? (2) What are the potential advantages and obstacles associated with the implementation of agile methodology in the context of oil and gas industry operations? (3) What conceptual framework supports the application of agile transformation to the oil and gas industry?

This study proposes critical success factor adaptation and the developing of a conceptual framework relating to agile transformation in oil and gas industry operations. It contributes to the previous literature on embedding agile methodology within industry. Firstly, it promotes variety in agile methodology framework adoption within business transformation, other than in governance (Chikhale & Mansouri, 2015) and decision making (Settembre-Blundo et al., 2021). Secondly, it focuses on agile transformation in high hazard industries, particularly oil and gas operations, which was previously limited in scope. The prior focus of agile transformation in this type of industry was on manufacturing (Z. Zhang & Sharifi, 2007). Thirdly, it contributes to the

large-scale system operated in the past by the military (Dove & Turkington, 2009) and national technological infrastructure (Amin & Horowitz, 2008). Fourthly, system thinking is embedded in the conceptual framework specifically relating to the oil and gas industry which was traditionally the preserve of SME organizations (Sánchez-García et al., 2023) and related to COVID-19 (Elias, 2021). By addressing these research questions and objectives, this study will contribute to the knowledge and understanding of agile transformation in this industry.

2. Literature Review

2.1. Agile Transformation in Oil and Gas Industry Operations

The oil and gas industry is recognized as a heavy and highly hazardous type of environment to work in. Its lengthy processes commence with exploration of hydrocarbon materials, continues with the exploitation and transportation of oil and gas to the production site, culminating in fuel preparation, product distribution and usage (Czachorowski et al., 2022). Oil and gas operations represent one of the upstream process sections, which involve numerous resource assets including refineries, terminals, and pipelines, to explore potential oil and gas reserves (Czachorowski et al., 2022). It is acknowledged to be "a complex socio-technical system which involves several operations, conducted by multiple teams, and occurs in an integrated and coordinated manner" (Henriqson et al., 2022, p. 18). While oil and gas operations are also considered to be "integrated operations" which constitute "… the combination of people, working processes, and technologies to enhance decision-making and operational outcomes" (Albrechtsen, 2015), they necessitate the integration of data in a real-time manner, the collaboration between various operations in several areas, and experts with diverse backgrounds drawn from different geographical regions (Henriqson et al., 2022). Since oil and gas operations work in numerous exploration sites to find and exploit fuel reserves, integration and automation of the process are essential in order to effectively manage the process remotely and achieve accurate results.

The agile approach is becoming evident in the software development industry which requires flexibility and responsiveness in each small and breakable process unit (Dingsøyr et al., 2012). It requires micro-sized teams which are often referred to as 'squads' with cross-disciplinary members who enable high-speed decision-making without the involvement of a complicated bureaucracy (Highsmith & Cockburn, 2001). Since software development is expensive and complex, the agile approach becomes appropriate due to its simplicity and iterative process resulting in less technical debt, higher user satisfaction and greater product quality. Oil and gas operations have similar characteristics to those of software development, with wells and refineries applying digital technologies to facilitate control, yet they still utilize heavy and complex procedures resulting in high-priced failure (Czachorowski et al., 2022). Therefore, agility becomes one of the substantial principles to be implemented in the oil and gas industry. However, agile principle implementation often sits uncomfortably with prevailing industrial processes. There is a prolonged history of the oil and gas industries exploiting traditional approaches and systems in managing processes requiring agile transformation (Henriqson et al., 2022) which promotes large-scale change in all process layers subsequently having a significant impact not only on technologies and organizations, but also on business processes and individual mindsets (Rogers, 2016). One salient mentality that is both evident and requires application is that of continuous improvement (Beck et al., 2001).

Since 2015, oil prices have hit new lows due to various factors. Between 2014 and 2016, the supply of oil remained high, yet the demand decreased markedly, resulting in unprecedently low prices (Czachorowski et al., 2022). Later in 2020, oil and gas companies faced significant challenges due to the coronavirus pandemic and political wars, which led to the crushed oil price crisis. These developments increased the pressure on many oil and gas companies to survive even further (Blackmon, 2020). These protracted events induceed the industry to accept a lower profit margin. At the same time, sustainability and clean energy became high priorities within the global situation (Czachorowski et al., 2022) which forced the oil and gas industry to re-think its organizational ability to respond by offering lower carbon energy products (Venables, 2019). As

a heavy-asset industry, the process of moving to agility has been hard and slow (Handscomb et al., 2019).

2.2. McKinsey 7S Framework and System Thinking Approach: Perspectives on Agile Transformation to Propose Conceptual Framework

More than fifty years ago, organization related solely to structure, whereas today it consists of much more than that. Peters and Waterman (2012) formulated several dimensions to be coordinated in order to achieve organizational effectiveness as the turning point of organizational change. In the 1970s, these were promoted as the McKinsey 7S framework whose dimensions comprise structure, systems, skills, style, strategy, staff, and shared values (McKinsey Quarterly, 2008). This framework is crucial to promoting interaction between dimensions as a means of supporting organizational transformation and describes both the organizational capabilities and the complexity of the change process. If one dimension was prioritized less, the transformation process would be more challenging. This McKinsey 7S framework suggests that coordination between each organizational dimensions plays a significant role in increasing organizational effectiveness (McKinsey Quarterly, 2008).

On the other hand, system thinking is one of the research approaches which provides an overview of a complex system to enable understanding of its behavior and predictions as to its future reoccurrence (Arnold & Wade, 2015). Numerous previous studies have attempted to define the concept of system thinking. In short, three core blocks required in this approach are elements, interconnections, and a function or a purpose (Meadows, 2008). There are many characteristics of system thinking mentioned in previous studies, such as whole parts, dynamic behaviours, systems as the cause of behaviours, interconnecting or interrelationships, stock and flow relationships, non-linear relationships, feedback loops, and system structures which generate behaviors (Arnold & Wade, 2015). System thinking has been utilized to simplify organizational change and solve problems within dynamic environments (Rigby et al., 2000). Organizational change has often been described by the system thinking due to the similarities. First, the complexity of organizational change can be portrayed by system thinking. Second, the dynamic interaction and interconnection between parts regarded as holistic in organizational change can only be identified by applying system thinking (Maes & Van Hootegem, 2019). Organizational change involves many parties and processes, while the interdependence between constructs needs to be explained as the whole. The patterns observed need to be recognized so that the interaction between each part can be further understood. Third, agile transformation, which constitutes one kind of organizational change, can be portrayed by system thinking due to the fact that the agile approach involves the iteration and feedback loop which is, in some ways, similar to the characteristics of system thinking (Elia et al., 2021). Therefore, system thinking methodology is appropriately used to describe organizational change, particularly agile transformation.

When applied to the process of change, the system thinking approach looks at the "whole" from various angles at the same time. The factors of strategic, cultural, structural, and behavioral transformation are evaluated via four unique discourses, which results in insights that are more powerful than one-dimensional models could ever be. In addition, an approach to change that is based on system thinking rather than the typically excessive reductionist methodologies enables one to adopt a holistic point of view (Jackson, 2001). The systemic technique is based on two overarching ideas that serve as its foundation. To begin, there is no such thing as a modification that does not in some way influence every aspect of the system to which it belongs. Second, any modification made to one part of a system will have an effect on all of the other parts of the system (Maes & Van Hootegem, 2019).

Due to the characteristics of agile transformation comparable to the difficulty of implementing agile transformation to the oil and gas business, agile transformation can basically be thought of as one form of organizational change. In addition, by analyzing the critical success factors and challenges of agile transformation, specifically within the context of the oil and gas industry, using the McKinsey 7S methodology and system thinking approach, each finding will be arranged into

a whole system that can help describe the environmental context of the study. This will be accomplished through the utilization of system thinking. During this step, the conceptual model for this study will be proposed.

3. Methodology

This study involved the conducting of a literature review and case study in order to develop a model of adaptation factors for transforming the organization into an agile oil and gas industry operation. Figure 1 outlines the various stages involved in the research methodology.

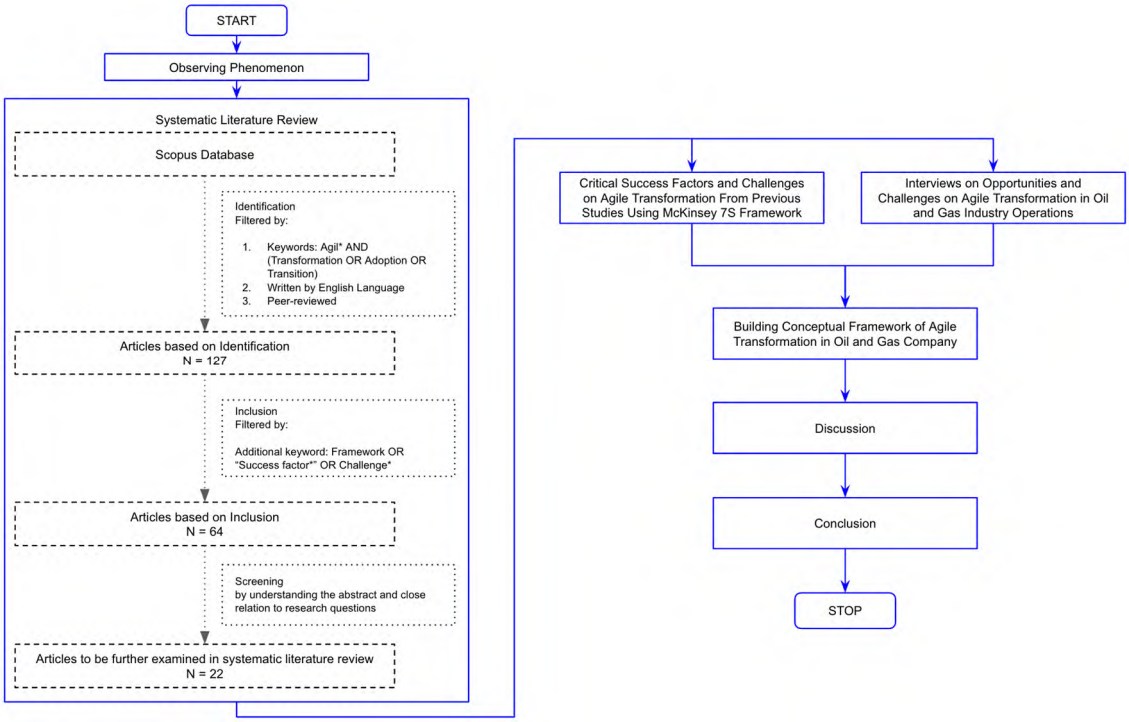

Fig. 1. The logical steps of the research methodology

The previous research conducted reviewed the contents of the Scopus database using the keywords "Agility transformation", "Agility transition", "Agility adoption", "Agile transformation", "Agile transition", and "Agile adoption." Focusing on English language articles which had been peer reviewed this exercise was able to identify 127 studies using these keywords. The second screening included 127 articles and used additional keywords (“Framework” OR “Success factor” OR “Challenge”) to narrow down the results. The screening process reduced the results to 64 studies that were incorporated into a state-of-the-art table. A further screening of literature review article abstracts produced twenty two relevant studies, twelve of which were used to highlight the key success factors and challenges of agility transformation.

The study involved conducting semi-structured interviews with a group of nine individuals, comprising of five Vice Presidents and four transformation leaders, who were affiliated with a multinational corporation operating in the oil and gas industry on a global scale. The aim of the interviews was to obtain valuable insights into the key factors that contribute to the success of agile transformation initiatives, as well as the opportunities and challenges that are associated with implementing such initiatives within this particular economic sector's operations. Each interview was conducted for an hour, which was deemed an appropriate duration to facilitate the acquisition of pertinent insights. The process of selecting adaptation factors was informed by a synthesis of critical variables that are essential for the effective implementation of agile methodologies in the context of oil and gas operations. A conceptual framework was formulated to tackle the intricate obstacles associated with the implementation of agile methodologies in the oil and gas sector. The table below contains details of the twenty two studies mentioned above:

No.	Authors	Title	Year	Source title
P1	Mkoba E.S., Marnewick C.	Organizational Culture Attributes Influencing the Adoption of Agile Practices: A Systematic Literature Review	2022	Journal of Information Systems Engineering and Management
P2	Khan R.A., Abrar M.F., Baseer S., Majeed M.F., Usman M., Rahman S.U., Cho Y.-Z.	Practices of motivators in adopting agile software development at large scale development team from management perspective	2021	Electronics (Switzerland)
P3	Abrar M.F., Ali S., Majeed M.F., Khan S., Khan M., Ullah H., Khan M.A., Baseer S., Asshad M.	A framework for modelling structural association among De-Motivators of scaling agile	2021	Journal of Software: Evolution and Process
P4	Dühring L., Zerfass A.	The Triple Role of Communications in Agile Organizations	2021	International Journal of Strategic Communication
P5	Muhammad A., Siddique A., Naveed Q.N., Saleem U., Hasan M.A., Shahzad B.	Investigating crucial factors of agile software development through composite approach	2021	Intelligent Automation and Soft Computing
P6	Naslund D., Kale R.	Is agile the latest management fad? A review of success factors of agile transformations	2020	International Journal of Quality and Service Sciences
P7	Pinton M., Torres A.S.	Human aspects of agile transition in traditional organizations	2020	Journal of Technology Management and Innovation
P8	Akbar M.A., Shad M.K., Lai F.-W., Hussain S.	Towards successful agile development process in software outsourcing environment: A systematic literature review	2020	International Journal of Business Innovation and Research
P9	Abrar M.F., Khan M.S., Ali S., Ali U., Majeed M.F., Ali A., Amin B., Rasheed N.	Motivators for Large-Scale Agile Adoption from Management Perspective: A Systematic Literature Review	2019	IEEE Access
P10	Kalenda M., Hyna P., Rossi B.	Scaling agile in large organizations: Practices, challenges, and success factors	2018	Journal of Software: Evolution and Process
P11	Dikert K., Paasivaara M., Lassenius C.	Challenges and success factors for large-scale agile transformations: A systematic literature review	2016	Journal of Systems and Software
P12	Gandomani T.J., Zulzalil H., Nafchi M.Z.	Agile transformation : A multi-dimensional process	2015	Jurnal Teknologi
P13	Qumer, A., Henderson-Sellers, B.	A framework to support the evaluation, adoption, and improvement of agile methods in practice	2008	The Journal of Systems and Software
P14	Chan F. K. Y., Thong J. Y. L	Acceptance of agile methodologies: A critical review and conceptual framework	2009	Decision Support Systems
P15	Qureshi, M R J., Kashif, M.	Adaptive Framework to Manage Multiple Teams Using Agile Methodologies	2017	International Journal Modern Education and Computer Science
P16	Gunasekaran, A.	Agile manufacturing : A framework for research and development	1999	International Journal Production Economics
P17	Jovanovic, M., Mesquida, A., Mas, A., Colomo-Palacios, R.	Agile transition and adoption frameworks, issues and factors: A systematic Mapping	2020	IEEE Access
P18	Gandomani T J., Nafchi, M. Z.	An empirically developed framework for Agile transition and adoption: A Grounded Theory approach	2015	The Journal of Systems and Software
P19	Conboy K., Carroll N.	Implementing Large-Scale Agile Frameworks: Challenges and Recommendations	2019	IEEE Software
P20	Amiri F., Overbeek S., Wagenaar G., Stettina C J	Reconciling agile frameworks with IT sourcing through an IT sourcing dimensions map and structured decision-making	2021	Information Systems and e-Business Management
P21	Van Wessel R M., Kroon P., de Vries H J	Scaling Agile Company-Wide : The Organizational Challenge of Combining Agile-Scaling Frameworks and Enterprise Architecture in Service Companies	2022	IEEE Transactions on Engineering Management
P22	Sidky A., Arthur J., Borner S.	A Disciplined approach to adopting agile practices: the agile adoption framework	2007	Innovations System Software Engineering

Table 1. The papers on Systematic Literature Review in agile transformation

4. Results

4.1. Critical success factors in, and challenges to, agile transformation identified by previous research

The study conducted a comprehensive analysis of 12 Systematic Literature Review (SLR) papers to ascertain the essential factors that contribute to the success of agile transformation across various industries and applications. The McKinsey 7S framework has been utilized to map the critical success factors and challenges, thereby identifying the various factors that impact the alignment of the organization. Table 2 contains the list of critical success criteria of agile transformation.

Strategy	a. Organizational strategy (P1)	b. Focus on innovation (P1)	c. Transformational change (P10)	d. Entrepreneurship (P1)	e. Customer relationships (P1)	f. Competitiveness (P1)	g. Customer satisfaction (P2)
	h. Defining business goals (P12)	i. Having convincing reasons for change / agile (P12),	j. Customer involvement strategy (P8)				
Structure	a. Organizational structure (P1)	b. Projectized organization structure (P1)	c. Decision-making structure, decentralized decision-making (P1, P6)	d. Pilot project in cases of a lack of experience (P2, P11, P12)	e. Aligning structures and processes (P4)	f. Communication, coordination and control (P5)	g. Define, align, and communicate new roles for employees (P6, P8)
	h. Work synchronization among distributed sites (P8)	i. Small team size (P8)	j. Parallel project testing (P8)	k. Task allocation and team division (P8)	l. Team setup (P12)		
System	a. Controlling process (P1)	b. Quality enhancement (P1)	c. Continuous improvement (P1)	d. Goal achievement (P1)	e. Face-to-face meeting (P2)	f. Sustainable planning (P2, P9)	g. Use of automated software tools (P2)
	h. Risk management (P2)	i. Knowledge-sharing management (P2)	j. Quality production using pair programming (P2)	k. Mechanism for change management (P2)	l. Requirement management using agile-oriented tools (P2, P8)	m. Requirement management process (P2, P8)	n. Aligning structures and processes (P4)
	o. Implementing agile tools and technologies (P4)	p. Quality management (P5)	q. Communication (P5)	r. Delivery strategy (P5)	s. Facilitate internal/external coaching (P6)	t. Involving change agents and agile champions (P6)	u. Report and adopt (P8)
	v. Tracking and control (P8)	w. Regular delivery of iteration (P8)	x. Effective requirement engineering methods (P8, P11)	y. Sustain agility (P8)	z. Deep and flexible planning (P8)	aa. Deliver in small iterations (P8)	bb. Tools and infrastructure (P10)
	cc. Choosing and customizing the agile approach (P11)	dd. Managing the transition (P12)	ee. Solid engineering practice (P10)	ff. Pre-start-up assessment (P12)			
Style/Culture	a. Management support / Strong executive support (P1, P2, P5, P6, P8, P10, P11)	b. Entrepreneurship (P1)	c. Customer relationships (P1)	d. Rapid response (P1)	e. Driving through barriers (P1)	f. Cooperative organizational culture (P2, P9)	g. Dedicated management (P2)
	h. Agile development environment (P2)	i. Team encouragement (P2)	j. Strong collaboration with customers (P2)	k. Strong collaboration and communication (P2)	l. Leadership strong commitment and team autonomy (P2, P9, P11)	m. Aligning culture and people (P4)	n. Leadership (P5, P11)
	o. Customer involvement (P5, P8)	p. Creating an agile mindset (P6)	q. Decentralized decision-making (P6)	r. Flexibility in developing process model (P8)	s. Regular feedback (P8)	u. Commitment to change (P8, P11, P12)	v. Friendly relationships (P8)
	w. Change acceptability and early identification (P8)	x. Cooperative organization culture (P8)	y. Shared views on values and practices (P10)	z. Teamwork support (P10)	aa. Engaging people (P11)	bb. Communication and transparency (P11),	cc. Culture (P5)
	dd. Informal communication (P8)						
Staff	a. Team capability (P5)	b. Internal/external coach (P6, P12)	c. Change agents and agile champions (P6)	d. Expert team (P8)	e. Confidence of development team (P8)	f. Team spirit (P8)	g. Facilitators (P12)
Skill	a. Creative thinking (P1)	b. Decisiveness (P1)	c. Team competency in the area of agile development expertise (P2, P9)	d. Scheduled training for team members (P2, P12)	e. Training, learning, (P2, P5, P6, P9, P11, P12)	f. Agile software technique (P5)	g. Facilitate internal/external coaching (P6, P11, P12)
	h. Continuous, evolutionary, step-by-step, continuous learning (P6)	i. IT infrastructure awareness (P8)	j. Understanding project scope (P8)	k. Re-use ability (P8)	l. Education and support (P8)	m. Awareness of organizational culture (P8)	
Shared Values	a. Articulating future vision (P1)	b. Trust, Participation, Commitment, Innovative, Efficiency, Agility, Accountability, Consistency (P1)	c. Customer satisfaction (P2)	d. Agile mindset (P6)	e. Trust (P8)	f. Acquire knowledge (P10)	g. Mindset and alignment (P11)

Table 2. The critical success factors and challenges of agile transformation

The seven dimensions in the organization need to be aligned with each other in order for agile transformation to be successful and organizational change driven forward as per aspirations.

4.2. Empirical experience of potential advantages of and obstacles associated with the implementation of agile transformation in oil and gas company operations

The study involved conducting interviews with a sample of nine individuals, comprising of five Vice Presidents and four transformation leaders, who hold leadership positions in the oil and gas industry at both global and regional levels. The findings of the study highlighted several crucial factors that must be taken into account when undertaking agile transformation. The operational leaders of the industry have articulated their expectations, indicating that there are prospects to convert the oil and gas operation from a functional organization to an agile model.

The collaborative efforts of professionals from various fields, motivated by a shared goal in a flexible setting, enhance the speed of decision-making and streamline the management procedures, ultimately expediting the organization's delivery of value. An agile organization prioritizes customer satisfaction and mitigates the occurrence of silo mentality, which is observed in functional organizations. The stakeholder engage in the planning process, review the deliveries, and contribute to the continuous improvement of the project through a retrospective procedure. The elimination of non-value-added products from the customer's perspective results in an increased competitiveness of the remaining products and deliveries.

The utmost importance is placed on safety in highly hazardous industries. An organization that adopts an agile approach places significance on transparency, ownership, and accountability. This is achieved by deploying small teams in a mission-driven squad model, which in turn reduces the complexity of interfaces involved in delivering projects. The team input activities into a clear backlog, then evaluated and ranked according to their ability to provide value. The implementation of agile methodologies and leadership practices fosters a culture of autonomy, allowing individuals to exercise discretion in resource allocation and personal mobility. Agile organizations exhibit a higher degree of expediency and reduced bureaucracy in their staff deployment processes. Facilitating opportunities for individuals to transition between teams as a means of personal development can enhance their level of engagement.

Despite the aforesaid potential exists, the agility of oil and gas operations is accompanied by a range of challenges. The oil and gas industry are inherently hazardous, and risk might increase due to the need for greater flexibility and faster decisions which represents a pitfall of agile organizations. In certain situations, organizations need to slow activities down to reduce the incidence of errors resulting from the human performance factor especially in complex situations. Certain agile-related operations executed by an organization will prove riskier, especially on-site operations and implementation procedures.

The corporation employs rigorous methodologies to establish its organizational structure. The attribute of agility fosters adaptability, which has the potential to generate instability and perplexity at the operational level. The operational practices of oil and gas companies are predominantly influenced by procedural frameworks and technological resources, whereas an organization that prioritizes agility places greater emphasis on interpersonal communication. A hazardous industry enterprise places significant emphasis on the negotiation of contracts at the outset. This entails pre-agreement as opposed to solely establishing principles and cooperating during execution to mitigate ambiguity. This approach represents a significant change in the operational methodology of agile organizations. Table 3 presents the outcomes of the interviews conducted, along with the variables of the conceptual framework.

No	Quote	Variable
1	"That's when we went through reinvention. It's the biggest change in [the company] in its 120-year history. So, I think with the whole move towards being an international energy company not an international oil company, that's a huge change." "That's what [the company] has been trying to make a lot of progress in over the last two years. You explain what our strategy and vision are, what we're trying to achieve, why we're doing these things. I think it's a work in progress."	Purpose and ambition
2	"It gives a lot of benefit. There's a lot of iteration. There's a lot of prioritizations that needs to be discussed, and all that. So, I think it works well with access to management."	Value prioritization
3	"… I think those two things are efficiency and ownership. Also being closer to management for support is important because connected by nature."	Top management support
4	"… more motivation for people to engage because they feel a bit less that they are part of a hierarchy. They feel part of a team that is going to deliver a mission or a product rather than hierarchy. So, when you see hierarchies, you are always looking at maybe not speaking up. You're afraid of what your boss is going to say."	Lean and flat organization structure
5	"So, I think it's more about breaking down the silos and the old ways of doing things. I think it's about making quicker decisions. But it's, for me, the root, it's about having a continuous improvement mindset."	Decentralized decision making
6	"So, I think the combination we have of what we call enablers, and that's the reason for calling them enablers, so function...the areas of expertise that provide talent from these multidisciplinary teams which are called 'asset teams; to deliver a product. People are getting, like, on the ground experience that they like that involves interacting with multi-disciplinary colleagues, but also we're getting the assurance and support from the function that we call 'enablers' now."	Embedded governance and quality assurance
7	"… Basically, we're actually, if you think about the adjusted structure in OKR, in squads, in Sprint reviews and retrospectives, it's very structured and it's not chaos .."	Continuous improvement infrastructure
8	"Until we figure out how to actually approach that because it's the engineering side of things in wells might be similar to software development, because you are iterating and you are actually testing and running different models to see the casing, the pipe, the fluids, the pressures … then when you execute. you need to have a decision-making process."	Short and iterative delivery
9	"I think we started like maybe 3.5 years ago. That was the first time I heard about agile and attending different kinds of training to understand a bit more and knew that was coming from the software industry and we were interested in adapting this."	Agile foundation training
10	"I think solving problems quicker means you can solve more problems as well. You grow capability by that." "Actually, I think it's more about mindset. So, it's about continuous improvement. It's about doing something better today than you did it yesterday."	Growth mindset
11	"... by deploying people in squads, they become like an asset, like a mini-asset model, because then you start to work more slowly. We call "flow-to-work" people that comes from different expertise. So, I use the term 'multidisciplinary team' that is actually delivering a product."	Transparent and collaborative
12	"… speak first. And then, the others may end up not speaking at all. So, I think it's more engaging, more motivational, because they feel that they're participating more in delivering the product."	Customer involvement
13	"… I think behaviors are absolutely critical and we're working on that to ensure that the squad leads become facilitators of these processes. They are not bosses who are saying, like, 'OK, you need to do this and that.' It's kind of interesting because he's not anybody's boss, but there is some level of accountability on the part of the squad member to the squad lead and the squad lead to the unit lead with the support of the enablers."	Servant leadership
14	"We have different types of activities and, so, have intervention. Another squad is responsible for early design and planning. Yet another covers detailed design and execution. So, they do different things and might have slightly different needs. The intervention squad is the most advanced thing because of its interventional integrity."	Flexible resourcing and deployment
15	"We have to adjust it because the coaches, the agile coaches, were telling us the way we do it… We explained our business to the coaches and they understood exactly why we're doing this thing. So, we actually evolve and now have a more balanced approach in terms of frequency."	Agile coaches and champion
16	"It's about engaging the workforce. So, I think it's massively important to get everybody on side and I'm on board." "… So, I think we need to keep an eye on behaviors and measure the level of engagement. satisfaction, and motivation of team members."	Employee engagement
17	"… But one of the characters is, of course, speed, flexibility at the top, meaning that we are going to go fast as you said. Whatever we want then might be an impact."	Agile organization capability: speed
18	"… because that's the meeting like flexible planning, staffing deployments. Just stay on top of that because, with agile being dynamic, the deployment of resources is critical." "I think the company has been flexible in adding and adjusting some resources because we didn't put them into different teams."	Agile organization capability: flexibility
19	"I think, ultimately, it's about business results and you can't just say that getting better business results… better safety performance, better financial performance, better engagement... will lead to greater business longevity"	Sustainable performance
20	"… If we, as a company, don't control costs and we are not effective in how we do things, we're going to lose competitiveness, and when you lose competitiveness there are many, many, many issues in the market. If you are at the bottom of the market, there are many risks. You could drop out of the market."	Dynamic market
21	"… if there are companies that are way more efficient, they're going to attract more capital. They're going to attract more talent. They're going to attract more customers."	Shareholder expectation

Table 3. Interview quotation and variables for conceptual framework

4.3. Conceptual framework on agile transformation in the oil and gas industry operation

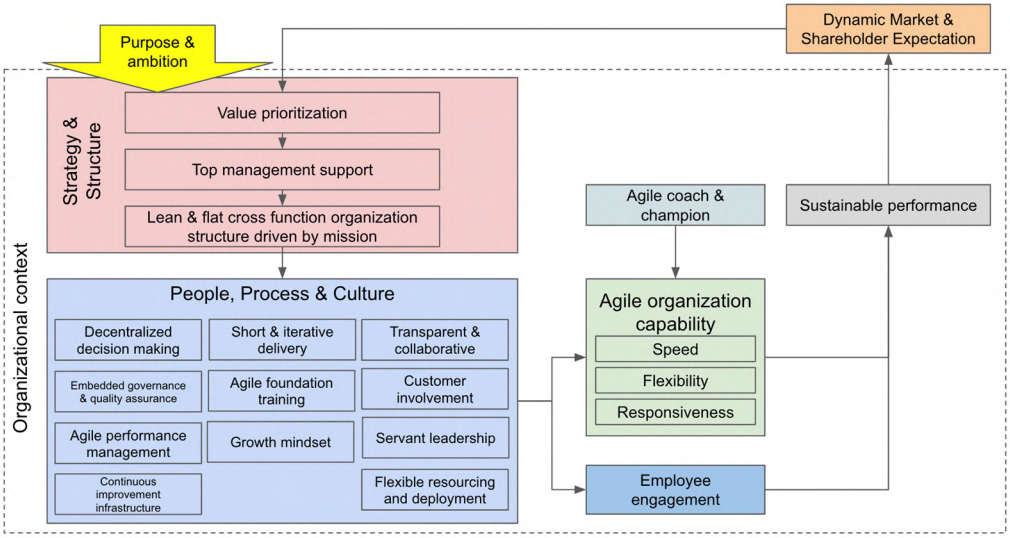

Fig. 2. Conceptual framework for agility-based organization transformation

The conceptual framework was developed using systematic literature reviews combined with interviews with top management from the oil and gas industry. The variables were decided on by identifying and analyzing the success factors of agile transformation, and by analyzing interview transcripts that had been coded post-recording. The primary objective of this framework is to determine the essential factors for success that must be incorporated while undertaking the transformation process to overcome the challenges. The visualization of the conceptual framework is shown in Figure 2.

5. Discussion

The objective of this study is to address three inquiries pertaining to the agile transformation framework within the oil and gas sector. The initial inquiry pertains to the essential elements and obstacles involved in the process of agile transformation. The study involved a comprehensive analysis of twenty-two systematic literature review papers to identify the critical success factors and challenges associated with organizational transformation. The findings were subsequently mapped onto seven dimensions in alignment that are encompassed within the McKinsey 7S framework. This model operates under the assumption that all seven elements are interconnected, and any modification to one element necessitates corresponding adjustments to the remaining components of the organization to ensure optimal functionality (Jharotia, 2019).

The secondary aim attempts to evaluate the potential advantages and constraints of implementing agile methodology in the oil and gas sector, by conducting interviews with the Heads of Transformation of companies in the industry. Identifying opportunities and challenges during the transformation process is a key focus, including improving operational safety, accelerating value delivery (D. Z. Zhang, 2011), workplace transparency and collaboration (D. Z. Zhang, 2011), customer satisfaction (Solinski & Petersen, 2016), and employee engagement (Solinski & Petersen, 2016). However, careful guidance is needed so as not to compromise company safety and reliability, and to facilitate organizational alignment, communication, and interpersonal cooperation. Implementation of an agile methodology can increase flexibility and contribute to an effective business strategy, reduce silo mentality, and increase stakeholder engagement. An important focus is also placed on safety, transparency, ownership and accountability in organizations adopting an agile approach. The risks and challenges associated with transforming into an agile operation in the oil and gas industry, including inherent hazards, the need for flexibility and quick decision making. Organizations need to adapt their operational practices in light of procedural, technological and interpersonal communication frameworks.

The third inquiry pertains to the fundamental principles and assumptions that form the basis of the conceptual framework governing the implementation of agile transformation within the oil

and gas sector. The closed-loop is an essential component in explicating the systemic process of agile transformation through the lens of systems thinking (Arnold & Wade, 2015). The *purpose and ambition* of *strategy and structure* are to decide which values of the organization need to be prioritized. In this section, *purpose and ambition* is similar as drivers or "reason for agile transformation" in previous literature (Gandomani et al., 2015). For some mature companies, being agile is difficult because they have to make large-scale changes to existing business processes and culture. The need for them to leave their comfort zone could prove pointless if it does not achieve a meaningful objective. Therefore, they should define clear goals or purposes, as stated in the conceptual framework, and aim to push their limits to undertake agile transformation which also needs to be embedded in the organization's strategy and documentation due to the importance of its operating on a long-term basis (Conboy & Carroll, 2019). Decision makers are required to approve the agile approach which, therefore, increases the importance of producing an integrated strategic plan.

Shared values and *prioritization* strong foundations for fundamental changes to organizational culture. Oil and gas companies often operate on a rigid functional model where each department has its own priorities that do not always align with each other. The process of value prioritization facilitates the modifications that align all tiers of an organization towards shared objectives. The successful implementation of agile transformation in large-scale change initiatives necessitates prioritization and the establishment of clear roles for all stakeholders involved (Gandomani et al., 2013). The process of value prioritization is founded on the value that is bestowed upon the enterprise and determines which activities are undertaken first and which are discontinued (D. Z. Zhang, 2011).

As decision makers, managers need to be on board with the change plan and involved as the change makers. Furthermore, the top management and type of leadership also influence organizational change strategy (Dikert et al., 2016; Muhammad et al., 2021). Leaders are paramount in deciding an organization's direction by being of the right "agile" mindset (Denning, 2016). In smaller companies, it is easier for the leaders to implement agile organization from the outset by creating clear goals that require agility. However, in their larger counterparts, the existing management team should be able to integrate an agile mindset in their thinking to further encourage their subordinates to do the same. The change will only happen if top management are supportive of reinforcing new behaviors and interactions, and becoming involved in transforming the organization to an agile one (Khan et al., 2021). *Lean and flat structure organization* in strict mature organizations is one of the large-scale transformations necessary to support an agile approach. Through a new organizational structure that supports an agile environment, decision making is undertaken by each smaller team, thus becoming faster and more appropriate. Even though, in a previous study, the implementation of scrum methodology as one agile method was shown to be viable in strongly hierarchical organizations (de Sá, 2023), horizontal interaction, cross-disciplinary teams, and flat structures are considered more desirable in achieving agile transformation.

The second cluster of the conceptual framework relates to *people, process, and culture*, requiring four dimensions of the McKinsey 7S framework, ranging from the third to the sixth. The third dimension is *system*, which refers to an agile governance system that effectively manages risk in the organization's processes and activities. This system should be integrated into the organization model without introducing unnecessary complexity and bureaucracy. In the conceptual framework, this is referred to as embedded governance and quality assurance. Many people assume that being agile means avoiding governance and expecting chaos (Dikert et al., 2016), whereas governance and quality assurance should form part of the system in order to maintain work. Some companies decide to assign different teams to product development and quality assurance, a policy which could improve product quality if both teams are open to joint collaboration and coordination (Dikert et al., 2016). However, in agile organizations, *governance and quality assurance* are embedded in the line of delivery to avoid extending bureaucracy. In the subsequent process, it is necessity to have new designs for *agile performance management and appraisal*, and a different and dynamic set of KPIs throughout the year reflecting value

prioritization. From the previous literature, it is evident that *agile performance measurement* is necessary to provide guidance as to whether the organization is successful in implementing agile tools and practice by assessing both the project and organizational level (Sidky et al., 2007). Planning is flexible with interactive delivery and feedback sessions. Transition and change management is available and there is a clear and robust *continuous improvement infrastructure*. One agile framework may come with an infrastructure that must be adhered to over the long-term (Conboy & Carroll, 2019). It must be aligned with the organization's structure and integrated with the regulatory framework. Any necessary changes to the existing structure and legal system considered necessary should be restricted to small scale fixes undertaken in order to avoid difficulties in integrating the infrastructure (Conboy & Carroll, 2019).

The fourth dimension is *shared value*, meaning that the organization establishes purpose and ambition, while creating a trust environment with strong emphasis on *customer involvement*. As the customers form part of the team membership in the agile approach, not involving them in the process would result in failure (Gandomani et al., 2015). In a previous study, *customer involvement* was highlighted as the most crucial factor of agile transformation (Muhammad et al., 2021). On the other hand, participation and commitment across the organization which promotes values such as accountability, transparency, consistency, and efficiency is also substantial. Such commitment, would render all problems and drawbacks easily solvable (Dikert et al., 2016). It only increases the probability of failed agile implementation if the organization maintains silos or internal boundaries which can lead to a scarcity of talent or diversity of priorities (Dikert et al., 2016). A fundamental prerequisite is that every team and its leadership possess a *growth mindset* to sustain their learning and adaptability. This is the opposite of a fixed mindset which often manifests itself through resistance to change. This represents one of the common challenges to agile transformation (Pinton & Torres Junior, 2020). One of the feasible preventions to encourage a growth mindset is by acknowledging the positive aspect of mistakes in manageable situations from the perspective of promoting learning and enabling rapid responses. Moreover, high frequency of management communication regarding any change and the benefit of agile transformation is crucial (Pinton & Torres Junior, 2020). Organizations should also motivate their employees to develop professionally by, for example, providing training or rewards (Naslund & Kale, 2020). A growth mindset also is highly related to continuous improvement which is one of the agile approach principles (Beck et al., 2001).

The fifth dimension is *style/culture* with top management engaged in, and supportive of, the organization embarking on the agility journey. The leadership style enables team autonomy and decentralized decision making. A collaborative mindset can be seen across the organization. The implementation of a *servant leadership* approach is deemed essential in fostering agility within an organization in order to facilitate change and empower the team to make decisions. Servant leadership, also closely related to *employee engagement* supported by leaders, organizations, is employee minded, and promotes a positive organization climate, empowerment, and proactive personality (Canavesi & Minelli, 2022). However, it also has negative effects such as poor work-life balance, high pressure, and remote working. The team exhibits a willingness to vocalize their thoughts and make valuable contributions. Customers become the main focus of agile development principles to ensure the products satisfy their needs (Beck et al., 2001).

The sixth dimension is *skill* which development high prioritized in the area of agile values, principles and practices across the entire organization and further labelled as *agile foundation training*. Training is crucial when the company seeks to move from a traditional to an agile approach in delivering values. From previous research, it is clear that many issues are caused by inappropriate training, for example unrealistic expectations, resistance to change, lack of collaboration, limited understanding of the agile mindset, and low confidence (Javdani Gandomani et al., 2015). Training in agile transformation should be prepared with strong planning and high attention to detail. Training should be conducted which covers complete, appropriate content and practices, together with full and continuous commitment, while also considering the human aspects. There are leaders and *coaches* acting as a team who are competent to lead and teach others about agile transformation and understand the change management process (Abrar

et al., 2019). For an organization to be agile, it is imperative to have a proficient workforce capable of executing ongoing enhancements. The implementation should also aim to cultivate a coaching habit that fosters the enhancement of the team's competencies (Paasivaara & Lassenius, 2014).

The overall outcomes of the *agile process, people and* culture will lead to higher *employee engagement* and the possession of agile organization capability consisting of speed, flexibility, and responsiveness. Three of these capabilities are well-known as agile principles that are expected to be demonstrated by the companies conducting agile transformation (Beck et al., 2001). Agile companies are expected to be faster in product delivery and processes (Jovanovic et al., 2020), flexible in uncertain situations, and responsive to change (Mkoba & Marnewick, 2022). Organization capability development has been enhanced with the role of agile coaches and champions. It is deeply relatable with the seventh dimension of the McKinsey 7S framework which is *staff* - a cohort of individuals functioning as catalysts for change, suggesting substantial endorsement from the leadership in facilitating this metamorphosis (Abrar et al., 2019). The involvement of dedicated coaches throughout the transformation journey is essential. High employee engagement signifies a closer employee-employee relationship and between employee and company. This scenario, in turn, produces a more trustful, supportive, and constructive working environment (Gandomani et al., 2015). If the workforce is engaged, there is transparency regarding individual workloads and productivity. Employees also participate in the training, the change, and the process of agile transformation (Pinton & Torres Junior, 2020). Through such change, employees are no longer reactive and passive, but motivated and active in seeking to be part of the change process. Employees are excited and passionate with an agile mindset (Dikert et al., 2016).

The ultimate goal of organizational capability is sustainable performance on the part of companies which surely strive to achieve improved financial and non-financial performance than was previously the case (Inman et al., 2011). Particularly in the oil and gas industry, the maintenance of safety standards is also considered a key performance indicator (Dühring & Zerfass, 2021). An organization's performance is always aligned with the dynamic market and shareholder expectations. Any deviation or misalignment with such expectations will need to be addressed through a revised organization strategy. By meeting shareholder expectations, remaining competitive in the market, and attracting both the capital and talent necessary for further growth of the company will prove easier.

6. Conclusion

In this study, both the critical success factors and challenges of agile transformation that have been found in earlier studies are investigated. A portion of the study elaborates on the potential and challenges presented by agile transformation in the operations of the oil and gas industry. It also provides a conceptual model for additional research to be conducted on this subject. This research makes a significant contribution to the current body of knowledge by establishing a framework for implementing agility into the operations of oil and gas companies using a system thinking approach that is backed by the McKinsey 7S framework. This paper investigates the applicability of agile methodology in industries that are significantly hazardous. During the course of the agile transformation, further research will hopefully result in the development of a performance measurement indicator.

The managerial implications of agile transformation in oil and gas operations are influenced by the the conceptual framework. Initially, these guidelines can serve as a source of direction regarding the prospects, obstacles, and pivotal factors for triumph in the agile conversion of oil and gas industry operations. Therefore, other oil and gas industry-related companies working towards agile transformation can study each section thoroughly. Second, this study helps in the aligning of all organizational variables that should be addressed comprehensively through agile transformation. There are numerous challenges and consequences that might represent drawbacks resulting from organizational change which are explained in this study. Hence, other practitioners can prepare for such events by focusing on how to prevent or overcome similar situations. Third, stakeholders can adopt the conceptual framework of the agile transformation

process and identify desirable and feasible changes. By doing so, the agile transformation of the company can be undertaken to maintain company performance during the transformation process.

This study also has several limitations which lead to recommendations for future research. First, the conceptual framework employed only explains agile transformation. Future studies can build conceptual frameworks from other contexts. Second, this study uses the 7S McKinsey Framework as its theoretical foundation. Several other frameworks exist that can be employed as the basic structure for agile conceptual frameworks. Third, as it is still a concept which require implementation and empirical in future studies. Fourth, it applies a system thinking approach which creates a close-loop conceptual framework to describe the interaction between variables in the system. Future studies could implement other methodologies to build the framework. Fifth, the conceptual framework employed in this research focuses on oil and gas industry operations. Other contexts could adopt similar frameworks or produce different conceptual frameworks regarding the range of values and characteristics of the industries analyzed.

Author Contributions

The contribution of each author is briefly as follows: Sidik Darusulistyo undertook the write-up, conducted the literature review, conducted interview, and proposed the content of the conceptual framework, discussion, and conclusion. Dermawan Wibisono reviewed the structure and provided feedback on the manuscript. Harimukti Wandebori reviewed the content, relating to the role of the Mckinsey 7S framework and provided feedback on the manuscript. Santi Novani proposed revisions to the conceptual framework and reviewed the methodology using SSDM. Retna Ayu Mustikarini Kencanasari assisted the first author by completing the manuscript, including developing literatures, the conceptual framework, and discussion.

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