







Conceptualizing the Active Ageing Index (AAI): A Systematic Literature Review of Frameworks and Supporting Digital Tools

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Abstract: Currently, due to the growth of cities, a sedentary lifestyle, and increase in life expectancy, multiple approaches are being analyzed on caring for the well-being of older adults. As part of these efforts, initiatives have been developed to measure full aging. The active ageing index (AAI) proposed by the United Nations (UN) is one of the most relevant measures; it was constructed using several lifestyle features. However, it is relevant to identify whether the initiative of AAI is being adopted around the world, emphasizing the frameworks and technological instruments for its execution, thus this work presents a Systematic Literature Review (SLR) for collecting data related to AAI's adoption by means of a qualitative analysis. The results reinforced that the UN index is the one with the greatest impact; however, other countries and organizations are proposing other approaches. On the other hand, the European Union countries are at the forefront in the development, specifically since 2015. A qualitative analysis demonstrated that specific features have a greater impact on its calculation, highlighting participation in society, people's educational achievements, and access to health services. Finally, the review shows insights for an analysis stage, but not yet the implementation phase.


1 INTRODUCTION


The older adult population is constantly growing, and is expected to reach 15.9% of the total population by 2050 (United Nations, 2019). Taking this into consideration, it has become important to define strategies and tools to support this segment of the population. Here is where the concept of active aging (AA) comes into light, which is defined by the World Health Organization (2002), as the process of maximizing health, engagement, and safety to improve the overall quality of life during the ageing process. It enables individuals to explore their capacity for physical, social, and psychological well-being. Furthermore, this concept strives to ensure appropriate safeguarding, security, and assistance for elderly individuals when needed.


Various approaches have been proposed around the concept of active aging that seek to measure it based on several aspects or features of lifestyle. The active ageing index (AAI), proposed by the United Nations (UN) is most relevant approach among them; however, other organizations and governments have proposed extensions of AAI, such as the Development of Self-Active Aging Index (S-AAI) among rural elderly in lower northern Thailand classified by age and gender (Keeratisiroj et al., 2023), or simply have proposed new methods such as the active aging-wellness index (AAWB) (Fritzell et al., 2021).


However, AAI is based on main pillars: participation, health, and security (World Health Organization, 2002), which are the basis for the policy making when referring to older adults. Using these characteristics within the three pillars. It is necessary to find a way to measure the fulfilling or lack of them; then the measurement of the AAI has emerged as a significant research topic in recent times. This provides insight into the potential of older adults and assists decision-makers in enhancing policies to include them promoting healthy living (Dugarova et al., 2017).


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There are different technologies and methodologies that could be used in benefit of the older population and in the creation of an AAI. For instance, the work by Haque and Afrin (2022), who studied the construction of an active ageing index specifically for Bangladesh, with satisfactory results. The work of Ko and Yeung (2018), who created a framework for the population of China, which could assist in the definition of policies for community based long term care. And lastly, Miķelsone et al. (2023) created a Healthy Ageing Index using and comparing data from Latvia and Iceland. Based on these specifications, the main question is "What are the frameworks that have been implemented for the conceptualization of the active ageing index?". It gives opening to a deep analysis about the conceptualization of the active ageing, including the demographic situation, frameworks and digital tools used in the measurement.

Seeking to address and cover the review, this work is structured as follows: Section 1 presents the introduction to the topic, followed by the Related work on Section 2. The methodology which was followed to perform this systematic literature review is presented on Section 3, while Section 4 present the obtained Results and the discussion, it includes the qualitative and quantitative analysis. Finally, the conclusions are presented.

2 RELATED WORK

Active ageing refers to the quality of life that an older adult should have, which includes daily activities within the home, work and job environment, and social activities that they are capable to execute. Another important area where older adults also are able to perform is in politics, due to their preparation, knowledge, and mainly, experience. Therefore, it is important to search the manner to calculate the AAI focused on our society, reaching towards the improvement of their quality of life. In this context, there are different methods to perform this calculation, however, this research performs a systematic literature review (SLR) of previous works related to methodologies, tools, and frameworks, to then analyze and interpret the data obtained.

The research developed by Sánchez-González et al. (2020) identifies a political framework of active ageing, through the study of strategies and programs carried out on the subject in Spain, Europe and the global context. Also, in the study carried out by Pequeno et al. (2020), the researchers identify the quality of life assessment instruments used in population studies in older adults around the world. In Naah et al.

(2020), the authors identified 3 key facets of active ageing: employment, community support and housing. A gender bias was identified in active ageing, with income having a significant impact. This study suggests that policies should incorporate a gender perspective and income options for older adults.

Related to literature reviews on this topic, in the study by Badache et al. (2023), the researchers conducted a SLR about the perspectives of older adults aged 75 and over on what it means to age successfully. Summarizing the results, the authors selected 15 studies of the 4661 proposed for research, as a conclusion to this, they identified that theories should continue to be developed, using the perspectives of understudied populations. In the work developed by Menichetti et al. (2016), the researchers conduct a review with the objective of mapping health promotion interventions aimed at promoting active and healthy ageing among older adults. As a result, they found that different recommended interventions promoted for active ageing are effective in improving health and quality of life, despite this, no study has undertaken a holistic study that improves long-term results.

Related to technology, the work by Rocha et al. (2019), the researchers identify relevant applications to promote active ageing, with the type of technologies that have been applied in the studies. As a result, in these studies they identified that different types of detection devices were developed for smart cities to promote active ageing, which allows older adults to fully participate and integrate into society. In Berde and Kuncz (2019), the role of the internet in older people is focused and increasing the weight given to internet use when calculating the AAI, and comparing different weighting systems. Furthermore, this study recommends including a more sophisticated indicator on the internet use in the AAI, added to this, they verified that older citizens of the European Union have increased their use of the internet, becoming increasingly relevant as basic literacy.

Related to frameworks for the analysis of AAI, in Xu et al. (2022), the quality of life of the older people in China is evaluated under the framework of active ageing. For this, they used security, participation and health information data from various statistical sources, from 2000 to 2016, showing that between 2005 and 2015 the quality of life improved in terms of security, participation and health. To improve the quality of life, this study proposes reducing the socioeconomic gap between regions, strengthening family support and improving social services for the elderly.

Another way to analyze the AA is proposed by Lak et al. (2020), who carried out a study based on the

concept of “active ageing”, where they tried to understand and apply the concept in a more effective way, for this the researchers identified 15 key aspects, ranging from personal characteristics to social health, with this, the researchers brought together these aspects using a 5P model (person, processes, place, principal, policy formulation), concluding that it is recommended to apply these aspects when addressing the topic of active ageing.

Related to features of living environment, the research carried out by Wood et al. (2022), they indicate how human characteristics could support active and healthy ageing, for this the researchers identified, defined facilitators and barriers in various domains, such as sociocultural, personal, environmental, political and economic. The researchers mapped their findings with the WHO List of Essential Characteristics of Age-Friendly Cities (World Health Organization, 2007), highlighting the need and relevance of taking into account transcultural and migrant communities. In addition to this, the researchers used the Citizen Science Evaluation Tool, which was used to rate the quality of participatory approaches.

Related to the application of the AAI across the word, the study by Przybysz and Stanimir (2023a) performed a comparison study between countries of the European Union (EU), based on a subjective evaluation of the activities related to active ageing, for this, they made use of the database of the European Social Survey, in order to obtain a result close to reality. Moreover, they developed analyzes based on gender and age groups, as a result of this, they identified recurring patterns based on behavior corresponding to active ageing; also, they were able to verify that these results were the same in different countries in which this study was replicated. In Przybysz and Stanimir (2023b), researchers discuss the importance of active ageing and how activity in different areas can translate into a better quality of life. This study as a basis compares the quality of life of older Polish inhabitants with others countries of the European Union to identify the causes of inactivity. To do this, they defined an original indicator of active ageing, examining the impact that various activities had on older adults, in terms of their life satisfaction, using a comparative analysis and a classification method.

In Robbins et al. (2018), they carried out a systematic review in order to emphasize the importance of promoting active ageing and how affordable and scalable these can become, through the use of digital initiatives such as e-health and telemedicine. Therefore, the researchers demonstrated a wide range of therapies that are available internationally, through an approach based on community and technological meth-

ods, despite this, the lack of depth of the studies they carried out resulted in limitations such as the small number of samples, restricted statistical analyzes and variability of measurements in the results. Also, the study indicates that research approaches (technological, conventional) should be included, in controlled trials, with the purpose of improving the quality of the information used to educate policymakers, health professionals, communities and individuals about active ageing efforts.

3 METHODOLOGY

This paper follows the guidelines proposed by Kitchenham and Charters (2007), which is a systematic and iterative process for literature reviews, based on three stages: planning, conducting, and reporting the results. The planning stage is focused on define the protocol including the research question and sub-questions (RQs), databases, inclusion and exclusion strategies, and data extraction criteria. The execution stage, where the primary studies are collected and coded, the initial number of articles are decreased due to the application of inclusion and exclusion strategies. And finally, the reporting stage, which is presented by means of charts and descriptive analysis addressing the discussion of the findings, this stage is shown in the section of results.

3.1 Planning the Review

The systematic review protocol is the base to perform a successful systematic literature review, therefore, in this subsection, the main features related to the protocol are shown. As a first activity, a research question needs to be established, for the purpose of this work is “What are the frameworks that have been implemented for the conceptualization of the active ageing index?”, then, there is needed to define the research sub-questions (RQs), which will help to address the main research question. Following are presented each of the research sub-questions:

- RQ1. What frameworks, tools and applications have been implemented to capture, process, and analyze information related to the AAI?
- RQ2. What conceptualization methods have been applied in research on the AAI?
- RQ3. What is the state of research in the field of frameworks used in the conceptualization of the AAI?

Once the RQs have been defined, it is necessary to define the digital databases (digital libraries) which

Table 1: Data extraction criteria.

RQ	Extraction criteria	Collected features
RQ1	EC01: Framework	active aging-wellness index (AAWB), active aging index (AAI), self-active aging index (S-AAI), other.
	EC02: Analysis type	development, research, other.
	EC03: Framework variables	age, sex, region, internet service, academic level, independent life, health services, finance indicators, society participation, other.
	EC04: Screening instruments	surveys, interviews, statistical data, historical data, others.
	EC05: Analysis features	age range, region classification, virtual environments, seg, others.
	EC06: Analysis process	mathematical models, mapping of local policies, Djurovic's coefficient, others.
RQ2	EC07: AAI	health surveys, participation surveys, security surveys.
	EC08: AAWB	social indicators, application domain.
	EC09: S-AAI	WHO's frameworks, age and gender classification, surveys, explorative factorial analysis, others.
	EC10: Data collection	EU's income and lifestyle survey (EU-SILC), Lifestyle European survey (EQLS), prior projects.
RQ3	EC11: Phase(s) in which studies are based	analysis, design, implementation, testing.
	EC12: Type of validation	proof of concepts, survey, experiment, quasiexperiment, prototype, case study, others.
	EC13: Approach scope	industry, academy.
	EC14: Methodology	new, extension.
	EC15: Country	
	EC16: Year	

allow to collect a high quantity of primary studies related to the main topic; these libraries were selected because they have technical and medical articles. Each library has different ways to obtain the articles, such as filters, reports, and search strings. The search strings are the best approach to get articles based on a query, the query is a set of words (quotation marks for literal searches), logical connectors (AND, OR, NOT), and wildcards (asterisk as word competition) that allow a user to refine a search of articles. Table 2 shows the search string for each library, and the quantity of articles returned by itself.

Table 2: Search string results by library.

Library	Search string	Result
WoS	"active ageing" AND (index OR framework)	211
Scopus	"active ageing" AND (index OR framework)	486
Embase	"active ageing" AND (index OR framework)	159

The definition of strategies to guarantee that the selected primary studies is the key to carry out a proper systematic literature review, the initial strategies are part of the exclusion and inclusion criteria,

these aspects allow to define whether a study will be part or not of the analysis. In this work, those were defined as follows:

- **Inclusion Criteria:** observational studies, randomized clinical trial, randomized controlled trial, language (only English, Spanish, Portuguese).
- **Exclusion Criteria:** books, book chapters, workshops, reviews or systematic reviews, duplicate reports of the same study in different sources, short works with less than 5 pages.

Data extraction strategy is based on providing a set of data extraction criteria that allows to systematically collect data, in addition, mark answers for each criterion were provided to facilitate the data collection process. Also, metadata will be collected from the sources, such as: conference, magazine, article, digital library, year of publication, country of origin and authors. Table 1 shows the extraction criteria of the primary studies, classified by the research question, with an identifying code and its classification.

3.2 Conducting the Review

In this phase, the activities declared in the planning stage are executed with the following structure: collecting the primary studies, applying the inclusion and exclusion criteria, executing the data extraction strategy, and finally, the data synthesis (see results and discussion). To improve the trace among each step, initially, in each digital library, the articles were filtered using the search string proposed above, after that each article was stored for revision, with a total of 446 articles obtained from this initial search.

In the selection of primary studies, the articles that were relevant were selected by reading their abstract and title, using the platform "Covidence", which is a platform for improving and tracing a SLR. In addition, the exclusion and inclusion criteria were applied, which helped for the selection of the required articles. Also, a quality assessment for each article was done, it was rated with "yes" for any research that agrees with the topic being addressed, otherwise it was rated with "no", resulting in 149 articles chosen for analysis. Figure 1 shows each stage and number of articles for each stage.

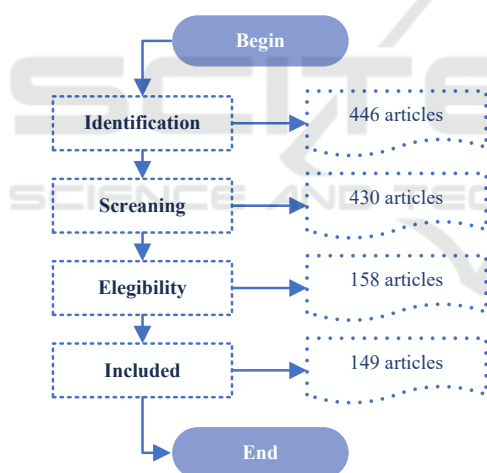


Figure 1: Stages and number of articles in stage 3.2.

For data extraction by means of each extraction criteria (EC), the studies were classified with 0 and 1 for each criterion. The first step was to tabulate the date of publication, digital library, country of origin and the criteria for data extraction. Following this, a count and cross-relation between variables was carried out, thus allowing a demographic study, trends and new lines of research to be obtained.

4 RESULTS AND DISCUSSION

The results of this review are structured on 3 stages: Demographic analysis, which is focused on understanding when and where the AA initiative is being adopted. After that, a quantitative analysis, which allows to identify and represent the reality of each extraction criteria. And finally, qualitative analysis, focused on answer the main research questions.

4.1 Demographic Analysis

The demographic analysis was tackled where primary studies show that 56 countries are developing research related to the active ageing. The Figure 2 shows a summary of the top 20 countries and their percentage of studies, which were determined with the data collected from the RSL. Then, the descriptive analysis shows that Spain, United Kingdom, and China are the top three countries where this topic and its research is widely addressed due to the amount of articles. On the other hand, even though the active ageing is a reality in some countries, the true is that the rest 36 of countries, out of the figure, are tacking the quarter of primary studies collected showing a less than one percent for each of them.

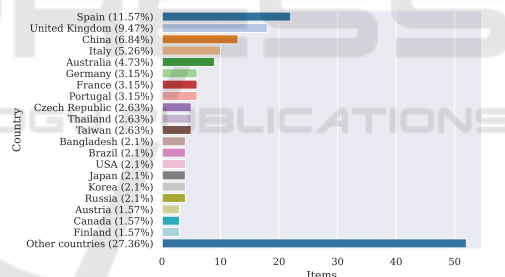


Figure 2: Top 20 countries and percentage of studies related to active ageing.

Regarding the years when the initiative was developed, Figure 3 shows that, starting in 2020, the trend tends to increase in terms of publications of active ageing, being this time in which the most studies were carried out.

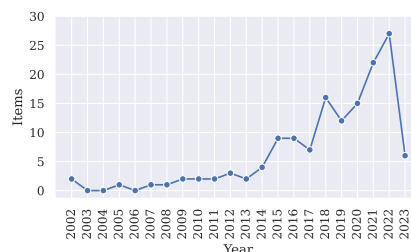


Figure 3: Trend of adoption of AA over the years.

4.2 Quantitative Synthesis

For this subsection, the analysis quantitative is shown by means of text, the percentage for each feature (related to the extraction criteria) is represented by one or two representative article(s).

EC1. Framework: there are 1% of studies related to the topic of the Active Ageing Wellbeing Index (AAWB) [SA106]; however, for the Active Ageing Index (AAI) there are 43% of studies that are related to that topic, in addition to this, 55% of the other frameworks were noted, highlighting [SA03], [SA14].

EC2. Type of framework: On the one hand, 35% of the studies are related to the use of the type of analysis framework, having as important examples [SA02], [SA04] and [SA08]. Furthermore, 11% regarding the types of frameworks of conceptual scope, relating studies such as [SA07], [SA21]. Added to this, there is 54% that refers to frameworks related to research [SA148], [SA149], [SA150]. Lastly, there is only a 1% for studies with other types of frameworks [SA23].

EC3. Variables: 17% of studies related to age, highlighting studies such as [SA154], [SA158]. Added to this, 9% for studies related to the region, the most representative being [SA135], [SA142]. Also, there are a 14% of studies that focus on the item about sex [SA113], [SA112]. For employment rates, a percentage of 7%, covering investigations such as [SA145], [SA138]. For Educational Achievement the 9% [SA158], [SA148]. For Access to health services, 7%, with research such as [SA141]. In relation to financial indicators, 6% [SA136]. Independent living 7% [SA149], participation in the company 10% [SA142].

EC4. Tools: Surveys 34% [SA158], Statistics 7% [SA154], Historical data with 5% [SA156], and Other with 34% [SA157].

EC5. Analysis: Age ranges with 29% [SA117], [SA111]. Virtual Environment 3% [SA116], Sex with 26% [SA112], Other 22% [SA110].

EC6. Process: Structural Equations for data analysis with 5% [SA144], Map local policies for each region with 6% [SA150], coefficients calculated by Djurovic formulation with 2% [SA74], and Other with 87% [SA69].

EC7. AAI: Health surveys with 39% [SA122], Participation surveys with 33% [SA128], and Safety surveys with 28% [SA133].

EC8. AAWB: with a percentage of 49% [SA144], and domains with 51% [146].

EC9. S-AAI: Framework approved by the WHO with 50% [SA126], Classification by age and gen-

der for the study 24% [SA127]. Questionnaires, 16% [SA135], Exploratory factor analysis, 8% [SA71]. Another with 1% [SA121].

EC10. Data Collection: EU Survey of Income and Living Conditions (EU-SILC) with 11% [SA48], [SA13]. Based on projects previously carried out by organizations or researchers, 69% [SA03]. and Other with 1% [SA68].

EC11. Phase(s) in which the studies are based: The most concurrent study phase was the analysis phase with a percentage of 72%, followed by the test study phase with a percentage of 11%.

EC12. Type of Validation: The types of validation most used in the study were, first, experimentation with a percentage of 29%, followed by proof of concepts with a percentage of 22%, and in third place was the type of validation. of case study with a total percentage of 21%.

EC13. Approach scope: It has been identified that 7% correspond to an industrial scope and the remaining 93% refers to academic scope studies.

EC14. Methodology: 38% of the studies implement a new methodology and the remaining 62% are the studies that are based on previous studies.

4.3 Qualitative Synthesis

The extraction criteria (EC), and their collected features from the 152 studies were classified, based on a heatmap, which was created answering each research question (RQ) formulated in the methodology, highlighting the following statements:

In the case of RQ1, a comparison between EC3 and EC1, where for the AAI framework variables such as age, sex and participation in society were used, in addition to this, the use of another type of framework is detailed which presented the frequent use of variables such as , age, other and sex.

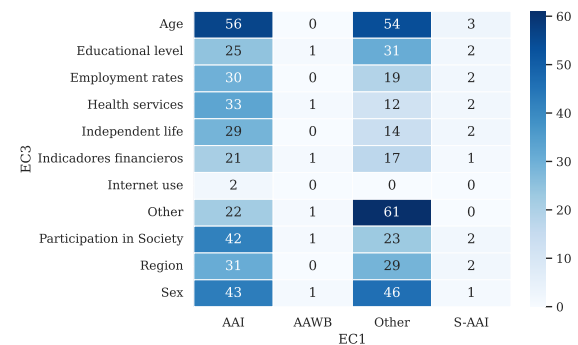


Figure 4: Evaluating the RQ1 by means of EC1 y and EC3.

In the case of RQ2, the comparison was made between EC3 and EC11, where it could be noted that

in terms of the studies that focused on the analysis study phase, they used more the variables that have been referents regarding the socio-economic characteristics. Demographic features such as: age and sex, the graph also details the use of other types of variables, in addition to those already used in the studies.

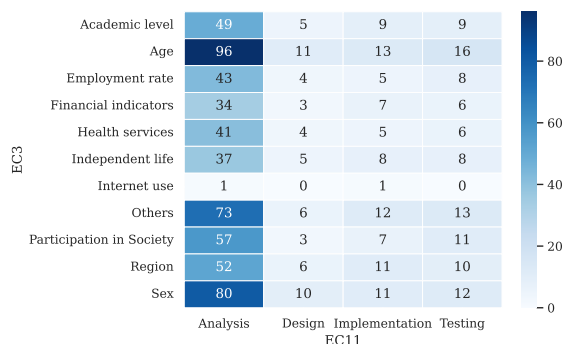


Figure 5: Evaluating the RQ2 by means of EC11 y and EC3.

In the case of RQ3, EC1 and EC11 were compared, where it can be noted that the tendency of the studies has indicated the use of other types of framework with regard to the present question and with a tendency to be in the analysis study phase, followed by this, another framework that has been implemented is the active aging index (AAI), in which it was found that the most used study phase was also the analysis phase.

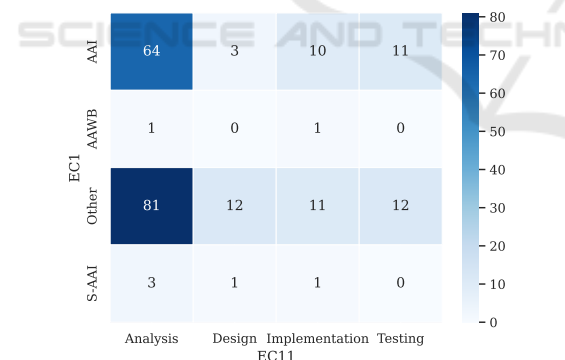


Figure 6: Evaluating the RQ3 by means of EC11 y and EC1.

5 CONCLUSIONS

In the context of this study, we have focused on answering three research questions formulated for this research. Subsequently, these were tackled by means of quantitative and qualitative analysis. Thus, in relation to the first research subquestion, it has been identified that the framework that has been used the most was the one that was related to the Active Ag-

ing Index (AAI), in addition to other types of frameworks used for the other investigations, all of them in the same amount of AAI. For the RQ2, it was found that the studies which were in the analysis phase, the Sociodemographic variables used were age, sex, and also, the use of other types of variables is highlighted. Regarding to subquestion 3, we have that in the sense of the frameworks used, the majority are related to the analysis study phase, focusing especially on the use of frameworks such as AAI, among others.

It can be concluded that the frameworks that have been dealt with the most in the selected studies are related to other types of frameworks. In addition, it was found that apart from this, one of the most used frameworks was the AAI. Many of these studies were related to the use of demographic variables such as age, sex and most of them were related to studies related to the analysis study phase, thus answering the questions formulated above. Moreover, the study is outlined so that in the future a framework related to our environment will be implemented based on the present research.

Moreover, after executed the systematic literature review, it was determined that, around the world, there have been identified many different types of indexes, which are used to calculate the level of active ageing among older adults. However, once studying the used variables, it has been clear that they constantly repeat across all found indexes. Therefore, said variables could be defined to, further, create and apply an active ageing index adapted to a latinoamerican reality.

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APPENDIX

The list of articles that were used in this literature review can be found at the following URL: https://drive.google.com/file/d/1--XzV8Gi8wmLzvvzleNXTYk-RYI8bw7Ex/view?usp=drive_link.