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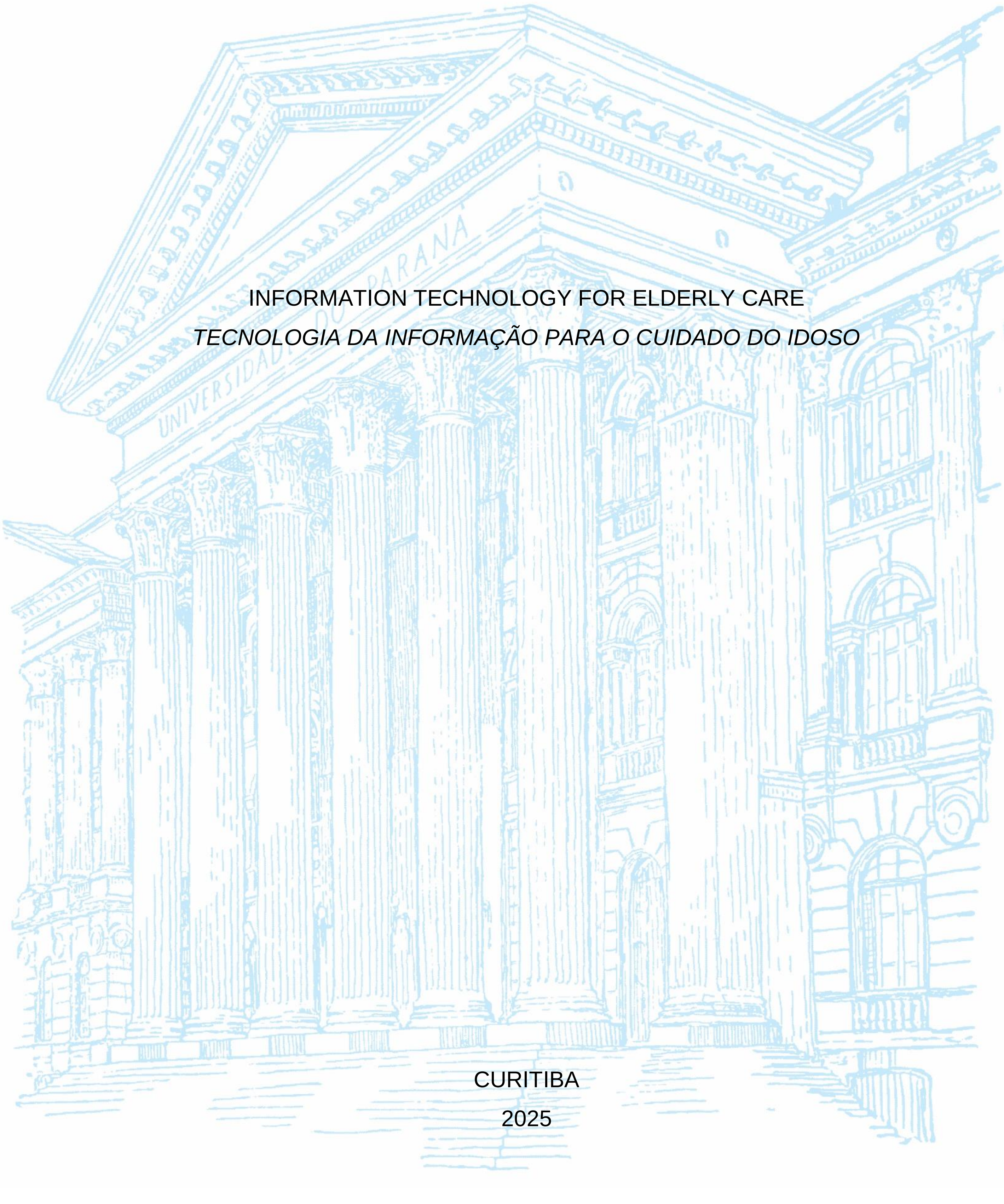

INFORMATION TECHNOLOGY FOR ELDERLY CARE

TECNOLOGIA DA INFORMAÇÃO PARA O CUIDADO DO IDOSO

CURITIBA

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INFORMATION TECHNOLOGY FOR ELDERLY CARE

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Projeto de pesquisa apresentado ao colegiado do curso de Análise e Desenvolvimento de Sistemas e ao Comitê Setorial de Pesquisa do Setor de Educação Profissional e Tecnológica, Universidade Federal do Paraná.

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RESUMO

À medida que as populações ao redor do mundo envelhecem, pesquisadores de várias disciplinas têm desenvolvido estratégias para melhorar o bem-estar dos idosos. Uma das principais preocupações é reduzir a fragilidade, pois, tornando-se frágeis, os idosos se tornam cada vez mais propensos a eventos adversos, como quedas. Este documento propõe um projeto de pesquisa em colaboração com pesquisadores do Programa de Pós-Graduação em Educação Física da Universidade Federal do Paraná (PPGEDF-UFPR). O trabalho destes pesquisadores foca principalmente no desenvolvimento de testes, tanto baseados em questionários quanto físicos, para identificar a fragilidade. O objetivo deste projeto é desenvolver uma solução de tecnologia da informação que facilite o gerenciamento dos dados dos testes de idosos, visando à criação de um banco de dados integrado para pesquisa e descoberta de conhecimento. Para isso, propõe-se um projeto de pesquisa-ação de cinco anos. Serão seguidas as diretrizes do método de pesquisa *Design Science Research* para desenvolver incrementalmente diversos softwares e artefatos relacionados. Espera-se não apenas entregar esses artefatos aos usuários finais, mas também criar oportunidades para que estudantes de graduação e pós-graduação participem do desenvolvimento de software, dos processos de pesquisa e de diversas atividades de extensão que potencialmente podem ser desenvolvidas ao longo do projeto.

Palavras-chave: fragilidade; tecnologia da informação; cuidado de idosos

ABSTRACT

As populations around the world age, researchers from various disciplines have been developing strategies to enhance the well-being of elderly individuals. One of their primary concerns is reducing frailty, as elderly individuals become increasingly prone to falls and even death as they age. We present a research project in collaboration with researchers from the Physical Education Graduate Program at the Federal University of Paraná (PPGEDF-UFPR). Their work primarily focuses on developing tests, both questionnaire-based and physical, to identify frailty. Our objective is to develop an information technology solution that facilitates the management of elderly adults' test data, aiming at creating an integrated database for research and knowledge discovery. To achieve this, we propose a five-year action research project. We will follow the guidelines of the design science research method to incrementally develop various software and related artifacts. We expect not only to deliver these artifacts to end users but also to create opportunities for undergraduate and graduate students to participate in software development, research processes, and numerous outreach activities that will emerge along the way.

Keywords: frailty; information technology; elderly care

TABLE OF CONTENTS

1 INTRODUCTION 6
1.1 RESEARCH PROBLEM 7
1.2 OBJECTIVE 8
1.3 MOTIVATION 9
2 THEORETICAL FOUNDATION 10
2.1 FRAILTY MEASUREMENT 10
2.2 PHYSICAL TESTS TO IDENTIFY FRAILTY 11
2.3 FALL DETECTION AND FALL PREVENTION 14
2.4 ELECTRONIC HEALTH RECORDS (EHR) SYSTEMS 15
2.4.1 Development of EHR Systems 17
3 RESEARCH APPROACH 21
3.1 RESEARCH DESIGN 22
3.2 RESEARCH SCHEDULE 24
3.3 EXPECTED RESULTS 24
4 CONCLUSIONS 26
REFERENCES 27

1 INTRODUCTION

We here present a research project to be conducted in collaboration with researchers from the Physical Education Graduate Program at the Federal University of Paraná (PPGEDF-UFPR). Their research focuses on the assessment and physical education of frail elderly individuals. Our contribution will be to provide information technology support for their research activities. This document thus presents the context of the research, theorical fundamentals and our research design and planning.

Populations around the world are ageing. According to the World Heath Organization (WHO, 2022), in 2050, almost 17% of population will be ageing 60 years or over. Besides it, the number of people ageing 80 years or older is expected to triple between 2020 and 2050. They will be 426 million by then. With this huge demographic shift, countries face major challenges to ensure that their health and social systems are ready: living longer leads to a gradual decrease in individuals' physical and mental capacity and a growing risk of disease and, ultimately, death (WHO, 2022).

The state in which individuals present physiological systems declination is called frailty (MOREIRA et al., 2023). According to Moraes et al. (2016), frailty commonly represents the degree of vulnerability elderly face to adverse occurrences, such as functional decline, hospitalization, institutionalization and even death.

One of the bad consequences of frailty is the increasing possibility of falls – an unpredicted event that leads individuals to rest on lower level (ground or floor). Consequences of falls in elderly people are psychological grievances (e.g. anxiety, depression), activity restriction, fear of falling – which leads to inadequate gait balance – and event death (USMANI et al., 2021). Furthermore, older adult falls result in substantial medical costs, with direct impact in Public Health Services expenditures (FLORENCE et al., 2018).

In this context, evaluating frailty is of utmost importance. The adverse consequences of elderly frailty can significantly harm individuals and potentially impact their families. By identifying frailty, it becomes possible to plan targeted intervention strategies, such as exercises, to address frail aspects and reduce the risk of developing complications.

Although health professionals usually identify frail adults by age and diseases, these features are not effective to predict frailty (MORAES et al., 2016). Individuals face different ageing patterns and the evaluation of frailty should consider a broad range of aspects, such as functional inabilities, cognition, humor, mobility, communication and multiple comorbidities (MORAES et al., 2016). Physical educators propose various complementary strategies to evaluate frailty and, based on these evaluations, recommend exercises as an intervention strategy to improve the well-being of elderly individuals (RODACKI et al., 2024).

One approach to assessing frailty involves the use of questionnaires that help identifying whether an elderly individual is frail. Examples of such questionnaire-based tests include the IVCF-20 (*Índice de Vulnerabilidade Clínico-Funcional* – Functional-Clinical Vulnerability Index) (MORAES et al., 2016) and the Fried Phenotype (FRIED et al., 2001). Another approach involves conducting physical tests with elderly individuals. These tests require the individual to perform specific tasks, which are evaluated by a physical educator, who can then determine whether the individual is frail (RODACKI et al., 2024).

Researchers apply these tests not only to identify frailty and develop intervention strategies but also to collect data that, over time, form a substantial aggregate of data for future studies. These data provide a means for sophisticated analysis of elderly physiological conditions and the effects of various intervention strategies.

1.1 RESEARCH PROBLEM

The Physical Education Graduate Program at the Federal University of Paraná has a laboratory equipped with specialized devices for performing physical tests. These devices offer sophisticated measurement capabilities and they are currently the primary source for data collection regarding frailty analysis. Additionally, questionnaire-based tests are conducted offline (using paper) or with regular online survey tools, such as Google Forms.

This situation presents two main challenges: first, for physical tests, study participants – primarily elderly individuals – must physically visit the laboratory. This requirement limits the participation of many potential subjects and constrains data collection opportunities. Second, data collected through questionnaires is often distributed and managed by specific researchers, potentially in non-standardized formats. This fragmentation hinders the creation of a large, integrated database, which is essential for sophisticated data analysis using statistics and artificial intelligence.

For the physical tests, one possible and feasible solution, is using smartphones technology to conduct the evaluations. Lately this kind of technology have already been largely used for preventing and detecting falls. These technologies are usually based on sensors and classifier models: they use different types of sensors (which can be within smartphones hardware) to collect useful signals for further processing and analysis, while various analysis algorithms are used to process the collected data (REN; PENG, 2019).

For the questionnaire-based tests, the lack of standardization and integration is not a novelty. Even in Brazilian large scale health databases there is a large number of health-related information systems that produce isolated and fragmented data (PANITZ, 2014). This situation led to a government initiative that has been working to standardize and promote the development and interoperability of Electronic Health Records (EHR) systems, guided by Regulation No. 2073 from August 21, 2011 (BRASIL, 2011).

The essential functions of Electronic Health Records (EHR) are: creating and maintaining medical records that aggregate demographic information and clinical history; allowing patients to access information about their health and their communities aggregated data and related diseases; offering protocols and evidence for decision-making to health professionals; contributing to the organization and dissemination of practices and clinical protocols; and allowing to aggregate collected information to extract knowledge (OLIVEIRA, 2018).

These functionalities are essential for developing a unique technological platform that integrates both physical and questionnaire-based tests. This platform consolidates personal and health/tests data to help identifying frail individuals and, more broadly, generate data to support research. Researchers can thus use electronic health record (EHR) data to identify eligible individuals for specific experimental interventions or to create large databases for studies examining patterns within certain patient groups, the effectiveness of interventions, or other population-level analyses (COLICCHIO, 2020).

1.2 OBJECTIVE

The objective of this research project is to develop an information technology solution – a.k.a platform – that enables the management of elderly adults tests data aiming at creating an integrated database for research and knowledge discovery. The specific objectives are creating software solutions that:

- Evaluate elderly individuals frailty through questionnaire-based tests and physical tests;
- Analyze collected tests data;
- Suggest clinical-functional intervention strategies, based on individuals needs;
- Apply artificial intelligence for assisting research and interventions strategies;

1.3 MOTIVATION

This research project is motivated not only by the elderly population well-being context mentioned in this section but also by its interdisciplinary application of knowledge. It is going to be undertaken as a partnership with the Physical Education Graduate Program at Federal University of Paraná (PPGEDF-UFPR). Researchers from physical education, mechanical engineering, health and information technology will collaborate to create more effective elderly care solutions.

Oliveira et al. (2021), indeed, state that scientific research is made to improve people’s living conditions and through interdisciplinarity, knowledge transitions from being segmented and specialized to becoming integrated, where scientific disciplines interact with each other. This potentially increases the likelihood of producing broader and more significant research project results.

Another motivation for conducting this project is the opportunity to involve undergraduate and graduate students, who will have the opportunity to actively learn through teaching, research and outrage activities.

This document, therefore, presents in the next chapter some concepts related to elderly care and associated technologies. Following that, in Chapter 3, we describe our research approach, design, and plan. Finally, Chapter 4 concludes the document.

2 THEORETICAL FOUNDATION

This section presents the concepts underlying elderly care and related technology. In terms of elderly care, it covers studies on frailty measurement and physical tests. Additionally, it discusses related technology from two perspectives: fall detection and prevention, and the development of Electronic Health Records (EHR).

2.1 FRAILTY MEASUREMENT

Frailty is a state in which multiple physiological systems gradually decline, as long as psychological, cognitive and social aspects of health (MOREIRA et al., 2022). Objectively understanding and identifying frailty is essential to providing elderly individuals with appropriate care, prevention, and intervention strategies (MORAES et al, 2016).

One of the first studies conducted to characterize frailty was the one by Fried et al. (2001). At that time, a standardized definition of frailty was not established yet. After a 7-year-study with 5000 men and women, they identified that frailty could be defined as a clinical syndrome in which three or more of the following criteria were present:

- Unintentional weight loss (4,5 kg in past year);
- Self-reported exhaustion;
- Weakness (grip strength);
- Slow walking speed; and
- Low physical activity.

Later, Moraes et al. (2016) propose that other aspects be considered on identifying frailty. They present a study that proposes the IVCF-20. It stands for *Índice de Vulnerabilidade Clínico-Funcional* – Functional-clinical vulnerability Index. It encompasses a questionnaire that collects information on global functionality (cognition, mood, mobility, communication), main physiological systems, medication use, past history and contextual factors (social-family evaluation, environmental and caregiver).

The questionnaire consists of 20 questions that, once answered, are converted into a score that classifies individuals on a scale from 1 to 9:

- Robust elderly: stratum from 1 to 3;
- Elderly under risk of fragilization: stratum from 4 to 7;
- Fragile elderly: stratum from 8 to 9.

The aspects evaluated are presented in TABLE 1.

TABLE 1 – ASPECTS EVALUATED IN IVCF-20 QUESTIONNAIRE

Indicators for funcional-clinical vulnerability
Age from 60 to 74
Age from 75 to 84
Age above 85
Self-perception of fair or poor health
Inability to perform at least one instrumental activity of daily living
Stopped taking a bath alone due to physical condition
A family member or friend mentioned the patient's forgetfulness
Worsening forgetfulness in recent months
Forgetfulness preventing you from carrying out some daily activities
Discouragement, sadness or hopelessness in the last month
Loss of interest or pleasure in previously enjoyable activities within the past month
Inability to raise the arm above shoulder level
Inability to handle or hold small objects
Unintentional weight loss OR BMI < 22 kg/m2 OR calf circumference < 31 cm OR time on 4 m walk speed test > 5 sec
Two or more falls in the last year
Difficulty walking that prevents you from carrying out some daily activities
Vision problems that can prevent you from carrying out some daily activities
Hearing problems that can prevent you from carrying out some daily activities
Multiple comorbidities: five or more chronic diseases or daily use of 5 or more different medications or hospitalization in the last 6 months

SOURCE: Adapted from Moraes et al. (2016).

When comparing these two scores and their association with falls, Moreira et al. (2023) found that both are relevant, but the IVCF-20 score may be more strongly associated with the probability of falling among community-dwelling older adults. Along with questionnaire-based evaluations, physical tests can also be used to evaluate frailty. Next section presents some of them.

2.2 PHYSICAL TESTS TO IDENTIFY FRAILTY

Frailty can be assessed through various physical tests that evaluate an individual's ability to perform specific tasks. Rodacki et al. (2024) propose the following physical tests to evaluate frailty in elderly individuals:

- **Timed-Up-and-Go (TUG):** This test is conducted in an obstacle-free area, using a standard, sturdy chair approximately 0.46m in height without arms. The participant begins seated with their back against the chair's backrest and their hands resting on their thighs. Upon the command to start, the participant must stand up, walk to a marked distance of 3m, turn around, return to the chair, and sit down again. They are instructed to walk at a usual, safe, and comfortable pace. The time taken from the start of the test until their back touches the chair's backrest is used as a performance reference. In this context, a longer duration indicates worse performance. Generally, longer times suggest poorer functional mobility, balance, and a higher risk of falls.
- **Imaginary TUG (iTUG):** This test was proposed to assess self-efficacy based on the discrepancy between the participant's actual and imagined performance. In this test, the participant will be seated in a chair with their back against the backrest. In this position, the participant will be instructed to mentally repeat the same task as the TUG. With a stopwatch in hand, the participant will be asked to estimate the time needed to complete the test and stop the stopwatch at the moment of its conclusion (when participant’s back returns to the backrest). The participant may keep their eyes open but will not receive any information from the stopwatch. Generally, the greater the discrepancy between the tests, the worse the self-efficacy.
- **Five Times Sit to Stand Test (5STS):** The test involves standing up and sitting down five times consecutively as quickly as possible from a standard chair (0.46 meters in height) with the arms crossed over the chest. The participant begins in a seated position, with their arms crossed in front of the chest and their back resting against the chair's backrest. Upon the "go" signal, they perform five repetitions as rapidly as possible. Timing starts from the "go" signal and ends when the participant completes the final repetition in a fully upright position, recorded using a digital stopwatch.
- **Limit of Stability (LoS):** The test requires the participant to stand on a force platform while holding a smartphone at the sternum level (center of the chest). Starting from a stable upright position, the participant

should lean their body to the maximum extent possible in each direction without shifting their base of support – specifically, without moving their feet, lifting heels or toes, or bending at the hips. The testing sequence is as follows: lean forward and return to the initial position, backward and return, right and return, and finally left and return. To ensure safety, the evaluator will remain beside the participant throughout the data collection to assist if balance is lost.

- **Up-on-the-toes Test (UTT)**: The test consists of performing repeated elevations of the body's center of mass by executing plantar flexion with both ankles (bilaterally) while standing upright for 30 seconds. The participant should hold a smartphone at sternum level (center of the chest) with both hands. To help maintain balance, they may lightly touch a stable surface (such as a chair) positioned in front of them using their fingertips.
- **Standing Heel-Rise (SRH) Test:** This variation of the UTT is designed for older adults who may have difficulty maintaining an upright posture during the standing test. The instructions remain the same as in the standing protocol; however, participants are seated on a chair with a backrest. They are instructed to perform the movements with maximum amplitude and speed continuously for 60 seconds.
- **2-Minute Stationary March:** The 2-minute stationary march test is used to assess cardiorespiratory endurance by measuring the number of steps and cadence performed while standing in place. Participants are instructed to alternately lift their knees at a self-selected pace and may stop the test at any time if they experience discomfort. The experimenter monitors the height of the knee raises, ensuring they reach hip level. The test is discontinued if the participant fails to achieve this height for more than three consecutive attempts.
- **4-Meter Walk Test:** walking along a 4-meter course marked by two cones indicating the start and finish points. Participants are instructed to walk at their usual pace, without running, "as if going to the supermarket." The time taken to cover the 4 meters is recorded, while the first and last 2 meters are designated for acceleration and deceleration.

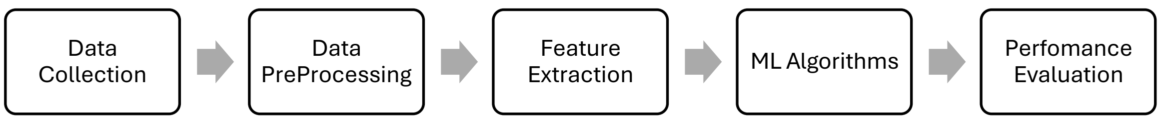
Rodacki et al. (2024) state that, although these tests have been successfully applied in laboratory environments, smartphones can and should be used to facilitate their application and extend their use to other settings. This requires the development of software utilizing smartphone sensors, such as those used for fall prevention and detection of falls, as presented next.

2.3 FALL DETECTION AND FALL PREVENTION

According to Ren & Peng (2019), fall detection methods have been studied over the past two decades. These systems use different types of sensors to collect useful signals for further processing and analysis, while various analysis algorithms are used to process the collected data. Generally, most of the fall detection systems detect shock caused by the body impact using accelerations.

The overall machine-learning-based system for fall detection and prevention comprises five steps as shown in FIGURE 1 (USMANI et al., 2021). The first step is data collection. According to Ren & Peng (2019), this database comprises collected data from various sensors, that directly or indirectly reflect the body motions. As mentioned, this sensors can be those available in smartphones. There are various data collection methods, i.e., public datasets, controlled environments, and realistic environments. In general, the acquired data are noisy. This is the reason why, according to Usmani et al. (2021), preprocessing these data is needed to remove the noisy and unwanted signals. Next, the third step is feature extraction. Ren & Peng (2019) explain that distinctive features are significant attributes to distinguish fall and nonfall, which should be extracted from the raw data. For example, a change in acceleration, rotation, or angular velocity. The fourth step uses ML algorithms to classify irregular gait, falls, or Activities of Daily Life (ADL) and, finally, the last step aims at evaluating the resulting system performance (USMANI et al., 2021).

FIGURE 1 – Procedure for fall detection and prevention using technologies



SOURCE: Adapted from USMANI et al. (2021)

Machine-learning analysis is not the only way to identify falls. However, current research has observed that the performance of machine learning-based fall detection systems is higher than that of threshold-based systems (REN & PENG, 2019).

Identifying falls can serve two purposes: detection or prevention. A fall detection system typically identifies body impacts to activate an alarm, whereas a fall prevention system analyzes gait information to provide an early warning of potential falls. Despite their different functions, both systems commonly utilize accelerometers, gyroscopes, pressure sensors, video/depth cameras, microphones, and/or radio frequency to assess falls or fall risks (REN & PENG, 2019).

When applying machine learning approaches for both detection and prevention, later studies have been mainly generating their own databases. According to Usmani et al. (2021) 67% of studies they analyzed generated their datasets using a controlled laboratory environment. In contrast, only 33% of studies relied on publicly available datasets for their experiments. However, authors identified that these datasets were mainly small and consisted of healthy subjects.

This situation is less than ideal for databases to be used in research and software development. Extensive datasets are crucial for enhancing classification accuracy. Therefore, it is essential to generate large datasets, and, in our case, primarily consisting of elderly data. Usmani et al. (2021) confirm it saying that more real datasets should be created so that research results get more accurate data and fall detection and prevention systems be more prepared to be used in real settings.

Building an Information Technology platform for elderly care is an effective way to create a database for fall detection and prevention and, similarly, for physical tests analysis. Additionally, such a solution can seamlessly integrate with other applications and scale to manage large volumes of data. This system architecture would support long-term data collection and provide various functionalities that can significantly enhance elderly evaluation and care. To achieve these features, we should consider this platform as an Electronic Health Records (EHR) System.

2.4 ELECTRONIC HEALTH RECORDS (EHR) SYSTEMS

An Electronic health Record (HER) is a database that keeps information digitally produced regarding patient’s health. When considering the management system to access and manipulate the information in this database, this concept expands to an Electronic Health Records System (PANITZ, 2016).

The collection, recording and availability of information about people’s health has been considered increasingly important because they support organization and management in health. However, managing these data is not a simple task due to the huge variety of information and the diversity of electronic systems where they are spread. Electronic Health Records Systems emerge in the context as a possible solution to electronically store people’s information throughout their whole life and become available whenever needed to provide proper care (ALBERGARIA et al, 2016).

According to Oliveira (2018), the essential functions of Electronic Health Records (EHR) are: creating and maintaining medical records that aggregate demographic information and clinical history; allowing patients to access information about their health and their communities aggregated data and related diseases; offering protocols and evidence for decision-making to health professionals; contributing to the organization and dissemination of practices and clinical protocols; and allowing to aggregate collected information to extract knowledge.

An Electronic Health Record System maintains a comprehensive, digital record of an individual's health information, accessible in real-time by authorized healthcare professionals. It enhances the use of clinical data for monitoring patient outcomes, audits, and research. Additionally, EHRs improve the efficiency and quality of care by reducing tests duplication, allowing healthcare professionals to spend more time with patients, and ensuring timely access to patient information (FENNELLY et al., 2020).

Among the various advantages of using an EHR, Panitz (2014) highlights the ease of retrieving relevant information through dynamic search mechanisms, transitioning information from paper to digital, quick access to previous appointments and medical history, remote access from any location, simultaneous access by multiple services and healthcare professionals, instant and continuous updates to registered information, enhanced systematization and coding of information, improved comparability between cases, no deterioration or loss of physical content, reduction in redundant information production, flexibility to modify the information model, easy structuring and restructuring of reports, and integration with other hospital information systems.

These features collectively enhance the efficiency, accuracy, and quality of data management in healthcare settings. They could be directly applied to our case, specifically in managing test data for elderly individuals. As the objective of this project is to develop a platform similar to an Electronic Health Record (EHR) system, it becomes relevant to understand the unique aspects of developing such systems.

2.4.1 Development of EHR Systems

An EHR is a complex system that requires robust software engineering methods in its construction to ensure that health information can be securely, integrally, and completely captured, stored, displayed, and shared (KIATAKE et al., 2021). According to Albergaria et al. (2016), Electronic Health Records (EHRs) are inherently complex due to the vast array of information they handle and the diverse electronic systems in which they are integrated. Consequently, implementing these systems presents numerous challenges, both in terms of the product itself and the implementation process (FENNELY et al., 2020).

Aiming at guiding requirements for these systems development, in Brazil, the Brazilian Society for Informatics in Health[1] provides a certification for Electronic Health Systems and Record (*Manual de Certificação para Sistemas e Registro Eletrônico em Saúde, S-RES*) (KIATAKE et al., 2021). To obtain certification, the developed product must meet specific system requirements based on its category (e.g., for clinics or hospitals). Additionally, there are general requirements – for system structure, content, functionalities, and security assurance – applicable to all categories. The manual also defines maturity levels to guide continuous improvements in these systems.

Also guiding the development of EHR systems, Albergaria et al. (2016) state that they must meet the following drivers:

- Address the specificities of numerous clinical concepts in medical specialties;
- Adapt to healthcare needs across various levels of health care;
- Allow healthcare professionals to plan interfaces according to their demands, using easily understandable language without requiring advanced knowledge of informatics or the adopted standard;

[1] https://sbis.org.br/

- Rely on an international standards for clinical records (for example, the ISO 13606).

According to these authors, there are three essential properties for EHR Systems: flexibility, standardization and interaction facility. FIGURE 2 summarizes them.

FIGURE 2 - Essential properties for EHR Systems

Flexibility	Standardization	Interaction facililty
• User may have the possibility to make changes that facilitate and expedite their work	• Following standards that define how to store and exchange information between different systems	• The interface combines hardware and software needed to allow and ease the communication of the user and the application

SOURCE: Adapted from ALBERGARIA et al. (2016)

Meeting international standards is also a concern mainly when interoperability is a major requirement. Brazilian government has defined the Open EHR as the national standard for EHR systems interoperability (BRAZIL, 2011). This standard guides data modeling by dividing models into two levels: the archetype model (AM) and the reference model (RM).

The RM is a stable and formal information model that focuses on the logical structures of an EHR and defines the basic structures and attributes needed to express EHR data instances, including data types, data structures, and components of an EHR. The AM consists of archetypes and templates. Archetypes are the formal and semantic artifacts that facilitate collecting, storing, retrieving, representing, communicating and analyzing clinical data, which can be modeled by clinical professionals and health informatics experts by constraining RM. An Open EHR template assembles and constrains archetypes for context-specific purpose, which is closest to users and typically used to generate application programming interfaces (APIs), XML schema definitions (XSDs), user interface forms, storage schemes, etc. (MIN et al., 2018; CUNHA et al., 2023).

These product features are important aspects to address in EHR systems implementation. However, process is also critical. According to Fennely et al. (2020), EHR systems implementation must be considered as an ongoing process beginning during procurement and continuing throughout each phase of design, development, testing, "Go Live" and optimization. They identified, in their study, numerous factors that influence in EHR Systems implementation and must be taken into account when conducting such projects.

First, there are the organizational factors, that comprise the processes by which the EHR was introduced and incorporated into routine care. Next, governance, leadership and culture should be considered, as proper leaders and organizational culture are paramount in ensuring a successful EHR system. End-user involvement was another important factor. During each stage of the EHR implementation process, end-user involvement was highlighted as important, as it helps to ensure that the EHR meets end-users' needs and workflows, as well as promoting a sense of ownership and acceptance amongst staff (FENNELY et al., 2020).

Another important factor is training: basic computer and EHR-specific training were identified by Fennely et al. (2020) as key to a successful EHR implementation. Also, expert, technical, executive and external support have been critical to successful implementations. As in any software development project, resourcing was also essential in the form of availability of resources in terms of finance, skilled workforce and time.

One factor that may hinder the implementation of the system is the inability to meet the workflows of end-users and organizations. Fennely et al. (202) found impacts on end-user efficiency, productivity, satisfaction and acceptance of the EHR. Together with workflows, human factors must be addressed. The implementation team must work on skills and individuals' characteristics, perceived benefits and incentives, and perceived changes to the healthcare ecosystem.

Finally, Fennely et al. (2020) list six essential factors relating to the technology aspect of EHR implementation. They are: usability (as it directly impacts user efficiency); interoperability (to enable health information exchange both within and across healthcare organizations); infrastructure (must support development, implementation and scaling); regulation, standards and policies (critical for interoperability and addressing privacy and security concerns); adaptability (to facilitate customization of the EHR software to meet the needs of the end-users); and testing (to ensure usability and safety).

This section has shown that building an information technology platform for elderly care is a process that should first consider aspects related to identifying frailty in individuals, using various available approaches (either by asking questions or collecting data through physical tests) and how to integrate them into a major system. We argue that the final product requires a building process with engineering principles that ensure functionality, maintainability, usability, portability, and reliability. These quality characteristics build a foundation that provide researchers a software that will enable them to achieve the goal of understanding elderly situation and developing effective intervention strategies. Next section presents our research approach.

3 RESEARCH APPROACH

The objective of this research project is to develop an information technology solution – a.k.a platform – that enables the management of elderly adults' data aiming at developing intervention strategies and creating an integrated database for research and knowledge discovery.

To accomplish this objective, our research strategy is primarily qualitative, as it tends to be more concerned with words, than numbers (BRYMAN, 2016). More specifically, it is an action research, which "combines research and practice through change and reflection in an immediate problematic situation within a mutually acceptable ethical framework" (AVISON et al., 1999, p. 94). With the focus on creating and implementing solutions for elderly care, our problem is delimited in the context of understanding how to evaluate frailty and acting upon reality by creating solutions that allow investigation and interventions.

As an information technology solution will be constructed, this research also characterizes as a design science research. It is a problem-solving research paradigm, which aims at creating innovations that define the "ideas, practices, technical capabilities and products through which the analysis, design, implementation, management and use of information systems can be effectively and efficiently accomplished" (HEVNER et al. 2004, p. 76).

In design science, according to Hevner et al. (2004), the researcher seeks to create and evaluate information technology artifacts to solve real problems. These artifacts are defined as constructs (vocabulary and symbols), models (abstractions and representations), methods (algorithms and practices), and instantiations (implemented and prototype systems).

Design science is a problem-solving process in which knowledge and understanding of the design problem and solution are acquired in the building and application of an artifact. There are, then, seven guidelines that must be followed so that design science can be properly differentiated from simple product development. TABLE 2 summarizes these guidelines.

TABLE 2 – DESIGN-SCIENCE RESEARCH GUIDELINES

Guideline	Description
Design as an Artifact	Design-science research must produce a viable artifact in the form of a construct, a model, a method, or an instantiation.
Problem Relevance	The objective of design-science research is to develop technology-based solutions to important and relevant business problems.
Design Evaluation	The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods
Research Contributions	Effective design-science research must provide clear and verifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies.
Research Rigor	Design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artifact.
Design as a Search Process	The search for an effective artifact requires utilizing available means to reach desired ends while satisfying laws in the problem environment.
Communication of Research	Design-science research must be presented effectively both to technology-oriented as well as management-oriented audiences.

SOURCE: Adapted from Hevner et al. (2004).

By following these guidelines on constructing and evaluating the artifacts of the project, our research design will follow an iterative process in which smaller objectives are incrementally achieved until the end of the product construction. This approach complies with agile principles of software development, in a continuous search for delivering valuable software (BECK et al., 2001), as detailed in the next subsection.

3.1 RESEARCH DESIGN

This is a five-year project to be executed in iterations (or cycles) in which the final solution will be incrementally developed, as long as other results (additional data analysis and studies) will be incrementally created.

Each cycle will be guided by a flexible framework in which we will perform the following activities:

- **Literature review**: according to Bryman (2016), existing literature is an important element in all research. When researching upon a topic, we should use literature review to know what is already known about the topic, what concepts and theories have been applied to the topic; what controversies exist about the topic and how it is studied; what clashes of evidence exist; among other important existing evidence.

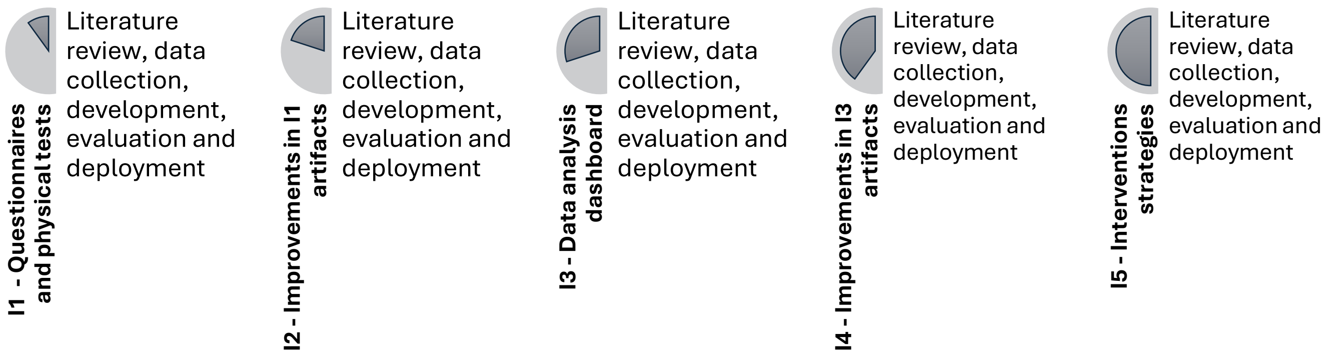
- **Data collection interviews and focus groups with research fellows and potential users**: interviews and focus groups are two forms are qualitative interviewing. Both focus on flexibility on collecting data when the great interest is on the interviewee's point of view (BRYMAN, 2016). In this project, we will use these methods to understand what the software solutions should do and how they will be used in elderly care. This should be mainly performed with research fellows from the Physical Education Graduate Program at Federal University of Paraná (PPGEDF-UFPR) and their research groups;
- **Solution conceiving and development**: this activity complies following a software development process in which we specify software requirements (based on data collected and literature review), project and develop the software (PRESSMAN & MAXIN, 2021);
- **Solution evaluation**: this is one of the main activities in software development process (PRESSMAN & MAXIN, 2021). The objective is to show that the solution we developed matches users' specifications. In our context, we will need to scientifically be sure (HEVNER et al., 2004) that the artifacts we build are according to the needs we identified in literature review and users interviews;
- **Solution deployment**: we will deploy in a production environment the information technology solutions created. This will allow our users to effectively collect elderly frailty data, manage this information and create knowledge and interventions strategies from them.

These activities will serve as a framework to guide the research project work. We will perform them in each iteration, or cycle, with the goal of constructing incremental parts of the information technology artifacts, as follows:

- Iteration 1 (I1): Develop IT solutions to questionnaire-based tests and physical tests;
- Iteration 2 (I2): Improve solutions deployed on iteration 1;
- Iteration 3 (I3): Develop a data analysis dashboard;
- Iteration 4 (I4): Improve solutions deployed on iteration 3;
- Iteration 5 (I5): Develop an intervention strategies platform.

FIGURE 3 presents this general research design with the five iterations, their goals and activities performed in each one.

FIGURE 3 – Iterations in research design



SOURCE: The author (2025).

3.2 RESEARCH SCHEDULE

Our objective is to complete this research project within five years. Each iteration should last one year, as shown in FIGURE 4.

FIGURE 4 – Research schedule

Iteration	2025	2026	2027	2028	2029
I1 – Questionnaires and physical tests					
I2 – Improvements in I1 artifacts					
I3 – Data analysis dashboard					
I4 – Improvements in I3 artifacts					
I5 – Intervention strategies					

SOURCE: The author (2025).

3.3 EXPECTED RESULTS

Performing this research project comprises activities related to research and software development. We expect various results in the academic context:

- Creating software artifacts that will effectively allow fellow researchers to collect and analyze elderly individuals data;
- Creating software artifacts that will enable the application of interventions strategies to improve wellness among elderly people;

- Creating opportunities for undergraduate and graduate students to participate in real-settings software development projects. This can be done as capstone projects or undergraduate research projects;
- Developing scientific papers that describe the activities and results of the project;
- Creating knowledge and initiatives for academic outrage projects, which will publicize results obtained in the execution of the project to local community;
- Integrating project activities with teaching initiatives to provide additional motivation for undergraduate students, enhancing their understanding of software development applications and its intersection with research.

In this chapter we characterized our research, described the general research design and the goals to be accomplished in each iteration. The artifacts will incrementally compose the information technology platform for elderly care, which is our ultimate research objective. We also described our expected results. Next chapter concludes this document.

4 CONCLUSIONS

One of the concerns in our ageing world is the growing frailty of elderly people. Frailty can have serious consequences, including falls and even death. Therefore, it is crucial to research and develop strategies to identify frailty and address it effectively. In this context, developing information technology solutions that support researches may be useful to help identifying frailty and developing intervention strategies.

This document presented a proposal for a research project with the objective of developing an information technology solution that enables the management of elderly adults data aiming at developing intervention strategies and creating an integrated database for research and knowledge discovery. This project is a partnership with researchers from the Physical Education Graduate Program at the Federal University of Paraná (PPGEDF-UFPR).

These physical educators adopt an approach that is to identify frailty through tests and, later, develop interventions strategies (e. g. exercises) that will reduce frailty and, consequently, improve elderly well-being. Our purpose is to develop technologies that will aid in the execution of these tests and integrate a large-scale database. This will allow developing studies that deeply analyze collected data and creating strategies that effectively will help elderly individuals.

Our research approach is to conduct a five-year project that characterizes an action research. Following the guidelines of design science research method, we will create various information technology artifacts that will incrementally compose the proposed final solution.

Our expectation is not only delivering these artifacts to final users, but also creating opportunities for undergraduate and graduate students to participate in the software development, in the research process and in a number of outrage activities that will emerge along the way.

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