

**INSTITUTIONAL PROJECT FOR
INTERNATIONALIZATION
UNISINOS**

Hospital of the Future - The
Use of the Internet of Things
and Machine Learning for the
benefit of people's health

SUMMARY

| | |
|---|-----------|
| 1. INTRODUCTION | 2 |
| 2. MANAGEMENT GROUP | 3 |
| 3. THEME: IOT AND HEALTH | 3 |
| 3.1. POSTGRADUATE PROGRAMS LINKED TO THIS THEME | 4 |
| 3.2. PARTNER COUNTRIES | 5 |
| 3.3. GOALS | 5 |
| 4. FUNDABLE ACTIVITIES | 6 |
| 4.1. Work Missions | 6 |
| 4.2. Resources for project maintenance | 7 |
| 4.3. Scholarships abroad | 7 |
| 4.3.1. Ph.D. Internship | 7 |
| 4.3.2. Junior Visiting Professor | 8 |
| 4.3.3. Senior Visiting Professor | 8 |
| 4.3.4. Short courses or "summer / winter schools" | 8 |
| 4.4. Scholarships in Brazil | 9 |
| 4.4.1. Visiting Professor in Brazil | 9 |
| 4.5. Dissemination of research results | 9 |
| 5. PROJECT: HOSPITAL OF THE FUTURE | 9 |
| 5.1. Description | 10 |
| 5.2. Context | 10 |
| 5.3. Problem | 11 |
| 5.4. Relevance | 12 |
| 5.5. Input | 13 |
| 5.6. Theoretical-methodological discussion | 13 |
| 9.1. References | 16 |
| 9.2. Results | 18 |
| 9.3. Impacts Expected | 19 |
| 9.4. Proposed Products | 19 |
| 9.5. Partner Universities | 19 |
| 6. OTHER INFORMATION | 19 |

1. INTRODUCTION

The Institutional Internationalization Project (PII) of Unisinos, submitted to CAPES, within the scope of the International Institutional Program, Public Call 41-2017, was approved in August 2018. The PII seeks to consolidate the university's internationalization policy for the period between 2018-2021, which aims to concentrate efforts in three priority thematic areas, foreseen in its PDI: (a) Innovation and Entrepreneurship; (b) Microelectronics and; (c) Health and Technology.

These three areas were mobilized through the development of research, work missions and various interaction in the global scenario, for four themes: 1) IoT and Health, 2) Industry 4.0, 3) Ecosystems of innovation, and 4) Digital Transformation and Humanities. The integration between the three priority areas that will be mobilized by the themes gave rise to four research projects in international cooperation capable of promoting a wide and systemic synergy among the University's PPGs, connecting in an interdisciplinary and unprecedented way 70 teachers and more than 400 students of 5 graduate programs. As only Graduate Programs with a grade higher than 4 (by CAPES scale) could take advantage of the resources of this call, those that fit the proposal were the Graduate Programs in Business Administration, Applied Computing, Communication, Design, and Education. Unisinos internationalization project foresees that in the next four years the institution will become a national reference in the study of hospitals, intelligent factories, innovation ecosystems and impacts of digital transformation on social processes, as long as it does not neglect its vocation related to humanities and technology. This means that the Capes Print Notice presents an opportunity for Unisinos to strengthen its physical presence internationally in an interdisciplinary way by expanding the contact networks in partner universities on the strategic themes, also placing Unisinos among the global clusters of research and innovation so that it can consolidate its vision of becoming a world-class university.

The project also aims to provide society with qualified study results and technologies that are closely related to the interests of international policies, especially connecting the PRINT Unisinos actions with the UN sustainable development actions. Nationally, it intends to subsidize the decisions of public policies and governmental actions, such as industrial development policies, the national policy on Health Technology Management, the Brazilian Strategy for Digital -E-Digital Transformation, the Work Group for a National Strategy for Industry 4.0, among other strategic issues relating to the Ministries of Health, Education, Science, Technology, Innovation and Communication.

The approved grant includes resources for work assignments, scholarships and consumable materials in the total amount of up to R \$ 6,167,610.08 for the 4 (four) years of project. The activities of the

first phase start in 2019 and end on 04/11/2020, when there will be a partial evaluation for the renewal of the project. If it is renewed, the project will continue until 04/11/2022.

2. MANAGEMENT GROUP

In order to manage the Institutional Project of Internationalization granted by Capes, Unisinos invited a group of researchers that met the demands of the edict. All should be active teachers and mentors in stricto sensu postgraduate programs, with permanent employment relationship in the institution, academic leadership and international experience in the areas defined as priority, including at least one (1) foreign member linked to an institution abroad. The group is led by the Provost for Academic and International Affairs:

Prof. Dr. Alsones Balestrin, Provost of Academic and International Affairs

Profa. Dra. Dorotea Kersch, Director of Graduate Studies Office

Profa. Dra. Claudia Bitencourt, Business Administration Graduate Program

Prof. Dra. Maura Lopes, Education Graduate Program

Prof. Dra. Carlo Franzato, Design Graduate Program

Prof. Dr. Sandro Rigo, Applied Computing Graduate Program

Profa. Dra. Adriana Amaral, Communication Graduate Program

Prof. Dr. Leonel Rocha, Law Graduate Program

Profa. Dra. Gelsa Knijjnik, Education Graduate Program

Prof. Dr. Emmanuel Raufflet, HEC Montreal

Prof. Dr. Flaviano Celaschi, University of Bologna

3. THEME: IOT AND HEALTH

According to business consulting firm Grand View Research, the global healthcare market invested US\$ 58.9 billion in IoT devices, software and services in 2014 and the amount should reach US\$ 410 billion by 2022. In 2017, the Royal Philips Institute published for the first time the Future Health Index (FHI), which revealed the Brazilian need to increase access to healthcare services and to education regarding the benefits of adopting connected technologies for health care. It is also common sense that the development of new technologies must be associated with public access to the benefits they can provide, where the area of healthcare is an important space for scientific production on access, adherence and impact of these technologies on the lives of individuals and

society. The choice is justified because the theme mobilizes the priority areas defined by Unisinos in its internationalization plan in a cross-functional and multidisciplinary way. The development of actions, research and interaction with international researchers and excellence centers could guarantee the use of microelectronic devices for the development of technologies applied to health and well-being, as well as studies on the adoption of responsible innovations based on IoT. The research, development and innovation generated on the theme will make an important contribution to the national scenario and is in line with the international strategic agenda, especially with UN's sustainable development goal 9, titled "health and well-being". Also, the development of research that mobilizes the theme "IoT and Health" will allow Unisinos to consolidate its position on the international scene through the interaction with important institutions of the global innovation clusters, especially by strengthening the relationship with Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Germany and the actors of the Medical Valley network, such as Siemens. In addition to expanding the health and medicalization systems, this theme is strongly connected with the national concerns shown in the National Policy on Health Technology Management - PNGTS. This is mainly due to the fact that information and communication technologies have the potential to revolutionize healthcare, particularly because of the advances in the area of distributed systems, microelectronics and the Internet of Things, as well as artificial intelligence.

3.1. POSTGRADUATE PROGRAMS LINKED TO THIS THEME

Applied Computing

This Graduate Program has been focusing efforts to consolidate partnerships in the area of Applied Health Computing. Of particular note are projects developed jointly with Brazilian and German institutions, such as Friedrich-Alexander-Universität (FAU), located in the city of Erlangen/Germany, Medical Valley, a medical technology cluster, and German Siemens. Some research projects are already under way. Project "Hospital Rooms of the Future" has the following partner institutions: Friedrich-Alexander-Universität Erlangen-Nürnberg – FAU (<https://www.fau.de>); Zentralinstitut für Medizintechnik – ZiMT (<http://zimt.uni-erlangen.de>); Medical Valley Europäische Metropolregion Nürnberg – Medical Valley EMN (<http://www.medical-valley-emn.de>); SAP Labs Latin America (<http://www.sap.com.br>); Sistema de Saúde Mãe De Deus (<http://www.maededeus.com.br>). Project "Technological Innovations in Hybrid Rooms" implements an applied research partnership between UNISINOS, the German company Siemens Healthineers and the German university Friedrich Alexander-Universität (FAU). Regarding this project, a number of results have already been observed,

such as: International recognition of published works, as evidenced by citations found in ISI, Scopus and Google Scholar; publications with international co-authors; research projects with international cooperation; sabbatical and postdoctoral internships at international centers of excellence, universities and research laboratories; student exchange, accepting and sending students; faculty members in positions of recognized academic prestige at international scientific organizations. In addition, a number of actions are planned, such as attracting international faculty and postdoctoral students; attracting renowned international researchers for long- and short-term visits; participating in thesis committees for doctoral degrees in foreign institutions; introducing faculty member of the Graduate Program in other foreign institutions (e.g. co-advisor, visiting professor, research fellow, etc.); in addition to developing software (free or proprietary), standards and technologies with proven use in the national and international community.

Business Administration

The Graduate Program, through the Ubi_Business research group, has been researching innovations for more than 10 years with the use of ubiquitous computing, whose technological platform is currently the IoT (Internet of Things). In addition, there is plenty of room for other Business Administration Graduate Program research groups and other Graduate Programs to work on various types of IoT-related innovations, such as product innovations, processes (Industry 4.0), social services and innovations, including human smart cities. This project can be related to both microelectronics and the area of innovation and entrepreneurship.

3.2. PARTNER COUNTRIES

Activities funded under this theme should be restricted to the following countries:

1. Germany
2. South Korea
3. United Kingdom

3.3. GOALS

| OBJECTIVE | ACTIVITY | INDICATOR | GOAL |
|---|---|---|---------------------------------------|
| Qualify the health sector in Brazil, making Unisinos a benchmark in the area of health and technology | Register software for use in hospitals | Protected software | Current: 0 2nd year: 0 Final: 1 |
| | Produce software prototypes for hospitals | Number of software prototypes produced and tested | Current: 0 2nd year: 0 Final: 1 |
| | | Software evaluation | Current: - |

| | | | |
|--|--|---|--|
| | | | 2nd year: - Final: Good feedback |
| | Biannual seminars on Health and Technology | Seminars | Current: 0 2nd year: 1 Final: 2 |
| | | Number of participants | Current: 0 2nd year: 30 Final: 60 |
| Foster the relationship between Unisinos and universities and organizations of the global cluster of research and innovation in the health field | PhD internships abroad | Number of students that did their PhD exchange internship on the theme | Current: 2 2nd year: 4 Final: 6 |
| | Increase the number of joint research projects | Joint Research Projects | Current: 2 2nd year: 3 Final: 4 |
| | Double degree / joint supervision abroad | Number of joint supervisions/double degrees on the theme | Current: 0 2nd year: 0 Final: 1 |
| | Conduct technical visits to Centers of Excellence on the theme | Number of technical visits conducted | Current: 0 2nd year: 4 Final: 8 |
| | Postdoctoral internships abroad | Number of faculty members that did their postdoctoral internship on the theme | Current: 5 2nd year: 7 Final: 9 |
| Qualify researchers for responsible IoT-based innovations. | Develop joint articles of international relevance | Joint publications | Current: 2 2nd year: 3 Final: 5 |
| | Impact Factor of Publications | | Current: good 2nd year: excellent Final: excellent |

4. FUNDABLE ACTIVITIES

4.1. Work Missions

Work missions include travel aid for flight tickets, 7 days accommodation and health and travel insurance. They may be carried out in the case of:

- Activities related to the execution of cooperation projects;
- Presentation of research results in congresses and international events of greater expression in the area of knowledge, with the possibility of technical visits in institutions to prospect for possible partnerships;
- Activities carried out by members of the Management Group or representatives indicated, aimed at enabling the internationalization actions of the Institutional Internationalization Project.

Average amount budgeted for mission is R\$ 17,100.00.

The Management Group will be responsible for selecting the beneficiaries of non-project assignments, while the Project Coordinator will be able to select beneficiaries among the members

of the project team. The same faculty member or researcher, with the exception of his or her coordinator, may not undertake more than one work assignment per year or consecutive years of project validity.

4.2. Resources for project maintenance

The resources for project maintenance will be managed by the project coordinator and may be used for: a) consumables, intended for the purchase of material necessary for the operation of the project; b) third party service (legal entity): regarding payment of suppliers of material or service, by means of a detailed invoice; c) third party service (individual): refers to payments by receipt to the person with no connection with the main or associated institution, the Public Administration or the Program, to perform a specific task that contributes to the achievement of the objectives of the project , provided that it is approved by Capes.

4.3. Scholarships abroad

4.3.1. Ph.D. Internship

In the form of a sandwich doctorate abroad, students regularly enrolled in doctoral courses in Brazil undertake part of the course in an institution abroad, returning and remaining in Brazil for finishing mandatory credits and thesis defense. In order to apply for the scholarship, the candidate must be in line with one of the Unisinos priority themes (it is suggested reading Unisinos internationalization plan, themes and research projects), be regularly enrolled in one of the participating Graduate Programs and wish to pursue his or her PhD internship in one of the countries that are part of the project.

The selection calls will be published on this page and will meet the CAPES criteria and also the internal regulations of each Graduate Program. It is important to pay attention to the foreign language proficiency requirements established by CAPES.

The scholarship payment will be made directly by CAPES to the scholarship holder and will not include full payment of tuition and fees or bench fees to foreign partner institutions.

It is necessary for Unisinos to have a cooperation agreement, memorandum of understanding, agreement or legal instrument with the university of destination.

If Unisinos does not have an agreement with the foreign institution, it is possible to ask the Program Coordination to evaluate the possibility of a new partnership.

4.3.2. Junior Visiting Professor

Professors or researchers employed by UNISINOS, who have a doctorate degree of up to 10 (ten) years, are eligible, with reference to the last day for enrollment in the selection process.

Candidates must submit a document from the host university stating that the candidate has sufficient language proficiency for the proposed activities or some of the proficiency certificates required by the host university.

It is necessary that Unisinos have a cooperation agreement, memorandum of understanding, agreement or legal instrument with the university of destination.

If there is no agreement with the foreign institution, it is possible to ask the Program Coordination to evaluate the possibility of a new partnership. It is the responsibility of the beneficiary to prepare the accountability and technical mission report.

4.3.3. Senior Visiting Professor

Professors or researchers employed by UNISINOS, who have a doctorate degree for more than 10 (ten) years, are eligible, with reference to the last day for enrollment in the selection process.

Candidates must submit a document from the host university stating that the candidate has sufficient language proficiency for the proposed activities or some of the proficiency certificates required by the host university.

It is necessary that Unisinos have a cooperation agreement, memorandum of understanding, agreement or legal instrument with the university of destination.

If there is no agreement with the foreign institution, it is possible to ask the Program Coordination to evaluate the possibility of a new partnership. It is the responsibility of the beneficiary to prepare the accountability and technical mission report.

4.3.4. Short courses or "summer / winter schools"

Scholarship for training in short courses or "summer / winter schools" abroad, valid for up to 1 month, or aid for participation in distance courses (MOOCs etc), aimed at postgraduate students linked to a research project in international cooperation or technical staff of the institution.

4.4. Scholarships in Brazil

4.4.1. Visiting Professor in Brazil

This grant aims to attract renowned professors and residents abroad to teach courses, trainings, lectures or face-to-face seminars, with a minimum duration of 2 months and a maximum of 3 months, divided into up to 3 periods throughout the duration of the Institutional Project. Internationalization.

In the teaching activities carried out, a recording must be made for online transmission and subsequent availability, whenever possible.

Foreign candidates who are not native speakers of Portuguese or English must meet one of the following three requirements:

- Present a document issued by Unisinos stating that the interested party has sufficient linguistic proficiency for the proposed activities;
- Present, for Portuguese language, Celpe-Bras certificate; or
- Present, for the English language, TOELF, IELSTS or Cambrigde Exams certificate.

It is necessary that Unisinos have a cooperation agreement, memorandum of understanding, agreement or legal instrument with the university of origin.

If there is no agreement with the foreign institution, it is possible to ask the Program Coordination to evaluate the possibility of a new partnership. It is the responsibility of the beneficiary to prepare the accountability and technical mission report.

4.5. Dissemination of research results

Amount available for articles English correction, paper publication payment, registration for events and participation on events, congresses, etc.

5. PROJECT: HOSPITAL OF THE FUTURE

For each theme, Unisinos created a research project in international cooperation to encourage transdisciplinarity and contemplate the Graduate Programs involved with resources and scholarships.

Name of the project: Hospital of the Future - The Use of the Internet of Things and Machine Learning for the benefit of people's health

Programs: PhD in Business Administration
PhD in Applied Computing

Coordinators: Dr. Cristiano Costa, Unisinos

Dr. Bjoern Eskofier, FAU Erlangen-Nuremberg

Start date: 01/12/2018

End date: 31/07/2022

5.1. Description

Information and communication technologies have the potential to revolutionize healthcare, particularly due to advances in the area of distributed systems and artificial intelligence. The combination of technology and management of these areas can allow for more efficient collection of vital signs and other information related to people's health, as well as enabling greater interaction of people with information related to their well-being.

The health data collected from people through the Internet of Things (IoT) can be processed by intelligent algorithms, based on machine learning, generating prognoses and anticipating treatments, preventive actions and reducing risks to the patient.

The project is based on partnerships already established between the University of Vale do Rio Sinos (UNISINOS) and other foreign universities, among which the Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Germany. In the scope of the project, several solutions are proposed in the context of company-university innovation that allow improving the quality of life of patients, combining concepts such as Internet of Things and Artificial Intelligence, including solutions based on machine learning.

These solutions are supported by strategies and management systems appropriate to these innovative contexts. In addition to caring for patients, a number of developments can be made in their relationship with patients, improving hospital process management and patient care experience, as well as organizational intelligence.

5.2. Context

Patients hospitalized in hospital rooms have several monitored conditions; not only vital signs, such as heart rate or respiratory rate, but also discreetly collected data, such as level of pain or reflexes of the patient. Inadequate or insufficient management of such information is often - for example, by storing this data in paper worksheets, which are often not uploaded to the patient's electronic medical record.

To minimize such problems, one possibility is to interconnect medical devices into a single device that filters and stores data. Another solution that can help hospital efficiency is to allow medical staff to use a tablet to record the sporadically collected data that will also be part of the patient's electronic medical record. This tablet can serve two functions: assist in the collection of sporadic data, which depend on the medical staff, as well as present the synthesis of the data collected, in addition to possible alerts or risks detected.

This scenario leads to the ubiquitous health concept that allows the use of mobile and ubiquitous computing (WEISER, 1991; DA COSTA, 2008; SATYANARAYANAN, 2011) - supported by administrative practices and strategies - for the monitoring of patient health anywhere and at any time, without the need for the person to be in a clinic or hospital. Directly connected to ubiquitous computing is the Internet concept of Things (GUBBI et al., 2013, COSTA et al., 2018). IoT introduces the idea of connecting to the Internet any physical object, allowing communication between people and objects and allowing the capture of data (JARA et al., 2013). In particular, the use of IoT in the health area becomes attractive and has been the target of several recent studies (COSTA et al., 2018; RAHMANI et al., 2018; ELHOSENY, 2018). The use of the IoT allows a collection of vital signs and health data that extrapolates the hospital environment, allowing health problems to be anticipated and, sometimes, even avoiding hospitalization.

All data collected from a patient can be sent to a distributed architecture, stored in a computational cloud (MELL & GRACE, 2011), allowing processing. These collected data constitute the different contexts of the patients and can be combined in a way that allows the generation of important knowledge for the medical team. These stored data constitute electronic medical records, also known as Electronic Health Records (RES), are structures in digital format of the data related to patients' health (ROEHRS et al., 2017; RUMBALLSMITH et al., 2018). These technological solutions are supported by administrative skills and strategies, deployed in their technical and social aspects. The information can also be used to improve work processes, provide care to patients and improve hospital management.

5.3. Problem

This project proposes the development, in the company-university context, of technological-managerial models that explore information related to the environment or as the users themselves, called context science (context awareness) (DEY, 2001; DU & WANG, 2008) . More specifically, the proposal focuses on the use of a special kind of context science called situation awareness, in which

several types of context are aggregated to generate a more complex view called situation (ANAGNOSTOPOULOS et al., 2007; STIPKOVIC et al., 2013). In this approach, the situation-aware application interacts with the user, learns from the behavior and its actions, obtained through sensors, and autonomously suggests actions according to the current situational context (ANAGNOSTOPOULOS et al., 2007).

To perform the situational science, machine learning techniques are used (MICHALSKI et al., 2013). The use of intelligent algorithms has grown significantly in health, particularly due to the large amount of structured and unstructured data that are available, also called big data (ANDREU-PEREZ et al., 2015). The use of machine learning techniques in large masses of data obtained from the monitoring of patients in hospital rooms may allow the detection of possible health risks, as well as an increase in efficiency, anticipating the need for hospitalization in Intensive Care Units (ICUs) or optimizing the need to use other additional resources.

In this context, the main objective of the project is to define a model that allows to collect vital signs of patients, to monitor in real time these data and to allow the inference of risks and needs related to the patient's health. The project also seeks to generate knowledge that allows the improvement of patient care, from their experience within the hospital context, as well as improvement of work and management processes in this context. Understanding the impacts of this innovative technology on organizational management and hospital performance are also addressed by the project.

The theme has already been explored in partnership by projects and joint publications of the University of Sinus Valley (UNISINOS) and Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Germany. The main expected result is the improvement in the efficiency and performance of hospitals, both in the optimization of resources and in accelerating the detection of deterioration in the health of patients. Summarizing, the present work intends to answer mainly the following research question:

How can we improve the efficiency and management of hospitals - and other health organizations - by monitoring patient data, detecting possible risks or needs supported by these new technologies?

5.4. Relevance

The project aims to improve the quality of life of people through the use of computer technology and management applied to health. The project is expected to expand the possibilities of the use of health technologies, both in and out of hospitals, through the exploration and management of IoT, Artificial Intelligence, and particularly machine learning. The scientific importance of the project can be

observed by several recent publications of the group involved in the project, in subjects such as IoT applied to health and patient monitoring in hospitals (COSTA et al., 2018), interoperability of electronic records (ROEHRS et al. , The use of sensors for the workflow monitoring (ANTUNES et al., 2018), the creation of repositories of personal electronic records (ROEHRS et al., 2017) and business models for IoT-based products (PACHECO et al. , 2016).

5.5. Input

To achieve this, resources were requested for the acquisition of some equipment, such as multiparametric monitors, wearables for the health area, as well as sensors and electronic prototyping platforms. In addition to equipment, resources were requested to support the open access publication of scientific articles produced, as well as the English revision of the written material. Finally, resources will be used that are already available in Unisinos and in the partner universities of the project, such as cluster of high performance, infrastructure of computers and network, as well as mobile and medical devices already acquired previously.

Regarding human resources, the project will include professors and students from the Graduate Program in Applied Computing from Unisinos and from the Graduate Program in Administration, as well as PPGs partners in the subjects studied. In addition, it will also have the staff of Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), both teachers and students, as well as other international partner universities.

5.6. Theoretical-methodological discussion

To get an idea of the problem, according to a survey conducted in 2014 by the Center for Studies on Information and Communication Technologies (Cetic.br) in Brazilian health care facilities, only 8% of hospitals with more than 50 beds use medical records totally electronic, of which 49% store the vital signs of patients (CETIC, 2015). Also according to the survey, 88% of hospitals with more than 50 beds keep patient information mostly or entirely on paper.

Another related problem, also faced in hospitals, is the overload in the nursing staff who routinely do the routine task of collecting data and registering it in a worksheet or later in the system. Traditionally the task of nursing teams involves patient surveillance, including detection of deterioration in health status and protection against errors (Elliot & Coventry, 2012). In addition to this, the process of automated and real-time collection of vital signs has been shown as an alternative that helps to identify more rapidly the deterioration in the health of patients (MOK et al., 2015; BELLOMO, 2012; CHALFIN et al. , 2007).

One factor that contributes to this problem is the constant lack of resources for the health area in the country, which makes obsolete or older equipment still used in the hospital service (KAMIMURA, 2015). Although there are standards and protocols for connecting such devices, such as the HL7, different forms of interconnection are employed, from serial interface (RS232) to wireless connections such as Bluetooth or Wi-Fi.

However, a particular problem in Brazil is the heterogeneity of the medical devices used in hospitals, particularly the typical bidding process employed, in which the lower cost equipment that meets the specifications is purchased. In addition, economic conditions, such as foreign currency fluctuations, also influence the purchase of equipment, since several devices are imported. In addition to having different manufacturers, the equipment has different forms of connectivity.

With the advent of the Internet of Things (GUBB et al., 2013), and particularly its application in the health area (ISLAM et al., 2015, ZHWANG et al., 2014) possible providers of data for electronic health records) are sensors, derived from wearable computing, and obtained through a smartphone (COSTA et al., 2008, SIMON et al., 2013).

This scenario leads to the ubiquitous health concept that allows the use of ubiquitous mobile computing (WEISER, 1991; DA COSTA et al., 2008; DA COSTA, 2009; SATYANARAYANAN, 2011) for health monitoring of the patient anywhere and anytime without the need for the person to be in a clinic or hospital. The purpose of maintaining ubiquitous healthcare, which is being called ubiquitous healthcare, is to provide a convenient service to patients, facilitating the diagnosis of clinical conditions, in order to increase the efficiency, accuracy and availability of treatment (GELOGO & KIM, 2013).

On the other hand, Electronic Records, also known as Electronic Registries in Health (RES), are structures in digital format of data related to patients' health (ROEHRS et al., 2017). Ideally, RES should keep information about people's health throughout their entire lives, often called Personal Electronic Records, accurately in digital repositories (ROEHRS et al., 2017). However, many RES do not follow open standards and are owners of specific institutions of the health care network (ALABBASI et al., 2015). Among the main problems of the current electronic medical records is the difficulty of integrating and consolidating the data among several providers, considering that people have relations with different clinics,

hospitals and laboratories (BELYAEV et al., 2013). In this way, an integrated view of a patient becomes difficult, without duplication of records, inconsistent information and the additional cost

resulting from the repetition of exams and other analyzes previously performed (ROEHRS et al., 2017b).

Particularly in Brazil, the adoption of electronic medical records is not universal and many institutions still use paper registration. Research carried out annually by the Center for Studies on Information and Communication Technologies (Cetic.br), seeks to evaluate the current state of Information and Communication Technologies in Brazilian health institutions and their appropriation by professionals in the sector. The research shows that only 62% of public health establishments use some type of RES, of which less than 30% allow some basic type of interoperability, such as sending or receiving test results or information from other establishments (CETIC, 2015).

Regarding the standardization of RES in the country, Ministry of Health Ordinance No. 2,073 regulates interoperability standards that must be followed within the Unified Health System - SUS (BRAZIL, 2011). For the definition of electronic medical records, this document establishes the reference model OpenEHR (2017) as the standard to be used. Despite this definition and due to the latest standardization, the use of the OpenEHR still occurs on a small scale (ARAUJO et al., 2014). The universal use of this standard will allow the definition of a RES as a flexible structure, ensuring interoperability, that is, the ability of a system to communicate with another in a transparent way.

There are several levels of interoperability as defined by ISO / TR 20514 (2005), which tells electronic medical records. At the most advanced level, the data is standardized, interpreted electronically and the information exchange is structured. This level, called semantic interoperability, allows different RES to exchange information using the same vocabulary and format (BACELAR & CORREIA, 2015). The use of ontologies (GUARINO, 1988) makes possible the formal representation of this vocabulary, including the concepts employed and their relationships.

In this context, the main objective of the project is to define models that allow the collection of vital signs and other information on people's health, real-time monitoring of these data and allow the inference of risks and needs related to the patient's health. Models that facilitate the interaction of the patient with their health information and the greater understanding of the treatment process are also sought. The improvement of patient care, the improvement of work processes and management in the context of health organizations are also targeted. The main expected result is the improvement in the efficiency of health care, both in reducing costs and greater efficiency in care and management, and in accelerating the detection of deterioration in the health of patients.

The development of the work will be based on bibliographic studies, research of existing proposals, creation of models, implementation evaluation in real environments. The project will be developed in the following steps:

1. Bibliographical studies related to the themes of work with big data, machine learning and deep learning applied to the health area;
2. Definition of models for collection of vital signs and health data;
3. Definition of models of interaction with patients and representation of health data;
4. Mapping of work processes and the management of the context of health organizations, to propose improvements based on IoT technologies.
5. Development of systems and methods for improving patient care, using organizational intelligence based on IoT resources.
6. Creation of computational cloud services to detect patient risks and health prognoses;
7. Application of prototypes of the proposed models in real scenario;
8. Evaluation of results and generation of scientific publications;
9. Training of specialized human resources in the themes involved in the project.

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9.2. Results

General Goal

Qualify the health sector in Brazil through the results of the projects in partnership, produce software prototypes that can be tried in Brazilian hospitals, evaluating the possibility of transformation into products. It is intended to register the software developed in partnership.

Specif Goals

- To strengthen the relationship between the institutions involved

To foster the relationship between FAU and Unisinos in research related to computing and health, particularly related to the themes of distributed systems and artificial intelligence. Through this objective, it will be possible to develop research projects and articles related to the hospital theme of the future.

- Conduct the exchange of professors and students

This objective enables the Brazilian teams to be trained through the exchange of professors from both universities and doctoral students.

9.3. Impacts Expected

1. Expand the number of joint research projects, particularly funded by development agencies or in partnership with companies.
2. Development of joint articles of international impact.
3. Training of Unisinos doctoral students through sandwich internship at the German partner institution.
4. Post-doctoral training for Unisinos faculty at FAU.
5. Production of a software prototype based on machine learning to predict patient risk.

9.4. Proposed Products

| | |
|--|---|
| Development of a set of software for the prediction of patient risks. As a basis for decision making, machine learning techniques will be employed | 1 |
| Development of methods and systems to improve patient care processes and hospital management | 2 |
| Scientific publications in qualified international journals | 4 |
| Development of joint research projects | 4 |

9.5. Partner Universities

- Universidade do Vale do Rio dos Sinos – Brasil
- Friedrich-Alexander-Universität ErlangenNürnberg – FAU

6. OTHER INFORMATION

Information regarding the operation of the project can be clarified through the documents available at <http://www.capes.gov.br/cooperacaointernacional/multinacional/programa-institucional-de-internacionalizacao-capes-print>