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Review Protocol

Internet of Health Things applied on Quality of Life

Overview and Goal

Health, Quality of Life and Well-being domains are closely related [1]. According to WHO, it is important to measure the QoL in order to provide essential information to healthcare [2]. These domains receive great benefits with the evolution of the Internet of Things [3]. In this way, we have observed the emergence of areas like the Internet of Medical Things and the Internet of Health Things, and that many reviews have been conducted on these areas.

However, we argue about the importance of a study that presents a comprehensive picture of the IoHT applied on Quality of Life. Thus, our goal with this work is to conduct a systematic literature review to systematize the challenges and opportunities related to the use of IoHT in monitoring and improving people's quality of life and well-being.

Research Questions

To elaborate research questions, there are several strategies. In this work, we decided for PICO methodology. In Figure 1, we have the description of population, intervention, and outcome. As our study is a systematic literature mapping, we have not defined any criteria for comparing the results.

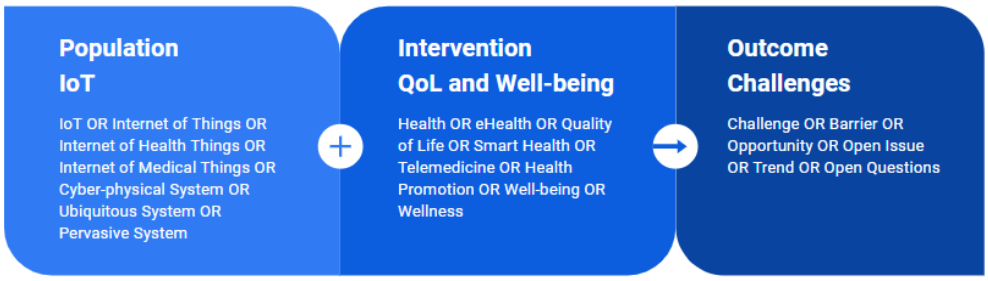

Figure 1. PICO strategy.

Thus, we defined the following **Research Questions**:

1. What is the context of the papers published in the QoL-related IoHT literature?
2. What are the challenges and opportunities related to IoHT for Quality of Life?
3. What is the evidence that IoHT can monitor and improve the people's Quality of Life?

Sources Select

Databases: we chose four (4) databases considering the representativeness that they have regarding scientific research involving health and technology: Scopus, Web of Science (WoS), Compendex, and PubMed.

Search String:

- **IoT**: IoT OR Internet of Things OR Internet of Health Things OR Internet of Medical Things OR Cyber-physical System OR Ubiquitous System OR Pervasive System
- **QoL**: Health OR eHealth OR Quality of Life OR Well-being OR Wellness
- **Challenge**: Challenge OR Barrier OR Opportunity OR Open Issue

Table 1. Pilot analysis conducted on June 03, 2020.

Database	Search String	# of Papers
Scopus	TITLE-ABS-KEY (({iot} OR {internet of things} OR {internet of medical things} OR {internet of health things} OR "cyber-physical system*" OR "ubiquitous system*" OR "pervasive system*") AND ({smart health} OR {telemedicine} OR {health promotion} OR {health} OR {ehealth} OR {e-health}) AND ({quality of life} OR {well-being} OR {wellness}) AND (challenge* OR barrier* OR opportunit* OR "open issue*" OR trend* OR "open question*")) AND (LIMIT-TO (DOCTYPE , "cp") OR LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English"))	147
WoS	TS=(iot OR "internet of things" OR "internet of medical things" OR "internet of health things" OR "cyber-physical system" OR "ubiquitous system*" OR "pervasive system*") AND TS=("smart health" OR "telemedicine" OR "health promotion" OR "health" OR "ehealth" OR "e-health") AND TS=("quality of life" OR "well-being" OR "wellness") AND TS=(challenge* OR barrier* OR opportunit* OR "open issue*" OR trend* OR "open question*")	94
Compendex	((((({iot} OR {internet of things} OR {internet of medical things} OR {internet of health things} OR "cyber-physical system*" OR "ubiquitous system*" OR "pervasive system*") WN KY) AND (({smart health} OR {telemedicine} OR {health promotion} OR {health} OR {ehealth} OR {e-health}) WN KY)) AND (({quality of life} OR {well-being} OR {wellness}) WN KY)) AND ((challenge* OR barrier* OR opportunit* OR "open issue*" OR trend* OR "open question*") WN KY))	120
PUBMED	((({iot} [Title/Abstract] OR {internet of things} [Title/Abstract] OR {internet of medical things} [Title/Abstract] OR {internet of health things} [Title/Abstract] OR "cyber-physical system*" [Title/Abstract] OR "ubiquitous system*" [Title/Abstract] OR "pervasive system*"[Title/Abstract]) AND ({smart health} [Title/Abstract] OR {telemedicine} [Title/Abstract] OR {health promotion} [Title/Abstract] OR {health} [Title/Abstract] OR {ehealth} [Title/Abstract] OR {e-health}[Title/Abstract])) AND ({quality of life} [Title/Abstract] OR {well-being} [Title/Abstract] OR {wellness}[Title/Abstract])) AND (challenge* [Title/Abstract] OR barrier* [Title/Abstract] OR opportunit* [Title/Abstract] OR "open issue*" [Title/Abstract] OR trend* [Title/Abstract] OR "open question*"[Title/Abstract])	17

Total	378
Total without duplicates	187

Studies Selection

The study selection process uses the inclusion and exclusion criteria. These criteria were defined in accordance with the objectives and research questions. The eligibility criteria for studies and the selection procedure are detailed below:

Inclusion Criteria

- Papers that discuss IoHT solutions, challenges, or open questions focused on Quality of Life;

Exclusion Criteria

- Do not discuss IoHT focused on quality of life;
- Be available only in the form of abstract or presentations or expanded summary;
- Do not be written in English;
- Be a short paper (four pages or less);
- Do not be available on the web;
- Do not be published in a workshop, conference, journal, magazine or newspaper;

Procedures for selection:

1. Researchers will apply research strategies in all available databases to identify primary studies;
2. Researchers will read titles and abstracts of 10% of primary studies applying inclusion and exclusion criteria for study selection.
3. The results obtained by each researcher will be compared using the Kappa statistical test (concordance analysis). In case of incompatibility in the results, there will be a meeting for perspective alignment and review of evaluations;
4. Once the agreement among the researchers has been proven, the analysis of the remaining primary studies will follow with the evaluation of only one researcher for each study.

5. The researchers will perform a complete reading of the selected studies to extract the relevant information from each study.

Data Extraction

The data extracted from each primary study accepted during the selection stage should be organized in a table that should contain the following fields to be completed:

- Basic fields: identifier, title, authors, authors country, year, abstract, source of publication, publication type (conference, journal, workshop), publication source (academia, industry);
- Research type;

Research Type	Description
Evaluation Research	The research investigates a practical problem and provides an implemented solution. Usually case studies or field studies are performed.
Validation Research	The research investigates a solution proposal that has not been implemented in practice. Usually experiments, simulations, or prototyping are performed.
Solution Proposal	The research proposes a novel or an improved solution, though not fully validated. Usually a proof-of-concept or an example is provided.
Experience Paper	The research reports personal experiences and lessons learned from projects in practice.
Conceptual Proposal	The research proposes a new conceptual framework, ontology, or taxonomies, etc.
Opinion Paper	The research reports the author's personal opinion, though with no reasoning arguments, or any means to validate the statements.

- Research questions or goals defined in the paper;
- Problems addressed by the study in two perspectives: health and technology;

- Major findings of study and contribution type (method, model, tool, formal study, experience, others);

Contribution Type	Description
Method	The contribution is a new or extended method, approach, process, procedure, technique, strategy or algorithm.
Model	The contribution is a software architecture, conceptual model or framework, system design.
Tool	The contribution is a software tool to support industry digitalization.
Formal Study	The contribution is a theory, or a formal analysis or measurement of some aspect of cloud computing or Internet-of-things aspects, such as performance, reliability and failure rates.
Experience	The contribution is a description of personal experience and lessons learned.
Others	The contribution does not belong to any of the types above. It can be general descriptions that cover various aspects, e.g., challenges of a specific cloud/Internet-of-things aspect.

- User profile related to the proposed solution (young, adults, older adults);
- Facet of QoL addressed by the paper;
- Type of solution: monitoring, acting, both;
- The authors proposal (solution) and its limitations;
  - Hardware devices and protocols;
  - Cloud provider: Infrastructure as a Service(IaaS) , Platform as a Service (PaaS), Software as a Service(SaaS);
  - Development process;
  - Strategies to act in the environment;
- Challenges and Open Questions discussed in the paper;
- Empirical validation technique used (WÖHLIN et al. 2000).

Data Summarizing

- Keywording with LDA;
- Tableau visualizations;

References

[1] ESTRADA-GALINANES, Vero; WAC, Katarzyna. Visions and challenges in managing and preserving data to measure quality of life. In: 2018 IEEE 3rd International Workshops on Foundations and Applications of Self* Systems (FAS* W). IEEE, 2018. p. 92-99.

[2] W. H. Organization, "Whoqol: Measuring quality of life," URL: http://www.who.int/healthinfo/survey/whoqol-qualityoflife/en/index3.html. Accessed by: 2020-05-20.

[3] Rodrigues, J. J., Segundo, D. B. D. R., Junqueira, H. A., Sabino, M. H., Prince, R. M., Al-Muhtadi, J., & De Albuquerque, V. H. C. Enabling technologies for the internet of health things. IEEE Access, v. 6, p. 13129-13141, 2018.

Survey Planning

Goal and Research Questions

We will perform a survey aiming to validate with researchers and practitioners the results achieved in our systematic mapping. With this empirical method, it is expected to get strong evidence about challenges and opportunities regarding the Internet of Things in eHealth. Thus, two research question arose from this goal:

- **RQ1**: How do IoT experts perceive the relevance of found challenges in IoT-Health?
- **RQ2**: What new opportunities do IoT experts observe for next years?

Decisions

- **Instrument**: questionnaires
- **Forms of questions**: open and closed questions
- **Sampling**: researchers and practitioners who have had experience with IoT-Health
- **Sampling strategies**: probabilistic sampling considering the authors of the papers selected in our review (cluster sampling), and non-probabilistic sampling considering a purposive strategy in our work contacts

What has been done to improve the Quality of Life using the Internet of Things?

Challenges and Opportunities

Dear participant,

Thank you for your participation in this survey. We are researchers of the Group of Computer Networks, Software Engineering, and Systems (GREat) at the Federal University of Ceará (UFC) and Laboratory of Software Optimization and Testing (LOST) at the Federal University of Piaui (UFPI). We are conducting this research to provide a comprehensive view regarding the challenges and opportunities faced by researchers and practitioners who work with IoT-Health applied on the Quality of Life area.

This survey has three parts, as follow:

- **Part 1**: Your professional experience
- **Part 2**: Challenges faced in IoT-Health
- **Part 3**: Your observations/suggestions

The survey will take your time for almost 15 minutes, and the findings and final results of our research will be forwarded to you when available.

Confidentiality and Consensus Term

The information you provide is strictly confidential, and no personal identification is permanently stored after the completion of this research. Your contact details will be used for administration purposes only, to let us conduct the follow-up (if needed), and email you the summary results. Also, the results will be presented and discussed in an aggregate form, with NO personal identification.

It is essential to highlight that this research does NOT represent any risk to the participants' health and that participation is voluntary. If you are in accordance with the terms presented, please continue.

Thank you! Your contribution is essential to better understand the IoT-Health challenges.

Part 1: Your professional experience

1. What is your name, email address, and country?
2. What is your level of education?
3. How much is your experience (in years) with IoT-Health projects?
4. What is your main role in these projects?
    a. Project manager
    b. Software developer
    c. Architect
    d. Researcher
5. Have you ever been involved in IoT projects in other areas? If yes, choose the areas.

Part 2: Challenges faced in IoT-Health

1. Classify the relevance of challenges considering the current state of IoT-Health and its future perspectives.
    a. Not at all important
    b. Low importance
    c. Slightly important
    d. Neutral
    e. Moderately important
    f. Very important
    g. Extremely important

Part 3: Your observations/suggestions

1. Is there any other important challenge that you think we should incorporate in this list?
2. In your view, what are the future opportunities in IoT-Health?
3. Do you have any comment, suggestion or consideration about this survey?
4. Do you use any kind of IoT-Health solution