A Reference Motivation Layer for Smart Health – an Enterprise Architecture Approach

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Abstract. The concept of smart health has emerged with the aim of improving citizens' quality of life and better healthcare services. As the cost of medical services increases and the population ages, along with time and space constraints, existing healthcare systems are facing great challenges. The implementation of smart health solutions imposes a set of requirement, best practices, concerns and motivations. We conducted a systematic literature review (SLR) with the purpose of identifying the key motivation elements that shall be present in smart health solutions. Based on this SLR, we propose an enterprise architecture for smart health solutions based on the SLR conclusions that can be used as a reference model and a set of guidelines for city authorities and other decision makers to follow.

Keywords: Smart city, Smart health, Enterprise architecture, ArchiMate, Motivation layer

1 Introduction

A smart city is a developed city that leverages the advance of intelligent sensor systems to promote smarter environments, raise awareness of surrounding, and enhance quality of urban life [1]. A smart city provides a secure, safe, environmental, and efficient urban center that incorporates advanced infrastructures, combining sensors, electronic devices, and networks, that can stimulate a higher quality of life and economic growth [2].

On the other hand, smart health is seen as a paradigm for smart environments, having the potential to improve healthcare systems within smart cities or other geographic contexts [3]. As recent research states, proper management and development of smart health is the key to success of smart city ecosystems [4]. For instance, Tian et al. defines smart healthcare as a service system that uses technology to dynamically access information, connect people, materials and institutions related to healthcare, and then actively manages and responds to medical needs in an intelligent manner [6].

Both economic and social challenges related with the ageing and the need for fostering healthy habits amongst the population poses both the public and the private sector to explore the possibilities of smart health. In Europe, for example, it is estimated that by 2025, 20% of Europeans will be at or over the age of 65 [13]. There are many other drivers and challenges to the development and uptake of smart health. The

use of technologies for data acquisition, processing, and analysis of healthcare data (such as mobile applications and sensors) increases along with the volume of data being recorded.

This paper proposes a "Smart Health Enterprise Architecture Framework" (or just "SH-EAF"), where smart health is a way to promote transparency on the health domain, as well as to enable efficient data integration and reliable analysis within smart health systems [7], reduce healthcare costs, among others. This approach would also favor the development of new applications, strengthening interoperability among systems. One simple example is described in [8], where patients with respiration problems use their smart phones to walk on the city with the minimal effect on their health. For that the application needs to use the context-aware network and sensing infrastructure of the smart city, taking advantage of data regarding pollution and pollen levels, among others. The major contribute of this paper is the proposal and discussion of an enterprise architecture framework motivation layer for guiding the implementation of smart health solutions by city authorities and other decision makers.

This paper is organized as follows: Section 2 explains the research methodology followed to obtain the elements presented in the proposed framework; Section 3 describes the framework, by introducing ArchiMate and motivation elements, explaining each element and exploring the relationships between them; Section 4 discusses the proposed framework and compares it based on related work. Finally, Section 5 presents the conclusion and future work.

2 Research Methodology

To define the relevant motivation elements for a successful implementation of a smart health solution, we follow the systematic literature review (SLR) methodology [21]. This analysis is conducted by the following question:

RQ: What are the key motivation elements that can be considered in implementation of a smart health solution?

The search terms and datasets used to search for existing articles are listed below.

Search Terms: "Smart City AND (Health OR Healthcare)"

Datasets: Google Scholar, ScienceDirect, Elsevier, IEEEXplore, ACM and ResearchGate

The inclusion criteria were the following: Written in English; Publication date after 2010, Public available papers; and Title and abstract relevance for the research. These criteria were used to obtain a final selection of 20 relevant articles for this research, published between 2013 and 2019. The distribution of those articles by venue (i.e., Conference, Journals, Technical Reports and Magazines) is shown in Fig. 1, and the number of selected articles by year is shown in Fig. 2. The list of the selected articles is shown in Table 1.

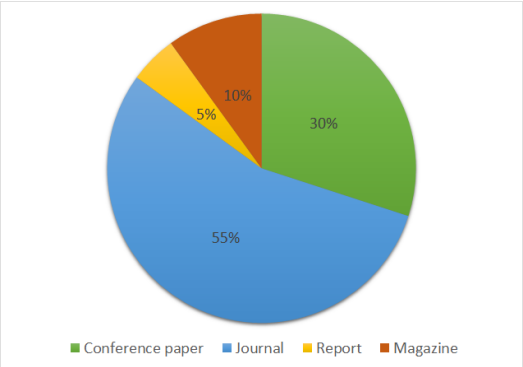

Fig. 1. Selected articles distribution by document type.

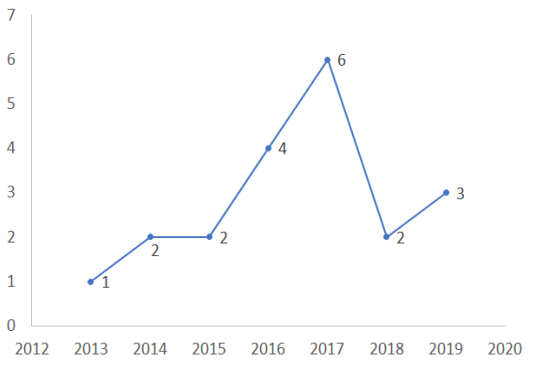

Fig. 2. Selected articles by year.

Table 1. Selected papers overview

ID	Reference	Title	Year	Type
SP1	[3]	A Smart Health Application and its Related Privacy Issues	2016	Conference
SP2	[4]	Big Sensed Data Meets Deep Learning for Smarter Health Care in Smart Cities	2017	Journal
SP3	[10]	Context-aware recommender for smart health	2015	Conference
SP4	[11]	Development of Monitoring and Health Service Information System to Support Smart Health on Android Platform	2018	Conference
SP5	[12]	Effective ways to use Internet of Things in the field of medical and smart health care	2016	Conference
SP6	[13]	Internet of Things: Smart Health	2015	Report
SP7	[14]	Everything You Wanted to Know About Smart Health Care	2018	Magazine
SP8	[15]	Smart health: A context-aware health paradigm within smart cities	2014	Magazine
SP9	[24]	Modular and Personalized Smart Health Application Design in a Smart City Environment	2017	Journal
SP10	[7]	Open data models for smart health interconnected applications: the example of openEHR	2016	Journal
SP11	[8]	Personalized medical services using smart cities	2014	Conference
SP12	[17]	PHR open platform based smart health service using distributed object group framework	2016	Journal
SP13	[16]	Smart City and Smart-Health Framework, Challenges and Opportunities	2019	Journal
SP14	[18]	Smart Health: Big Data Enabled Health Paradigm within Smart Cities	2017	Journal
SP15	[19]	Energy-harvesting based on internet of things and big data analytics for smart health monitoring	2017	Journal
SP16	[6]	Smart healthcare: making medical care more intelligent	2019	Journal
SP17	[25]	Smart healthcare monitoring: A voice pathology detection paradigm for smart cities	2017	Journal

SP18	[20]	Smart Health and Wellbeing	2013	Journal
SP19	[9]	Stretching 'Smart': Advancing Health and Wellbeing Through the Smart City Agenda	2019	Journal
SP20	[26]	Toward a Smart HealthCare Architecture Using WebR and WoT	2017	Conference

From the selected articles, we identified a set of key motivation elements, by searching for motivation elements that occur in two or more of the selected papers. The inferred conclusions are going to be systematized in next section.

3 Smart Health EAF

This section introduces the ArchiMate language and its motivation elements and then proposes the Smart Health Enterprise Architecture Framework (SH-EAF), a graphical view of its motivation elements. The relationships between the motivation elements are discussed in 3.10. In the end of this section, we present the SH-EAF (see Fig.5).

3.1 ArchiMate and motivation elements

ArchiMate is a popular modelling language for enterprise architecture [21]. It is a visual language with a set of default iconography for describing, analyzing, and communicating many concerns of Enterprise Architectures as they change over time [21]. The ArchiMate Enterprise Architecture modeling language provides a uniform representation for diagrams that describe Enterprise Architectures [21].

To analyze the key concepts to achieve a successful adoption of a smart health solution, we use the following of ArchiMate motivation elements:

- **Stakeholder** represents the role of an individual, team, or organization that represents their interests in the effects of the architecture.
- **Driver** represents an external or internal condition that motivates an organization to define its goals and implement the changes necessary to achieve them.
- **Assessment** represents the result of an analysis of the state of affairs of the enterprise with respect to some driver.
- **Goal** represents a high-level statement of intent, direction, or desired end state for an organization and its stakeholders.
- **Outcome** represents an end result of a specific goal.
- **Principle** represents a statement of intent defining a general property that applies to any system in a certain context in the architecture.
- **Requirement** represents a statement of need defining a property that applies to a specific system as described by the architecture.
- **Constraint** is a particular requirement that represents a factor that limits the realization of goals.

3.2 Stakeholders

Regarding the individuals, teams or organizations that have interest in smart health, we identify 6 key stakeholders: Patient, Healthcare Regulator, Healthcare Provider, Entrepreneur, Healthcare Professional, and City Government.

Patient (S1) should be provided with a more comprehensive medical care [3]. A patient relies on receiving better healthcare services, with shorter waiting and treatment times and lower costs. An example of a concern that the Patient may have is the privacy of his personal data. **Healthcare Regulator** (S2) plays a role in ensuring proper standards and procurement processes. **Healthcare Provider** (S3) is a person or a company that provides healthcare services to patients. Examples are pharmacy, blood tests laboratory, hospitals, among others. **Entrepreneur** (S4) has interest in regarding the innovation part of technology that fails in most of medical facilities, in the latest developments in technological innovation to the healthcare challenges [13].

Healthcare Professional (S5) has interest in the uptake of Smart Health as some of the health monitoring technology solutions would also allow to prevent diseases. Examples are doctors, nurses, and others. The **City Government** (S6) has the most interest in the uptake of smart health solution due to the ageing of the population and the increase of unhealthy habits amongst the population, which are creating a lot of pressure in the public healthcare systems [10].

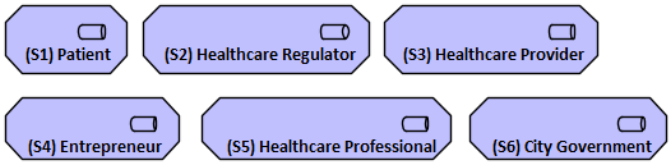

Fig. 3. SH-EAF: Stakeholders

3.3 Drivers

From our analysis the following key drivers are identified: Population increase, Population ageing, Population quality of life, Quality of healthcare services, and Healthcare costs.

Population increase (D1) is a driver that comes from the need of smart cites, as the world population growth will soon be unsustainable as cities will exceed their capacity [8]. With that, also come the problem of quality of life and the societal challenge of **ageing** (D2) [13]. **Population quality of life** (D3) of those citizens will be impacted. Several of the selected articles mention the quality of life of the citizens as a driver for the uptake of smart health and agree on the impact it can have [1][2][3][12][15][17].

Whilst smart health can significantly improve the quality of life it can also improve the **quality of healthcare services** (D4) and help reducing **healthcare costs** (D5) [8].

The population increase is also deeply connected to the quality, availability, effectiveness, and efficiency of the healthcare system services, as one negligence or improper service may lead to an outbreak of diseases and infections [4]. We can see the

example of the COVID-19 pandemic, where countries that did not had a high standard of healthcare services faced a harder challenge.

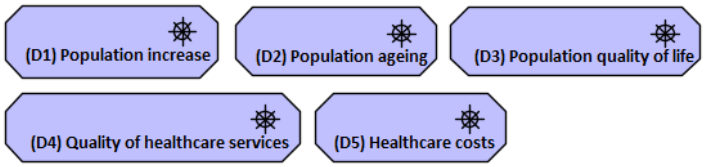

Fig. 4. SH-EAF: Drivers

3.4 Assessments

An assessment element defines a quantitative indicator that can help the decision-makers to monitor and control the performance of their system. For instance, if a city has: an allocated financial budget lower than a certain value, a certain number of complaints about its healthcare systems, reached a representation of a certain percentage of the city population marked as unhealthy, a certain percentage of the population that does not have proper access to pharmacies, hospital, and other health facilities, registered a certain percentage of rise in chronic diseases.

Based on this set of indicators it is possible to discuss if there is a need (or) not to bring smart healthcare solutions to the table.

For smart health providers, the **public sector's financial budget** (A1) often poses a challenge, as there are a lot of bureaucracy behind investments and there are often late payments [13]. In countries dealing with financial crisis, the public sector's financial budget is almost close to zero, due to austerity measures [13]. However, regardless of that, governments shall invest in smart health solutions to reduce costs and increase the efficiency, as these solutions can take advantage of the existing smart city infrastructures [15]. If this investment is made in earlier disease detection and prevention, we will be watching a decrease in hospital visits and treatment numbers [15].

To ensure there are not many **complaints regarding the existing healthcare** (A2) **systems**, it's necessary to guarantee better services, providing more satisfactory services with lower medical costs and more efficient treatments [12][15]. In fact, as the population increases and ages the quality of life of citizens decreases, leading to a rapidly **increase of the number of chronic diseases patients** (A3) [15][17]. Chronic diseases pose a threat to the quality of services of healthcare organizations, both in expenses, resources, and medical research [17]. Some patients may also be putting their quality of life (and life) in risk as some of them may not have **proper access to hospitals and other health facilities** (A4) [12]. As the actual healthcare systems are not able to accommodate everyone's needs (mostly due to population increase), healthcare costs tend to become unaffordable and unavailable to some [14].

Lastly, we see a trend of **unhealthy habits among the population** (A5), posing a challenge for the fostering of healthier habits and therefore for the implementation of smart health solutions [10].

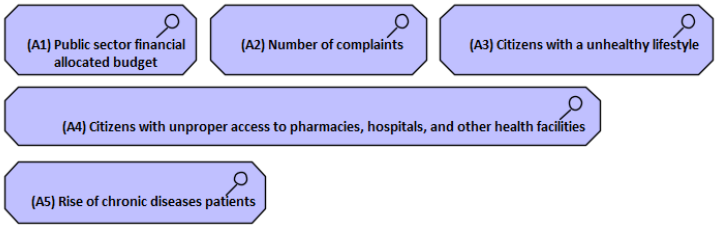

Fig. 5. SH-EAF: Assessments

3.5 Goals

From our analysis seven key goals are defined: Promote healthier lifestyles and improve quality of life, allow citizens to access healthcare services more easily, Provide more efficient and reliable health services, Monitor and analyze health related data, Improve and further develop health applications, Introduce Open Data Models, and Reduce healthcare costs.

The uptake of smart health has the goal to **promote a healthier society**, where people can live longer and with **better quality of life** (G1) [4][9][15][20]. Although, to improve patient's quality of life and help reducing healthcare costs, it is needed that patients have an **easy access to the healthcare services** (G2) [3]. Another important goal to take in consideration is to **provide a more efficient and reliable health service** (G3), ensuring the best medical assistance, prompt medical service, more efficient treatments, and the most satisfactory service, to improve the quality and efficiency of the healthcare systems [3][4][8][9][12][14][15][16][20].

Improper health services may lead to disaster situations. See the case of COVID-19 pandemic, where the outbreak of a virus exposed countries healthcare systems fragilities and improper health services. The focus of the smart health solution should be on improving the efficiency and quality of medical care [6][14].

To ensure that the patients get the required treatments in time, it is needed that their **health-related data is properly managed** (G4), allowing remote monitoring of health conditions and opening the possibility for patients to receive health services in patients' homes [4][11][14][15]. By taking proper advantage of the data interoperability and analysis within smart city, it is possible to set a goal to **improve and further develop applications** (G5), part of innovative smart health solutions. Context-aware services and applications are especially important here, as they automatically adapt to discovered context and allow real-time data collection from/by patients, which can then be combined with the city data [15].

An important goal to ensure transparency on the goal and to enable the efficiency of data integration and health-related data analysis is the **introduction of Open Data models** (G6).

Lastly, the authors of the analyzed articles identify the **reduction of healthcare associated costs** (G7) as one of the more important goals. Smart health can help in cost and wastage reduction, reducing number of unnecessary visits to the hospital, by providing health services in patients homes, for example [15][16][18][20]. This is

very important as the tradition health services are many times not available or affordable to everyone [14] and quality smart health services can help patients improve their quality of life whilst reducing the healthcare costs [3].

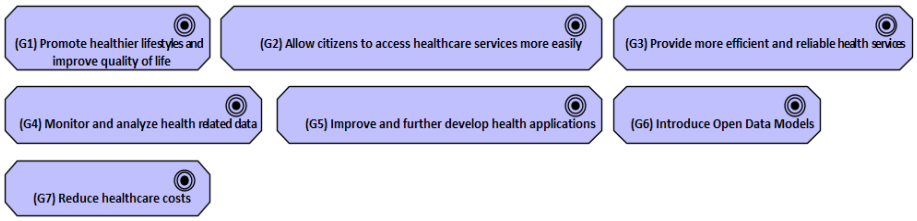

Fig. 6. SH-EAF: Goals

3.6 Outcomes

From the SLR analysis seven key outcomes are defined: Improved living standards and healthier lifestyles, Increased patients' satisfaction with healthcare services, Reduced space and times constraints in medical service, Reduced burden of healthcare system economics, Provision of remote and context-aware services, Transparency on medical errors and Increased data integration and processing efficiency.

The motivation behind achieving **better living standards and healthier lifestyles** (O1) comes from ensuring the creation of a healthier society [15]. Better healthcare services help citizens improve their quality of life and therefore prolong their lifetime [3][4].

Another benefit from its adoption is the **increase of patient satisfaction with healthcare services** (O2), as improved services make treatments and health monitoring more comfortable to patients as well as more efficient and affordable [15]. Quality and efficient healthcare services also tend to imply an experience improvement for the user [14]. Remote health monitoring comes with a great benefit of **reducing space and time constraints** (O3), as by providing services remotely we are eliminating space constraint by providing services remotely and time constraints, by reducing treatments time [12][17].

By providing health services by the comfort of patients' house, expenses decrease, as the medical cost is lower for the patient and for the healthcare institutions, as it decreases the unnecessary visits to hospital [15][16]. Patient can then have access to electronic healthcare records and therapeutic procedures at a **lower cost** (O4) [3]. Another aspect to consider in smart healthcare is the **provision of remote and context-aware services** (O5) that comes from the adoption of smart health solutions as well as the **transparency** that this solution can bring to the field (06), especially **with medical errors** (O6) [15][20].

Lastly but not less important, smart health applications provide a **more efficient and accurate processing** (O7) when taking conclusion, deduction, or predictions regarding the state of health of an individual [4].

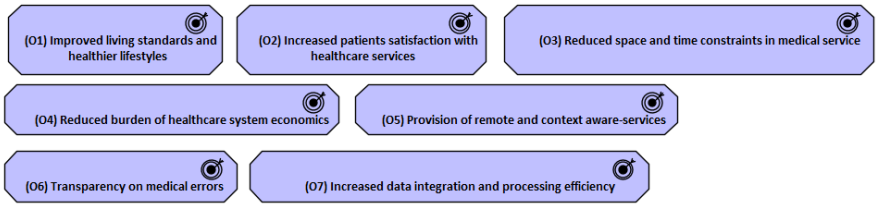

Fig. 7. SH-EAF: Outcomes

3.7 Principles

From the SLR analysis two key principles are defined: Ensure uniform technical standards among medical institutions and utilize available resources to their maximum potential.

Ensuring uniform technical standards among medical institutions (P1) is a good principle to adopt when taking in consideration smart health, as the adoption of healthcare solutions many times require changes in rules and regulations of hospitals and other healthcare providers [13]. Current smart healthcare lacks macro guidance and programming documents, which may lead to unclear goals and waste of resources [6]. Also, regarding data integrity, is fundamental to ensure uniform standards [6]. When talking about reducing healthcare costs with smart health adoption it is also important to ensure that we are **utilizing available resources to their maximum potential** (P2) [6][14].

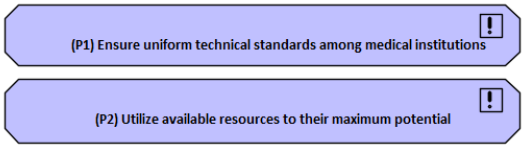

Fig. 8. SH-EAF: Principles

3.8 Requirements

While the adoption of smart health may be very beneficial to stakeholders, it imposes several requirements for the architecture of the solution.

One of them is that the smart health **shall be user-oriented and personalized** (R1), ensuring and enriched user experience. Redefining traditional healthcare, with higher quality and efficient services, allows to provide a personal customization of services with enriched user experience [3][4][14][15].

It also needs to **ensure interoperability, compatibility, ample connectivity, reliability, and scalability of the system** (R2), addressing problems with compatibility across different platforms and devices, connectivity issues, ability to interoperate

across different platforms and upgrades to newer system versions and technologies [7][14].

Also, very important is to **ensure data confidentiality, integrity, and privacy** (R3), as smart health poses some challenges regarding this, taking in account that large amounts of information are going to be gathered [16]. The healthcare networks contain personal information that can be easily manipulated [14]. Therefore, we shall ensure that the data is only shared with authorized users (confidentiality), that the data transmitted and received was not altered or compromised (integrity) and that proper standards regarding personal information and privacy breaches are implemented (privacy) [6][14].

Then, we **shall ensure proper management of health record to store health monitoring data** (R4), because proper management of patient records ensures that the patient gets required treatment when due and helps in the development of personalized medicine applications [4]. This can be achieved with the help of IoT, and it provides doctors and care givers with new ways to exchange medical records and test results remotely and instantly [8][12]. This way it is very important to allow data sharing and communication between systems (R3).

And lastly, the solution shall **collect, classify, and analyze data from patients and combine that with the city data and between systems** (R5). There are some challenges regarding this requirement, as some data remains trapped in EHR (Electronic Health Record), complicating the exchange of data [7]. But this requirement also benefits the system because by allowing data integration and exchange, we are promoting transparency and enabling efficient data integration and reliable analysis within Smart Health systems [7]. It also helps with the development of new applications and the maintenance of the existing ones [7]. One of the articles, gives an example: an application that collects data from the mobile phones of citizens regarding traffic lights and pollen concentrations by using wire-less sensors distributed in trees and streetlights [3]. The application analyses the data and advises citizens to take a route with low level of pollution or pollen. It would also allow that real time data could be collected from citizens and combined with city data [15].

An example on how to collect, classify and analyze data from patients between systems: system where patients report their health condition based on the level of pain felt at the that time (taking in consideration temperature, heart rate, …). If these health conditions pass a certain level, system will give notification to the doctor for further communication and advise patient to check health condition to a health clinic [11].

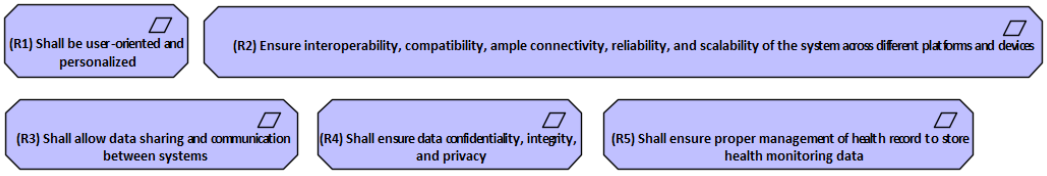

Fig. 9. SH-EAF: Requirements

3.9 Constraints

There are several factors that limit the realization of smart health goals, such as: Funding and economic aspects; Data collection, presentation, and analysis; Data quantity, variety, velocity, consistency, and storage; Usability and human-computer interaction; Sensor integration and battery; May require technological developments in ICT, technology, and connectivity.

As for the **funding and economic aspects** (C1), although smart health reduces the cost of healthcare systems [3], there is a limited financial budget for this solution (especially in the public sector) [13] and the medical services may not be approachable or affordable to everyone [14]. Another thing to consider, in special when the smart health solutions are implemented by private entrepreneurs, is the cost of design of the solution [14], as the technologies implied require funding to be maintained and upgrade [6]. With the increase of elderly patients and the rise of chronic diseases, so does the demand for assisted living increases, increasing the healthcare costs and creating a shortage of healthcare professional [20].

One pillar of smart health application is the **proper use of health-related data** (C2), as it is essential for the provision of health services [15]. But, with data is necessary to take in account its **quantity, variety, velocity, consistency, and storage** (C3). Many time the information stored in non-uniform, too complicated and too big [6] [18]. The information collected by sensors is very diverse and smart health demands it being collected and analyzed almost in real time (to prove useful to patients) and it also pose a challenge of volume, as the sensor take measurements every few seconds [15]. Regarding **usability and human-computer interaction** (C4), it poses a constraint as how the citizens interact with the city can lift many problems such as sensor design, system reliability, among others [15]. Smart health is constrained by the **technological developments in ICT, technology, and connectivity** (C5), as smart health solutions are enabled by specific technologies on which their functionalities rely [13]. Lastly, a constraint that is often forgotten has to do with **sensor integration and battery** (C6). Battery life of sensors is limited and the co-existing of heterogeneous systems represents a challenge [15][19].

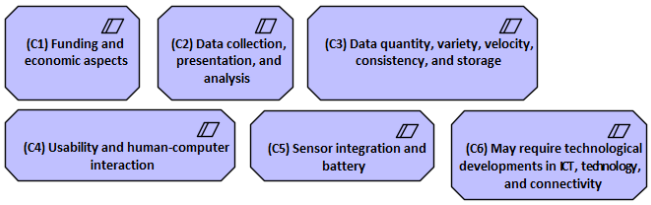

Fig. 10. SH-EAF: Constraints

3.10 Relationship between elements

There are many relationships between the motivation elements of SH-EAF, as suggested in Fig.11. The model is divided in 5 different levels: Level 1 - Stakeholder; Level 2 - Drivers; Level 3 - Assessments; Level 4 - Goals; Level 5 - Outcomes. The

stakeholders are concerned with the drivers and the drivers originate from the assessments. In turn, the assessments lead to goals and goals lead to outcomes.

Regarding the relationship between stakeholders and driver:

- The City Government is concerned with all the driver identified in this framework, as it is the stakeholder that has the most interest in the uptake of smart health.
- Healthcare professional, as being a person who provides healthcare treatment, is concerned with the quality of life of the population and the quality of healthcare services that he/she can provide.
- Both Entrepreneur, Patient, Healthcare regulator and Healthcare provider are stakeholders that only have concern regarding the quality of healthcare services.

Moving on to the relationship between drivers and assessments, in the EAF we only represent assessment that reveal weaknesses of the healthcare systems. Therefore, both assessments A5, A1 and A3 are associated with the quality of healthcare services. The rise of chronic diseases patients is associated with the ageing of the population and lastly, low public sector allocated budget is associated with healthcare costs.

As for the goals, we have goal G4 that is directly connected to the driver of Quality of healthcare services, as opening data can make the public sector more efficient. When data produced by cities is made available and accessible (for example, through open APIs), it can be utilized by both organizations and other parties [5]. All other goals are associated to the assessments and represent what would be desirable. As for the smart health implementation we set the goals around trying to solve the weaknesses of healthcare systems. And so, the represented outcomes are the expected end result of the goals to each they are connected (Realizes connection).

As we already saw before, if we introduce Open Data models [7], we can achieve increased data integration and processing efficiency. If we provide more efficient and reliable health services, we are increasing patients' satisfaction. If we promote healthier lifestyles and improve quality of life, we are improving living standards and healthier lifestyles. If we manage to reduce healthcare costs, we are reducing the burden of healthcare system economics on the government and therefore redistributing it to other areas that may be needing it more.

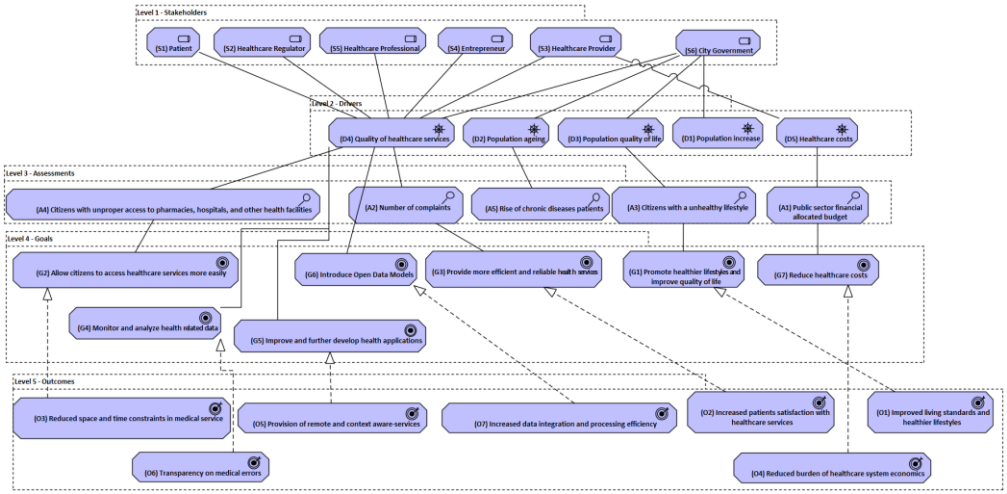

Fig. 11. Relationships between Stakeholders, Drivers, Goals, Assessments and Outcomes.

4 SH-EAF Discussion

Table 2 presents a mapping between each specific ArchiMate motivation element and the selected papers.

The Popularity metric shows the popularity of the element in face of the SLR and was calculate dividing the number of articles the element gets mentioned by the total of articles that were analyzed (20). As we can observe from this table, all the motivation element from SH-EAF have been referenced at least on two articles, therefore each element has at least 10% of popularity.To apply this enterprise architecture model to a city, its elements can be used as guidelines for its implementation. The most popular elements shall be the priority in an implementation of this framework, followed by the remaining. The context can also the adapted to each city reality (for example, some cities may not have problems with citizens access to health facilities, there may be already open data models put in place, etc.)

Concluding, this research intends to provide a general mode for city authorities and to have a reference enterprise architecture when working on their smart health solutions, from a motivation perspective.

Table 2. Mapping between ArchiMate motivation elements and elements relevance

	Motivation Elements	Popularity (%)	SP1	SP2	SP3	SP4	SP5	SP6	SP7	SP8	SP9	SP10	SP11	SP12	SP13	SP14	SP15	SP16	SP17	SP18	SP19	SP20
Stakeholders	Healthcare professional	25%											X	X				X	X		X	
	Healthcare provider	25%				X		X										X	X	X		
	Patient	60%	X	X	X	X	X		X	X				X				X	X	X	X	
	City Government	30%	X							X			X		X					X	X	
	Entrepeneur	15%						X											X	X		
	Healthcare regulator	10%						X									X					
Drivers	Population increase	20%	X	X					X				X									
	Population ageing	30%		X	X			X		X				X							X	
	Population quality of life	35%	X	X		X				X										X	X	X
	Quality of healthcare services	30%		X			X		X						X				X			X
	Healthcare costs	35%	X	X	X		X		X	X					X							
Assessment	Public sector financial allocated budget	10%						X		X												
	Number of complaints	15%					X	X		X												
	Citizens with a unhealthy lifestyle	10%		X	X																	
	Citizens with unproper access to pharmacies, hospitals and other health facilities	10%					X		X													
	Rise of chronic diseases patients	10%								X				X								
Goals	Promote healthier lifestyles and improve quality of life	20%		X						X										X	X	
	Reduce healthcare costs	45%	X				X		X	X			X		X	X				X	X	
	Improve and further delevop health applications	10%			X					X												
	Allow citizens to access healthcare services more easily	10%	X							X												
	Introduce Open Data models	10%										X		X								
	Monitor and analyse health-related data	15%		X		X			X													
	Provide more efficient and reliable health services	55%	X	X			X		X	X			X		X	X		X		X	X	
Outcomes	Increased data integration and processing efficiency	10%		X												X						
	Provision of remote and context aware-services	10%		X						X												
	Improved living standards and healthier lifestyles	30%	X	X			X			X			X							X		
	Increased patients satisfaction with healthcare services	20%		X					X	X						X						
	Reduced burden of healthcare system economics	40%	X	X			X		X	X			X		X	X				X		
	Reduced space and time constraints in medical service	10%					X							X								
	Transparency on medical errors	10%						X												X		
Principles	Ensure uniform technical standards among medical institutions	15%						X									X	X				
	Utilize available resources to their maximum potential	10%							X									X				
Requirements	Shall ensure proper management of medical health record to store health monitoring data	30%		X			X	X			X	X	X									
	Shall collect, classify and analyze data from patients and combine that with the city data and between systems	20%	X							X		X						X				
	Shall ensure interoperability, compatibility, ample connectivity, reliability and scalability of the system	10%							X			X										
	Shall ensure data confidentiality, integrity and privacy	30%	X						X	X					X	X		X				
	Shall be user-oriented and personalized	25%	X	X					X	X								X				
Constraints	May require techonological developments in ICT, e-location technology and connnectivity	15%		X				X		X												
	Data quantity, variety, velocity, consistency and storage	15%		X												X		X				
	Data collection, presentation and analysis	20%								X					X	X			X			
	Sensor integration and battery life	10%								X							X					
	Usability and human-computer interaction	5%								X												
	Funding or economic aspects	35%	X					X	X							X		X		X	X	

5 Conclusion and future work

In this work, a SLR was conducted to identify the key motivation elements for smart health implementations. With the summarized information and the analysis above, we answer the original research question (RQ) and the propose the SH-EAF.

The enterprise architecture elements set the foundations for a discussion about smart health implementation. The purpose was mainly to demonstrate how motivation elements are used to model the motivations, or reasons, that guide the design or change [21], and we believe these topics should be further addressed in future work to complement this framework proposal. By identifying the key motivation elements for smart health implementation, cities are better prepared to guide the design or change of an Enterprise Architecture [21]. On other hand, our framework is focused on motivation elements, as the goal was to give a reason and a context behind smart health implementation. Therefore, we believe that a similar approach on business, application and technological elements for smart health implementation would extend this framework proposal.

Lastly, the framework was based on the motivation element which are the most relevant for smart health.

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