Value Engineering and Agile for building Urgent and Emergency Care

Daniela America da Silva, Samara Cardoso dos Santos, Wilson Cristoni, Luiz Coura, Fabio Kfouri, Gildarcio Sousa Goncalves, Alyson Basilio, Ricardo Alvarenga, Breslei Max Reis da Fonseca, Jean Carlos Lourenco Costa, Juliana F. Pasquini Martinez, Claudio Lima, Alexandre Nascimento, Johnny Marques, Luiz Alberto Vieira Dias, Adilson Marques da Cunha, Paulo Marcelo Tasinaffo

Electronic Engineering and Computing Department
Brazilian Aeronautics Institute of Technology
São José dos Campos, São Paulo, Brazil
Email: stagiho-bd@googlegroups.com

***Abstract*—In health care, combating waste is an emerging issue as clinicians face the complexities of current patient care requiring to apply new technologies as also collaborate with professionals from engineering and computer science background. Answering to that call, during the 1st Semester of 2018, at the Brazilian Aeronautics Institute of Technology (Instituto Tecnológico de Aeronautica - ITA), a successful Collaborative Interdisciplinary Problem-Based Learning (Co-IPBL) experience took place, for conceptualizing, modeling, developing, and testing a Computer System based upon Big Data, Blockchain Hyperledger, Micro-services, and other emerging technologies applied to Urgent and Emergency Care. The Co-IPBL experience had the participation of a medical technical team from the Hospital of Clinics at the Faculty of Medicine of the University of São Paulo. In the present article, we discuss how value engineering, agile and the business model canvas could help improve functionality benefit, reduce cost, combat waste and reduce complexity. We then propose a process to apply a quantitative method to prioritize valuable User Stories, reducing scope and demonstrating real delivered value as proposed in the Business Model Canvas. For the implementation, the Blockchain Hyperledger was used as a common database of health care information that doctors and providers could access.**

Keywords-Health Care System; Big Data; Internet of Things; Agile method and testing; Intelligent Systems; Micro-services Architecture; Cloud Computing; Blockchain; interdisciplinarity; Collaborative problem-based learning.

I. INTRODUCTION

This paper tackles the development of an academic project using the Collaborative Interdisciplinary Problem-Based Learning (Co-IPBL) and how value engineering, agile and the business model canvas could help to improve functionality benefit, increase the effectiveness of attendance in hospital and/or reducing cost for the specific urgent and emergency care domain.

Combating waste is a permanent goal and priority of all organizations. Any activity in the project that is not adding some value or utility to someone is an unnecessary activity and must be eliminated. Another area requiring attention is the capacity and human energy, and the waste of these capabilities has brought huge losses to companies. Combating waste is a responsibility everyone can not be left out of it, because non-participation is already a waste of a very valuable resource, which is human talent.

In health care, combating waste is an emerging issue as clinicians face the complexities of current patient care: the need for applying new technologies in health care management and the need for health care professionals to collaborate with professionals from engineering and computer science background. Interdisciplinary health care teams with members from many professions and value engineering usually answer calls, by working together, collaborating, communicating closely and improving functionality benefits to digitize patients' care [10]-[12].

This research work provides an integration of 3 different courses taught at the Brazilian Aeronautics Institute of Technology (*Instituto Tecnológico de Aeronáutica - ITA*): CE-240 Database Systems Projects, CE-245 Information Technologies, and CE-229 Software Testing. It involved some cooperative work with technical Physicians from Urgent and Emergency Health Care at the Hospital of Clinics from the Faculty of Medicine at the University of São Paulo, Brazil.

This academic project was driven by ITA to generate expertise on developing, integrating, and managing Urgent and Emergency Health Care in the Hospital of Clinics [4]. This project was named in Portuguese *Soluções Tecnológicas Aplicáveis ao Gerenciamento de Informações Hospitalares Ostensivas com Big Data - STAGIHO-DB*, meaning in English, "Technological Solutions Applicable for Managing Ostensive Hospital Information with Big Data-TSA4MOHIBD". Scrum Agile Method [1]-[3], Value Engineering [15][16], Business Model Canvas[19] and its best practices were used, in order to develop a computer system to satisfy project requirements in a time frame of just 16 academic weeks.

This TSA4MOHIBD Project [5] was divided into two groups of application: External Regulation and Internal Regulation, by sharing its development among four student teams, which were responsible for developing different functional requirements involving the verification of quality, reliability, safety, and testability.

This research work project was developed by using GitHub to store program code, NodeJs [21] for the development of Java Micro-services (fine-grained services), NoSQL Databases [22] to store the internal data for the Hospital, Blockchain Hyperledger [9] to store the electronic

 ISBN: 978-1-61208-651-4

health records, Kafka [23] for message exchanging in the common communication data bus, and other emerging technologies. During this collaborative project development, more than 20 students have practiced the roles of Product Owner (PO), Scrum Masters (SMs), and Team Developers (TDs).

At the end of this project, a total of 52 Atributtes has been identified to prepare 35 User Stories (USs) to compose the Product Backlog. However, only 20 USs were developed within 3 monthly sprints as part of scope reduction and value engineering. For each Sprint was built a Business Model Canvas describing the benefits to be delivered. In the first week of each sprint it was performed the Sprint Planning to identify the USs aligned with the Business Model Canvas, and every week the development process was monitored to keep the focus on the big picture and final product more aligned to target audience desires and needs [19]. At the end of each sprint, reviews and retrospective meetings took place. Moreover, the Acceptance Test Driven Development (ATDD) [6] was applied by generating a minimum, necessary, and sufficient set of artifacts stored at the Project Internet Portal [5].

For each US, more than one test case and acceptance test were developed. The integration strategy between groups of subsystem components occurred, by using Micro-services, a Commom Data Communication Bus, and Blockchain Hyperledger, allowing information to be available via broadcast to every hospital area and also to the External Regulator named CROSS (named in Portuguese *Central de Regulação de Ofertas de Serviços de Saúde* and meaning in English the Regulation Center for Health Services Offerings).

An overview of the Urgent and Emergency Care flow is presented in Figure 1.

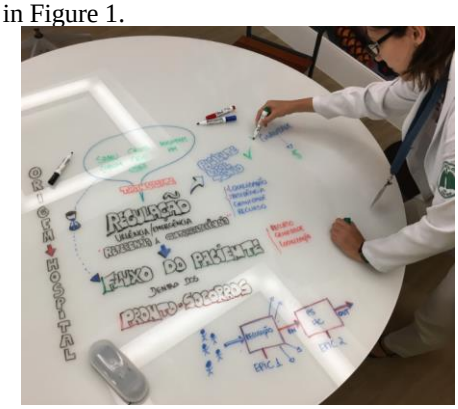

Figure 1. The Emergency and Urgent Care Overview.

In Section II, we describe the attributes of Urgent and Emergency Care at the HCFMUSP. In Section III we present the analysis of attributes and the process applied to reduce scope prioritizing the most valuable USs according to the Value Engineering analysis. In Section IV, we present the Proof of Concept. In Section V, we present the final deliverables using Blockchain Hyperledger. And in Section VI we state our conclusions and suggest possible topics for future research.

II. The Urgency and Emergency Health Care In the HCFMUSP

Before starting the academic year, some students from the Brazilian Aeronautics Institute of Technology (ITA) had a planning meeting with some members of the Emergency Care in the Hospital of Clinics from the Faculty of Medicine at the University of São Paulo (in Portuguese, *Hospital da Clínicas da Faculdade de Medicina de São Paulo - HCFMUSP).*

On that opportunity, the internal members of the hospital have presented some details of the internal and external regulation and clarified the diagram presented in Figure 1. At that time, there was also an on-site visit to some emergency areas and hospital sectors and it was agreed that some information should be shared with ITA developers, such as students and professors, in order to provide requirements specifications for the next steps of project development.

A. Regulations

Regulations of Hospitals and Health Units attending Urgencies and Emergencies are usually carried out by the Health Care Supply Regulatory Center (CROSS). Some urgencies and emergencies are referred to the CROSS by: the Mobile Emergency Response Service (in Portuguese, *Serviço de Atendimento Móvel de Urgência - SAMU*); the Military Police Operations Center (in Portuguese, *Central de Operações Policias Militares - COPOM*); the Firefighter Operations Center (in Portuguese, *Centro de Operações do Corpo de Bombeiros - COBOM*); and/or Health, Secondary Hospitals, and Specialized Hospitals.

It is through the CROSS that the HCFMUSP use to be contacted, in order to respond to urgencies and emergencies. An emergency patient may also arrive by the regular entrance of the HCFMUSP and after contacting the CROSS (usually via email or through the CROSS Web Portal), the HCFMUSP will screen through an Internal Hospital Regulation to filter relevant cases for hospital care.

B. The External Regulation

The Health Care Secretary of São Paulo understood the regulation as an important tool for the management of public health systems, which has among its objectives the equity of the access implemented through dynamic actions executed in an equitable, orderly, timely and rational way, creating the CROSS, which brings together actions aimed at regulating access in hospitals and outpatient areas, contributing to the integrality of the assistance, providing the adjustment of the available health care supply to the immediate needs of the citizen as described at the CROSS Internet Portal [13].

C. The Internal Regulation

The Internal Regulation is the area responsible in the Hospital for verifying availability to receive a Patient and will also make the contact with the appropriate hospital institute to evaluate if a Patient could be transferred to the Hospital.

 ISBN: 978-1-61208-651-4

III. THE BUSINESS MODEL CANVAS

The Business Model Canvas is a simple graphical template describing nine essential components and it brings clarity and simplicity to evaluate business models in minutes [19] and a way to refocus the way you view your business. Between the elements analyzed are: Customer segments, value propositions, channels, customer relationships (such as self-service or personal assistance), revenue streams, resources, activities, partnerships, and costs.

The individual elements prompt consideration of a business' full scope, while the layout encourages thought about how the pieces fit together. In Figure 2 is presented the Urgent and Emergency Care Business Model Canvas. And in Table I and II the details analyzed for each Business Canvas Element.

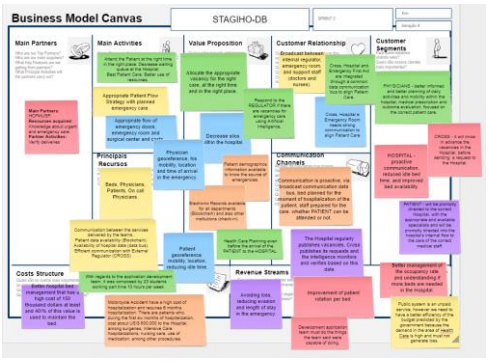

Figure 2. The Urgent and Emergency Care Business Model Canvas

TABLE I. THE BUSINESS MODEL CANVAS - MAPPING RESOURCES

Elements	Urgent and Emergency Care
Main Partners	HCFMUSP. Resources acquired: Knowledge about urgent and emergency care. Partner Activities: Verify deliveries.
Main Activities	Attend the Patient at the right time in the right place. Decrease waiting queue at the Hospital. Best Patient Care. Better use of resources. Appropriate Patient Flow Strategy with planned emergency care. Appropriate flow of emergency doors, emergency room and surgical center and costs.
Main resources	Beds, Physicians, Patients, On Call Physicians. Communication between the services delivered by the teams. Patient data availability (Blockchain). Availability of hospital data (data bus). Efficient communication with External Regulator (CROSS)

TABLE II. THE BUSINESS MODEL CANVAS - MAPPING VALUES

Elements	Urgent and Emergency Care
Value proposition	Allocate the appropriate vacancy for the right care, at the right time and in the right place. Respond to the REGULATOR if there are vacancies for emergency care using Artificial Intelligence. Decrease silos within the hospital. Patient demographics information available to know the source of emergencies. Physician georeference, his mobility, location and time of arrival in the emergency. Patient georeference, mobility, location, reducing idle time. Health Care Planning even before the arrival of the PATIENT to the HOSPITAL. Electronic Records available for all departments (Blockchain) and also other institutions (check-in).
Customer Relationship	Broadcast between internal regulator, emergency room, and support staff (doctors and nurses). Cross, Hospital and Emergency First Aid are integrated through a common data communication bus to align Patient Care. Patient data is in BlockChain.
Communication Channels	Communication is proactive, via broadcast communication data bus, bed planned for the moment of hospitalization of the patient, staff prepared for the care. The communication is proactive, the Hospital regularly publishes vacancies, Cross publishes its requests and the intelligence monitors and verifies based on this data whether PATIENT can be attended or not.
Customer Segments	CROSS - It will know in advance the vacancies in the Hospital, before sending a request to the Hospital. PHYSICIANS - better informed and better planning of daily activities and mobility within the hospital, medical prescription and outcome evaluation, focused on the correct patient care. HOSPITAL - proactive communication, reduced idle bed time, and improved bed availability. PATIENT - will be promptly directed to the correct Hospital, with the appropriate and available specialists and will be promptly directed into the hospital's internal flow to the care of the correct medical staff.
Costs Structure	Better hospital bed management that has a high cost of 150 thousand dollars at least and 40% of this value is used to maintain the bed. Motorcycle Accident have a high cost of hospitalization and requires 6 months hospitalization. There are patients who, during the first six months of hospitalization, cost about R\$ 600,000 to the Hospital, among surgeries, Intensive Care hospitalizations, nursing care, use of medication, among other procedures. With regards to the application development team, it was composed by 23 students working part time 10 hours per week.
Revenue Streams	Avoiding loss, reducing evasion and length of stay in the emergency. Improvement of patient rotation per bed. Better management of the occupancy rate and understanding if more beds are needed in the Hospital. Public system is an unpaid service, however we need to have a better efficiency of the budget predicted by the government because the demand in the area of Health Care is high and must not generate loss. Development application team must do the things the team said were capable of doing.

IV. VALUE ENGINEERING

A. *Analyzing Urgency and Emergency Care Attributes*

In order to collect data, a visit to the HCFMUSP was carried out, and documents provided by the Hospital were collected to provide initial understanding on the flow of care from the CROSS service request until the patient arrived at the Hospital and patient care started. The adoption of the meeting with the technical team is justified to identify the team's perception of the current service operation and the opportunities for improvement.

The people of the HCFMUSP technical team selected for the meeting are those who participate in the internal regulation of the hospital for patient care authorization: the director of internal regulation, and two physicians who coordinate the internal regulation. The people from the ITA

 ISBN: 978-1-61208-651-4

selected for the meeting were one PhD Candidate student and one Master's degree student for the preparation of the requirements specification.

As a result, it was possible to understand the characteristics of urgent and emergency service assigning degrees of importance to each service attribute. On top of most valuable attributes, to simplify the Proof of Concept and to reduce the scope and complexity of the system to be developed, a mission assigned was developed to the rescue of motorcycle accident victims, mainly because it is a frequent occurrence in the city of São Paulo [17][18].

The Definition of Ready (DoR) checklist was created to indicate to the team that the US was READY to be INITIATED, that is, all necessary definitions, information, data and resources have been provided, UNDERSTOOD and ESTIMATED, and the development and testing phase can be initiated.

The Definition of Done (DoD) checklist was created and tells the team that the US is READY to be DELIVERED, that is, all development and testing activities have been performed. Without the DoD the US can not be considered delivered to the Product Owner.

The User Stories were written using the INVEST (Independent, Negotiable, Valuable, Estimable, Small, Testable) method because it solves practically the entire DoR. If US does not meet DoR's requirements, it can not be placed on the Sprint Backlog. Also, team members did not wait for Sprint Planning to prepare the next US, it was done constantly and the Product Backlog was updated according to the expected benefit to be delivered during the Sprint. The USs that comply with the DoR were placed at the top of the Product Backlog, according to the example in Figure 3 below.

Figure 3. Managing the Product Backlog

Table III and IV presents details of scope reduction, from the identification of attributes to the deliverable of a product propitiating good benefits to the Urgent and Emergency Care, and specifically for the External Regulation, from the request placed by CROSS for Patient Care, to Hospital vacancy and confirmation of acceptance from the Hospital.

TABLE III. THE EXTERNAL REGULATION SCOPE REDUCTION - MAIN STEPS

Attributes	Quantity	Valuable for USs	Scope reduction	USs Developed
About Patient Care	10	5	3	1
About Logistics	6	1	1	1
About the Internal Controller	10	6	5	3
About the Governance	8	7	2	2
About the Standards	5	0	0	0
About Systems Integration	14	5	4	2
About the Management of Beds	4	2	2	2
TOTAL	60	26	17	9

TABLE IV. THE EXTERNAL REGULATION SCOPE REDUCTION - INTERACTIONS

Attributes	Quantity	Valuable for USs	Scope reduction	USs Developed
About Data Quality	4	3	2	1
About the Human Factor	1	0	0	0
About the Telemedicine	2	2	2	0
About the Hierarchy	2	1	0	0
TOTAL	9	6	4	1

Table V presents details of scope reduction specifically for the Internal Regulation from the response to the CROSS confirming Patient Acceptance to the Patient identification, arrival and care after arrival in the Hospital propitiating good benefits to the Hospital Internal Health Care Flow.

TABLE V. THE INTERNAL REGULATION SCOPE REDUCTION

Attributes	Quantity	Valuable for USs	Scope reduction	USs Developed
About the Lobby	5	2	1	1
About the Identification	8	5	3	3
About Patient Care	7	3	1	1
About Patients in the Emergency Room	5	2	1	1
About the Internal Flow of Patients	3	2	1	1
About the Internal Flow of Physicians	4	1	1	1
About the Internal Flow of Nurses	2	1	1	0

Attributes	Quantity	Valuable for USs	Scope reduction	USs Developed
Integration Needs	11	4	4	2
TOTAL	45	20	14	10

In Figure 4, it is presented a chart demonstrating how the value engineering, agile method and business model canvas combined could simplify the Proof of Concept and reduce the scope and complexity of the system to be developed, and demonstrates that developing team managed to choose USs that could delivery the benefits mapped in the Business Model Canvas presented in Table I and II and how this process based on value could reduce complexity in developing phase.

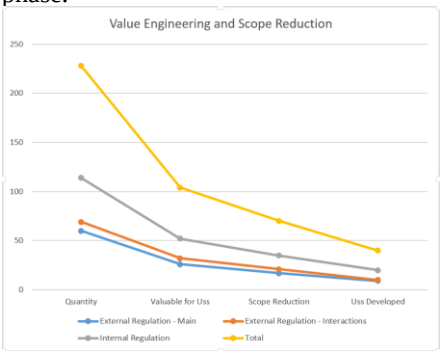

Figure 4. The Value Engineering Results and the Scope Reduction

Figure 5 presents a summary on the Urgent and Emergency Care deliverables based on the Value Engineering Analysis. It demonstrates that value could be increased focusing in improving process to propitiate the right Patient to the correct Patient Care, proactive communication with Regulator, sharing vacancies prior to receive requests, improving speed to plan and predict Patient Care and sharing Patient Information to internal institutes and other Institutions through blockchain [20].

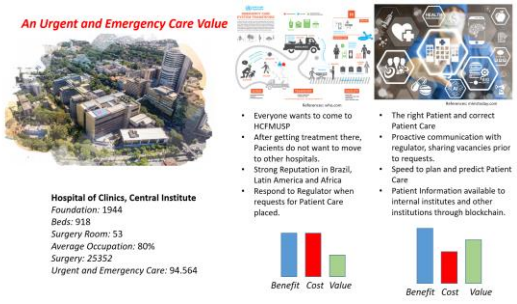

Figure 5. An Urgent and Emergency Health Care Value

As presented in Figure 6, for the external regulation the team focused on USs related to communication between CROSS and Internal Controller, Governance, Systems Integration, Management of Hospital Beds, and Data Quality using Blockchain.

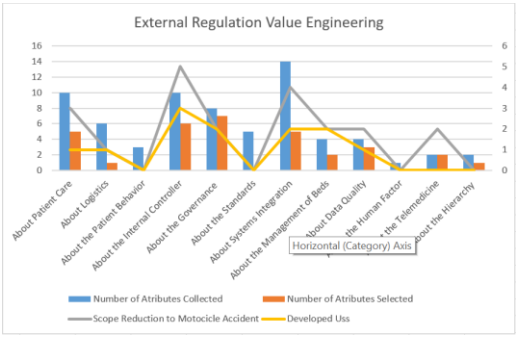

Figure 6. External Regulation Value Engineering

And as presented in Figure 7 for the internal regulation the team focused on USs related to patient identification, planning and managing patient care in the emergency room, managing flow of Patient and Physicians in the Hospital, and improving integration needs using blockchain.

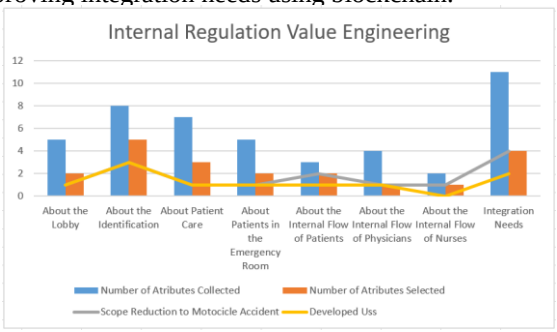

Figure 7. Internal Regulation Value Engineering

B. *The Proof of Concept as an Assigned Mission*

To reduce the scope and complexity of the system to be developed, a mission assigned was developed to the rescue of motorcycle accident victims, mainly because it is a frequent occurrence in the city of São Paulo. On a regular workday, every 15 minutes, the SAMU assists a motorcyclist in the city of São Paulo. Most of victims are not made up of motoboys. Usually, they are drivers who use vehicles (motorbikes) to go to work or are weekend drivers. Rehabilitation of those who are injured is usually time-consuming and laborious, as described below:

- 40\% of motorcycle accident victims need to undergo complex surgeries and long physiotherapy treatments;
- The most serious injuries caused by motorcycle accidents are usually in the skull and spine;
- Most motorcycle riders use the vehicle as transport, only for 2 hours a day, usually to move between home and work place; Most of them have been injured before;
- Of the total number of accidents initially investigated, 2% resulted in death of motorcyclists;
- Of the total number of injuries: 48% had serious injuries, 17% in the legs and feet; 12% in arms; and 23% had other types of trauma;
- Most of them were discharged immediately after care and only 18% had to be hospitalized; and

 ISBN: 978-1-61208-651-4

- Considering the annual costs, about R$ 100 million are invested by the Orthopedics Institute of the HC, exclusively for the recovery of motorcyclists: "These are patients who, in the first six months of hospitalization, cost about R$ 300 thousands to the Hospital, on surgeries, ICU hospitalizations, occupations of wards, use of medications, among other procedures.

Based on previously reported motorcycle accident data, the development of the TSA4MOHIBD project should be able to provide an adequate management for the control of victim assistance only considering motorcycle accidents, in such a way that:

- Those motorcycle accident victims (PATIENTS) may be appropriately diagnosed, promptly identified and/or attended to;

- PHYSICIANS may have computers and/or computer tools capable of providing preventive and appropriate planning, scheduling, and controlling of motorcycle accident emergency services, for example, identifying the needs of: hospitalization time; procedures; medical teams; procedures for surgery preparations; as well as the availability of operating rooms and Intensive Therapy Units;

- The HOSPITAL and/or the INTERNAL CONTROLLER shall have computers and/or computer tools capable of using appropriate technologies to provide efficient screening methods, prioritization of care, patient and physician locations within the HOSPITAL, in order to locate, if necessary, other HOSPITALS to attend emergencies of motorcycle accident victims, according to the criticalities and needs from specialized treatments of the PATIENTS;

- HOSPITAL must have adequate computers and/or computer means to collaborate in the process of managing large data flows, involving efficient attendance of injured motorcycle patients, by using appropriate technologies and efficient screening methods for this type of emergency;

- SUPPLIERS of medicines, devices and/or technologies must have appropriate tools to participate in logistics and/or supply process to be used in care and/or care for victims from motorcycle accidents attended by urgent and emergency care of HOSPITALS;

- PHYSICIANS and NURSES must have appropriate tools to provide care to victims from motorcycle accidents attended by the urgent and emergency care of the HOSPITAL, for example, to identify them from their entrance hall, by verifying and controlling also the movement of the stretchers, according to internal flows of required services;

- Each confirmed case of motorcycle-injured PATIENT can and should generate, within the inventory control of a HOSPITAL, the release of care kits containing materials and medications, according to the size of events. In these cases, in addition to medicines, other supplies can and should be considered important, such as blood bags for transfusions, as accident victims need quick rescue and motorcycle accidents kill from blood loss;

- The population/society should have access to computers and/or computer tools of the System Project involving the TSA4MOHIBD and/or the Real-time TSA4MOHIBD capable of providing appropriate records, management, controls, and governance of resources used in the area of Health Care;

- Public administration must have reliable data to provide a comprehensive situational awareness to support decision making for accidents and/or crises, involving motorcycle accidents.

V. THE FINAL PRODUCT

In order to provide appropriate speed in the communication with the Regulator and also to allow the Regulator to know in advance the number of bed vacancy in the Hospital, it is suggested that the communication between the Regulator and the Hospital works similarly to the AirBnB model. Then, the hospital will publish in a data bus communication how many vacancy, physicians, and specialists are available and also the Regulator will publish an attendance request for a patient and its initial conditions.

After that, an Artificial Intelligence algorithm will perform some analysis to identify what kind of treatment is necessary for the Patient, and to search among the Hospitals which one is closest, has a vacancy and suitable resources to receive this Patient. The Artificial Intelligence algorithm, after finding the appropriate Hospital, will place in the same data bus a message to the Hospital.

In the Hospital at the Internal Regulator, the operator will analyze the request and through the application system the operator will place a message in the Data Bus, by informing to Artificial Intelligence algorithm that the Patient was accepted and will inform straight the Urgent Care Unit that a Patient will arrive, also informing the date and time of the estimated arrival. The patient information will be available in the Blockchain Hyperledger, and then data from the CROSS and also data about the Patient will be internally matched in the Hospital. From that point onwards, the planning for Patient Care will be started prior to the Patient arrival.

When the Patient arrives the technical team, the bed, and the required examination and health care steps will proceed as per suggested planning. After acceptance from the Internal Controller, the intelligence of the system will place a message to the Regulator, by informing that the Patient was accepted by the HCFMUSP.

After a Patient arrived at the Hospital, his Electronic Health Record could be read by any Institute or professional from inside of the HCFMUSP, and information about patient care steps, as all the current bed management in the Hospital, would be presented through a dashboard that could be available for the governance team, by physicians and nurses looking at the next steps of the Patient Care.

For the Urgency and Emergency Care at the HCFMUSP, our proposal is to use two separate Blockchain networks: one for Patient and other for Attendance. The Blockchain Patient network has overall patient information and is a private network with information that can be accessed by the CROSS and any other Institution that would like in the future to access Patient Identification (e.g., Single Health System, in Portuguese, named *Sistema Único de Saúde - SUS*). The Blockchain Attendance network has detailed patient information and all the heath care details performed

 ISBN: 978-1-61208-651-4

by the Hospital. And it is a private network with information that can be accessed only by the Hospital and internal institutes. For future work, examination details could be also stored in this Blockchain network.

The main benefit of isolating patient's data from patient's own care is to provide data safety, since confidential information will be managed only by the hospital. The indirect benefit is to allow that two different groups of students learning Blockchain could also learn separately and then the integration has worked smoothly during the Sprint 3 of the TSA4MOHIBD project, focusing in the Integration.

The Blockchain Hyperledger implementation also makes use of encapsulated micro-services allowing smooth functionalities' integrations, which were developed during Sprint 1, focusing in the External Flow implementation, and Sprint 2, focusing in the Internal Flow Implementation. The overview of The Proposed Product Architecture is presented in Figure 8.

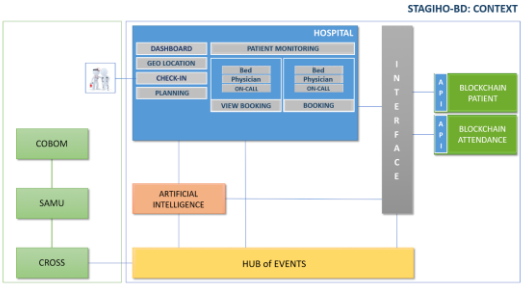

Figure 8. The Proposed Architecture Overview

VI. CONCLUSION

This paper aimed to describe the development of an academic interdisciplinary project combining Scrum agile method, value engineering and the business model canvas in order to develop a prototype for a Proof of Concept (PoC) to improve functionality benefit and/or reducing cost in the urgent and emergency care domain.

It has described a Collaborative Integrated Problem-Based Learning (Co-IPBL) performed with the participation of a medical technical team from the Hospital of Clinics from the Faculty of Medicine of the University of São Paulo (in Portuguese, *Hospital das Clínicas da Faculdade de Medicina de São Paulo - HCFMUSP*), focusing in the Urgent and Emergency Care. This academic research project was named in Portuguese as "*Soluções Tecnológicas Aplicáveis ao Gerenciamento de Informações Hospitalares Ostensivas com Big Data - STAGIHO-DB*", meaning in English, "Technological Solutions Applicable for the Management of Ostensive Hospital Information with Big Data - TSA4MOHIBD", a Computer System based on Big Data, Blockchain Hyperledger, Micro-services, and other emerging technologies for governmental organization and private sector.

The purpose of this system was to aggregate data and integrate sectors, such as External and Internal Regulations through its PATIENTS, HOSPITALS, PHYSICIANS, and HEALTH CARE SUPPLIERS, for the decision making process related to Urgency and Emergency Care, involving motorcycle accidents. The TSA4MOHIBD project was developed by students from three different Computer Science courses taught at the Brazilian Aeronautics Institute of Technology (*Instituto Tecnológico de Aeronáutica – ITA*), on the 1st Semester of 2018.

A. *Specific Conclusions*

The use of interdisciplinary in 3 courses of Computer Science has worked as expected, since students were able to know how to work in teams to successfully develop a complex computer system.

The cloud-computing environment has been widely used by students to enable collaborative work from distance, by using remote meetings, personal websites, and an official project website. The Scrum framework has been adapted to the reality of the interdisciplinary academic environment of ITA, helping the entire team of more than 20 students to offer value to stakeholders at the end of each sprint and also at the end of this project.

Combating waste is a permanent goal and priority of this project as well active participation of team members, since human talent is a very valuable resource. The Collaborative Interdisciplinary and the use of Value Engineering and Business Canvas propitiate identify the valuable functionality to be developed during the Proof of Concept and the benefits desired for the Urgent and Emergency Care. And the process increased creativity in the use of disruptive technologies and in the use of innovative practices in software development.

The application of Test Driven Development (TDD) and Acceptance Testing Driven Development (ATDD) techniques in the project was closely related to the interdisciplinary approach adopted, since acceptance tests were created by CE-229 Software Testing course students, while the Blockchain, NodeJS applications, and the Value Engineering and Business Model Canvas were implemented by CE-240 Database System Project and CE-245 Information Technologies course students.

Its operating logic was established and all teams were able to perform development integration, by defining and accomplishing the phases of an Assigned Mission to reduce scope, mapping User Stories to functionalities for the External and Internal regulations integration, which variables and detailed characteristics would be changed as inputs and/or outputs. The main results obtained from the use of the TSA4MOHIBD project prototype were successful.

At the end of this project, in just 17 weeks, it was possible to demonstrate the building of the Collaborative Interdisciplinary Project TSA4MOHIBD, without completeness, but following a model with quality, reliability, safety, testability, norms, and standards applicable to a product of this nature. Finally, students have presented the TSA4MOHIBD Academic Project Prototype, as the final project for their courses, as a Proof of Concept (PoC) to professors, entrepreneurs, and some invited guests from industry and academia.

 ISBN: 978-1-61208-651-4

B. General Conclusions

The academic development of a critical intelligent system is a rewarding experience that can be used in different undergrad and graduate courses. The use of interdisciplinary, Blockchain Hyperledger, cloud computing, value engineering, business model canvas, and agile methods seems to be an interesting novel and exciting way to achieve academic goals, in just one semester of 17 weeks and can also be extended to other knowledge domains.

It is possible to avoid waste and increase value by either improving the functionality benefits and/or reduce costs. The technique applied uses rational logic and analysis of functionalities, modern technologies and agile practices to increase value. The Proof of Concept demonstrates the importance of customer perception of value, the business goals, needs and issues to build the best solution. It also propitiated keep the focus on the big picture prioritizing first the most important functionalities, better support for business decisions, points out waste that could be eliminated, speed up solution delivery, and promoted better communication, alignment and commitment between project team members.

C. Recommendations

It is strongly recommended to align expectations and results that may be compromised and quickly adjusted to review deliverables, when working with emerging technologies. This cycle, in the area of computing science, should be repeated all the time we have to deal with new technologies. It is important to have on the team participants who will face the challenge of learning and preparing a legacy.

It is also fundamental to have participants in the team that could identify in advance were the team could fail with the new technology, proposing improvements and allowing the team to repositioning itself to deliver what is agreed in consensus in the appropriate time.

The business model canvas produced presented a summary on the valuable functionality for the Urgent and Emergency Care, and for an investor view it is recommended to prepare a simplified Business Model Canvas that focus on cost reduction. While using new technologies, such as Blockchain and Node JS, it is important to build tutorials to speed up team members learning curve.

It is recommended the continuation of this Project, by starting from what has already been done, possible to obtain and execute, within the courses on the next semesters, on new Sprints, generating the possibility of increasing completeness.

D. Future Work

It is suggested that the process used in this TSA4MOHIBD academic project prototype can be extended to other Agile projects, in order to improve estimation of efforts, resources and avoid waste to attend Urgent and Emergency Care. It is also suggested the use of some simulation processes to measure Urgent and Emergency Care with and without the use of Value Engineering supporting projects development in health care.

Finally, for future work, it is suggested to expand some cooperation among the ITA, hospitals, innovation foundations, medical suppliers, industries and public and private enterprises, in order to get a selection of academic projects aligned to updated needs from the market.

ACKNOWLEDGMENT

The authors would like to thank the Hospital of Clinics from The Faculty of Medicine at The University of São Paulo, the Brazilian Aeronautics Institute of Technology, the Ecossistema Negócios Digitais Ltda for its finantial support and scholarships, during the STAMPS Project Development and The Casimiro Montenegro Filho Foundation (FCMF) for their support, during the development of this TSA4MOHIBD Project.

REFERENCES

[1] J. Sutherland, "SCRUM Handbook", Scrum Training Institute Press, 2010

[2] D. Cohen et al., "An Introduction to Agile Methods", Fraunhofer Center for Experimental Software Engineering, ADVANCES IN COMPUTERS, VOL. 62, 2004.

[3] M. Cohn, "Succeeding with agile: Software development using Scrum", 1st Edition, Pearson Education, Inc., 2010.

[4] FMUSP, "Medical School of São Paulo", 2018, accessed from http://www.fm.usp.br/fmusp/portal/ in June 10, 2018.

[5] TSA4MOHIBD Project, "Technological Solutions Applicable for the Management of Ostensive Hospital Information with Big Data", 2018, accessed from https://sites.google.com/site/projetointerdisciplinar2018/ in June 10, 2018.

[6] K. Pugh, "Lean-Agile Acceptance Test-Driven Development: Better Software Through Collaboration", Addison-Wesley, 2011, ISBN 978-0321714084.

[7] Forbes, "This is Why Blockchain will Transform HealthCare", 2017,accessed from https://www.forbes.com/sites/bernardmarr/2017/11/29/this-is-why-blockchains-will-transform-healthcare/13be90781ebe in June 10, 2018.

[8] GitHub, "Open-source landscape map for healthcare-related blockchain", 2018, accessed from https://github.com/acoravos/healthcare-blockchains in June 10, 2018.

[9] Linux Foundation Projects, "Blockchain Hyperledger", 2018, accessed from https://www.hyperledger.org/ in June 10.2018.

[10] D. A. Silva et al., "Health Care Information Systems: a Crisis Approach", In 15th International Conference on Information Technology: New Generations (ITNG 2018), 2018, Las Vegas.

[11] D. A. Silva et al., "Health Care Transformation: An Academic Application System Case Study", In 10TH IFAC Symposium on Biological and Medical Systems - International Federation of Automatic Control (IFAC BMS 2018), 2018, São Paulo, Brazil.

[12] J. C. Martins et al., "Internet of Things, and Agile for Crises Management", In 14th International Conference on Information Technology: New Generations (ITNG 2017), 2017

[13] CROSS, "Health Care Supply Regulatory Center", 2018, accessed from http://www.cross.saude.sp.gov.br/ in June 10, 2018.

[14] A. Conceicao et al., "Eletronic Health Records Using Blockchain", XXXVI Brazilian Symposium on Computer Networks and Distributed Systems (SBRC 2018), 2018, accessed from http://www.sbrc2018.ufscar.br/wp-content/uploads/2018/04/07-181717-1.pdf in June 10, 2018.

[15] P. Vieira, "Engineering and Value Analysis: a question of efficiency and survival", 2018, e-Disciplinas University of São Paulo, accessed from

https://edisciplinas.usp.br/mod/resource/view.php?id=891829 in June 10, 2018.

[16] CiT, "Presentation CiT Value Engineering Framework", 2018, accessed from https://www.ciandt.com/card/business-value-engineering-framework in June 10, 2018.

[17] M. A. B. Lima, "Target Costing in Public Hospital Services", Accounting Journal, 2013, accessed from https://periodicos.ufpe.br/revistas/ricontabeis/article/download/7966/8040 in June 10, 2018.

[18] C. Bonacim, A. Araujo, "Cost Management Applied to Public University Hospitals", Public Administration Journal, 2010, accessed from www.scielo.br/pdf/rap/v44n4/v44n4a07.pdf in June 10, 2018.

[19] Forbes, "Business Model Canvas: A Simple Tool For Designing Innovative Business Models", 2012, accessed from https://www.forbes.com/sites/tedgreenwald/2012/01/31/business-model-canvas-a-simple-tool-for-designing-innovative-business-models/ in June 10, 2018.

[20] WHO, "Emergency Care System Framework Infographic", 2018, accessed from http://www.who.int/emergencycare/emergencycare_infographic/en/

In June 10, 2018.

[21] Linux Foundation Projects, "Node.JS Foundation", 2018, accessed from https://nodejs.org/en/ in 10 June, 2018.

[22] Apache Kafka, "Apache Kafka Distributed Stream Platform", 2018,accessed from http://kafka.apache.org/

[23] MongoDB, "MongoDB", 2018, accessed from https://www.mongodb.com/

 ISBN: 978-1-61208-651-4