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Systemic service value stream mapping.
Application to a healthcare case

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Abstract

The application of value stream mapping (VSM) for performance improvement in service companies including healthcare service systems is still in development in Latin America. When this Lean tool is applied with a systemic approach for mapping these value streams, the application should represent customer actions and interactions within the complete service system and the internal interactions between contact employees (front office) and back office employees, as well as identify the segments of the value stream as loops, defining these loops as partial units of improvement. A value stream in a clinical laboratory in Colombia was selected as the application case. Three loops were identified in this value stream: blood sample collection loop, sample processing loop (chemical analyses and tests) and results delivery loop (report of findings). This research only focuses on improving the sample collection loop. Lean Thinking principles and tools are applied in order to improve value flow to customers and key operative performance indicators of the system. Some of those key operational performance indicators were improved above 20%.

Key words

System Thinking
Lean Thinking
Health care Service
Process Loop

Mapeo de cadenas de valor: Aplicación a un caso de servicios de salud

Resumen

La aplicación del mapeo de cadenas de valor para mejorar la productividad en compañías prestadoras de servicios, incluyendo aquellas que prestan servicios de salud todavía está en su etapa de desarrollo en Latino América. Al aplicar esta herramienta lean de manera sistémica para mapear estas cadenas de valor, la aplicación debería representar las acciones e interacciones en el sistema de servicio completo y las interacciones internas entre los empleados de contacto (frente de la oficina) y los de la parte trasera de la oficina, así como identificar los segmentos de las cadenas de valor como bucles, definiendo estos bucles como unidades de mejoramiento parcial. Se seleccionó una cadena de valor en un laboratorio clínico colombiano como caso de aplicación. Se identificaron tres bucles en la cadena de valor: recolección de muestras, procesamiento de muestras (análisis químicos y pruebas) y entrega de resultados. Esta investigación se enfoca en el bucle de recolección de muestras. Se aplicaron principios y herramientas de Pensamiento Lean para mejorar el flujo de valor hacia los clientes y los indicadores de desempeño claves del sistema. Algunos de estos indicadores de desempeño fueron mejorados en más de un 20%.

Palabras clave

Pensamiento sistémico
Pensamiento Lean
Servicios de salud
Bucle de proceso

Introduction

Lean thinking is a time-based philosophy that focuses on creating value for the customer by eliminating several forms of waste including: overproduction, delays, unnecessary transport, over processing, excess inventory, unnecessary movement, defects and unused employee creativity (Liker, 2004). This philosophy aims at continually reducing the time from client order arrival until delivery with the smallest cost and highest quality. Dan Jones, Chairman of the Lean Enterprise Academy (The Lean Enterprise Academy, 2010) defines Lean Health care as a way of streamlining patient journey and making it safer by helping staff eliminate all kinds of waste and treat more patients with existing resources. The five Lean thinking principles (Womack and Jones, 2003) adapted to health care cases are (Joosten et al., 2009):

1. Specify value from the point of view of the patient (and the company)

2. Identify the value stream flow including activities that add value or don't add value to the patient

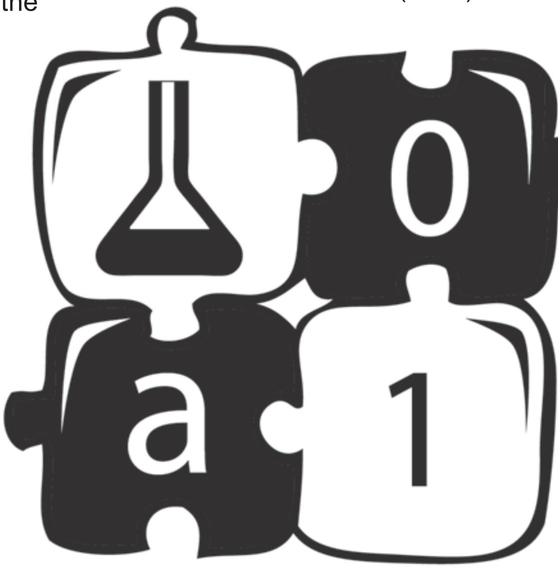
3. Enable the patient to flow smoothly and quickly through every process

4. Match capacity with demand so work is done in line with the pull of the patient

5. Pursue perfection through continuous improvement of the value stream flow

A value stream includes all activities, even those that don't add value and provides a pictorial view of the process elements that the customer is willing to pay for (Tapping and Shuker, 2003). Rother and Shook (2003) define "value stream" to be "all the actions (both value added and non-value added) currently required to bring a product through the main flows essential to every product: (1) the production flow from raw material into the arms of the customer, and (2) the design flow from concept to launch". Value Stream Mapping (VSM) is a graphical Lean tool that integrates the materials and information logistical flows (Taylor and Brunt, 2001) (Hines and Rich, 1997) by using normalized icons in a chart, showing a "Big Picture Mapping" of the value stream. This tool began was first used in the Toyota Motor Company as "flow of materials and information mapping" and was developed by Rother and Shook (2003). Jones and Womack define VSM as the process of mapping the flow of information and materials as they are in a graphical manner and preparing a future state map with better methods and performance (Jones and Womack, 2002).

The purpose of the tool is identifying value flow improvement opportunities for customers using rules based on Lean thinking concepts. Starting from an added value analysis, a desired future state is drawn and flow gain actions/projects/programs in order to implement it are proposed. A key element of VSM is recording the most important performance indicators in the value stream such as: cycle times; work in process, finished goods, up times, down times, yields and others. According to Rother and Shook (2003) VSM offers seven benefits:



a) Visualizes the value stream as a whole.

b) Shows all activities including those that add waste and those that add value. It also shows sources of waste in the value stream.

c) Relates process operation to supply chains, distribution channels and information flows.

d) Links Production Control and Scheduling (PCS) functions such as production planning and demand forecasting to production scheduling and shop floor control using operational parameters of the manufacturing system, for example: Takt time (the production rate at which each step in the value stream should operate).

e) Provides a simple and common language for discussing value stream processes.

f) Forms the basis for a lean manufacturing implementation by designing a production system based on the complete door-to-door flow for a product family.

g) Provides a company with a 'blueprint' for strategic planning for lean thinking principle deployment during its transformation into a lean enterprise.

In short, VSM stems from the second Lean principle, as it is a too to map value streams. In this research the circular nature of value streams is highlighted, starting when the customers make a requirement, and ending when those customers express satisfaction by having received the required added value. Circular thinking principles (O`Connor and McDermontt, 1998) and tools have been applied to characterize the value streams. Extending the research developed by Rubiano and Micán (2008) the amplified VSM structure proposed for this application is formed by the combination of Lean Thinking (Womack and Jones, 2003), System Thinking (O`Connor and McDermontt, 1998) and Service Blueprint (Shostack, 1984).

1. Identification of the sample collecting loop in the value stream studied[1]

The company under study is a non-profit providing health care services in Colombia. It is legally approved by the Colombian National Health Superintendence and its quality management, environmental and occupational health systems are certified by ICONTEC[2]. It has recently achieved its health systems accreditation and has been recognized for its high technology (Rubiano and Mican, 2008). In this paper the sample collecting loop this company was selected for study.

The loop starts with the arrival of a user. This user is received and guided by a customer service clerk who assigns the patient a service number according to the number of users that have previously arrived. Once the service number is given, the user waits to be called and then he/she walks to the cashier area to obtain an authorization for the exam or medical test and makes the corresponding payment. The user then goes to a waiting room until one of the laboratory assistants calls him/her to a cubicle (the place where the laboratory assistants will administer the medical exams).

While the user waits in front of the payment area, the cashier performs some administrative tasks. When these are completed, the service order is transported to the cubicles where it becomes part of the in-process inventory until a lab assistant is available receive and verify it. If the cashier generated information does not coincide with the order, the lab assistant takes the order to cashier for reprocessing. If all the information is correct the lab assistant calls the user. The user then walks to the cubicle where the lab assistant verifies the date, fills out a form and takes the samples required for the laboratory analysis in the medical order. The user then leaves to eventually return to retrieve the results on the assigned date at the corresponding counter.

When there's an increase in demand for the service the waiting time increases, especially during peak hours. This causes an increase in the total service time that results in a diminishing satisfaction levels and an increase in customer complaints, leading to a negative effect on the demand itself.

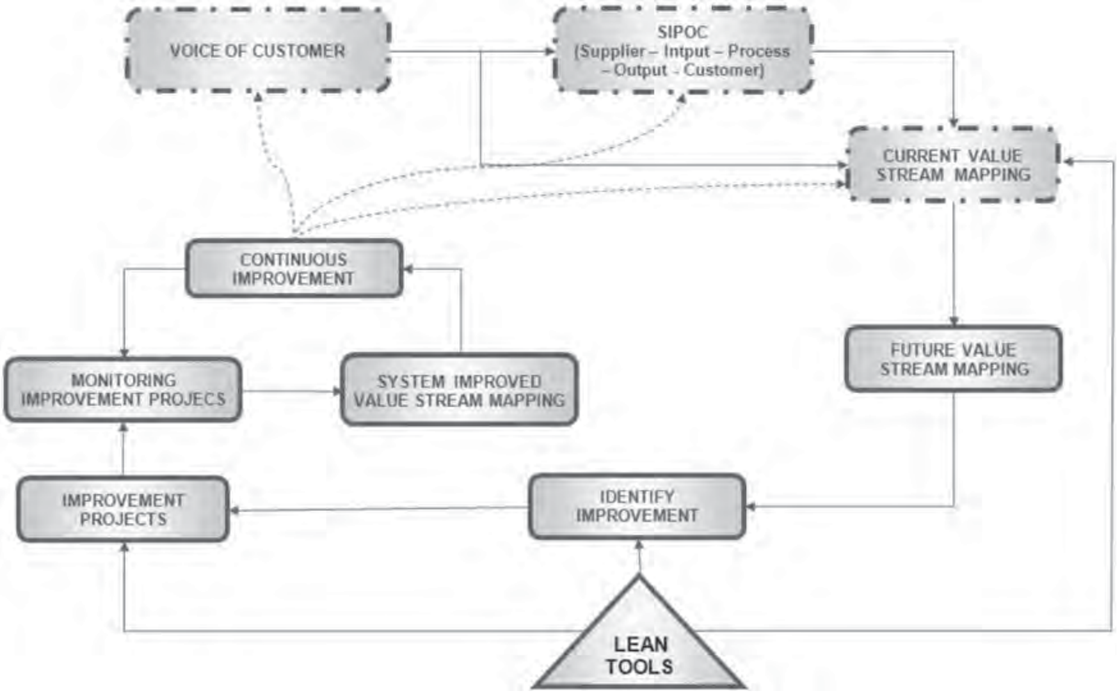
1 The formulation of this case was taken from Rubiano and Mican (2008)

2 ICONTEC is an acronym of *Instituto Colombiano de Normas Técnicas*, Colombian Institute of Technical Standards

2. Application Road Map

An improvement road map is used to apply Value Stream Mapping in the Clinical Laboratory selected as pilot for this investigation is presented in Figure 1.

Figure 1. Road Map



2.2 SIPOC

To start a Lean project, define its scope and identify all its relevant elements a high level characterization of studied value stream must be developed before the VSM is built (Pande and Holpp, 2002). Defining the scope and characterizing the value stream gives the improvement team a visualization at the highest level and highlights the processes and elements that will or won't be part of the improvement project core, those are the start and end processes and all the physical, informatic and human entities. For this purpose a Supplier, Input, Process, Output, and Customer SIPOC tool was used (Pande and Holpp, 2002). Completing the SIPOC of the studied value stream, created the ability to manage expectations and quickly identify and communicate the following aspects: a) who the process serves (kind of patients), b) the required inputs to make the process successful (inputs), c) who provides the required inputs (specific kind of suppliers), d) steps, e) agents, f) the productive environment involved to service to customer (process) and g) the results that the value stream delivers (outputs related to the VOC).

The SIPOC diagram clarified the internal structure of the value stream for serving the customers and its interaction with the external environment, composed by: general for suppliers, customers, legal entities, the market and the community. Figure 3 illustrates the SIPOC that characterizes the value stream for ambulatory patients in the selected service unit.

Figure 2. VOC from the ambulatory sample collecting value stream

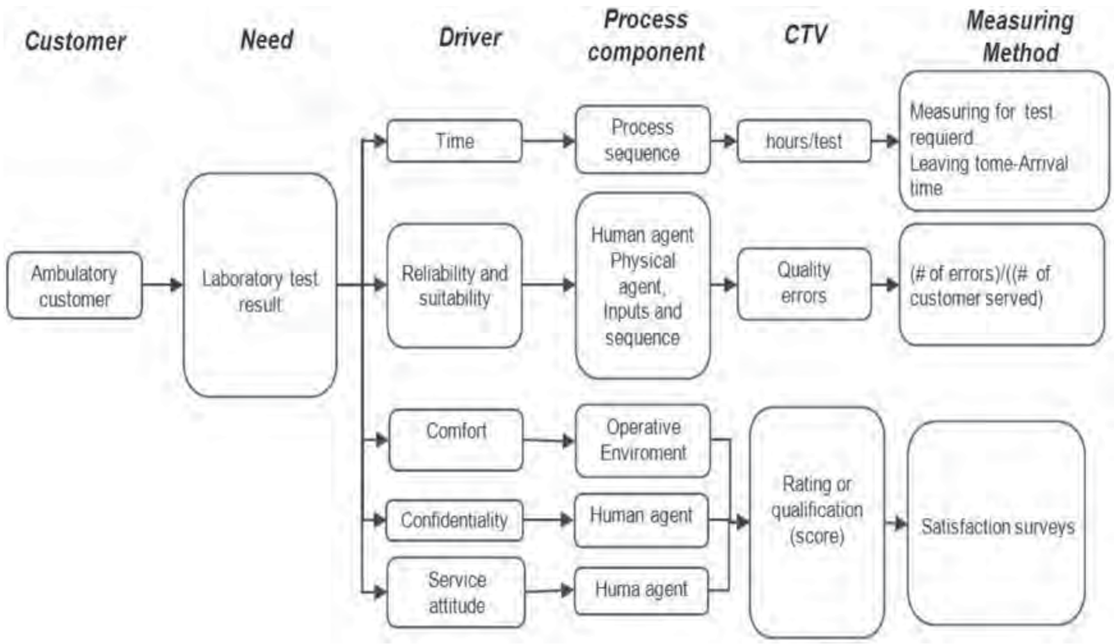
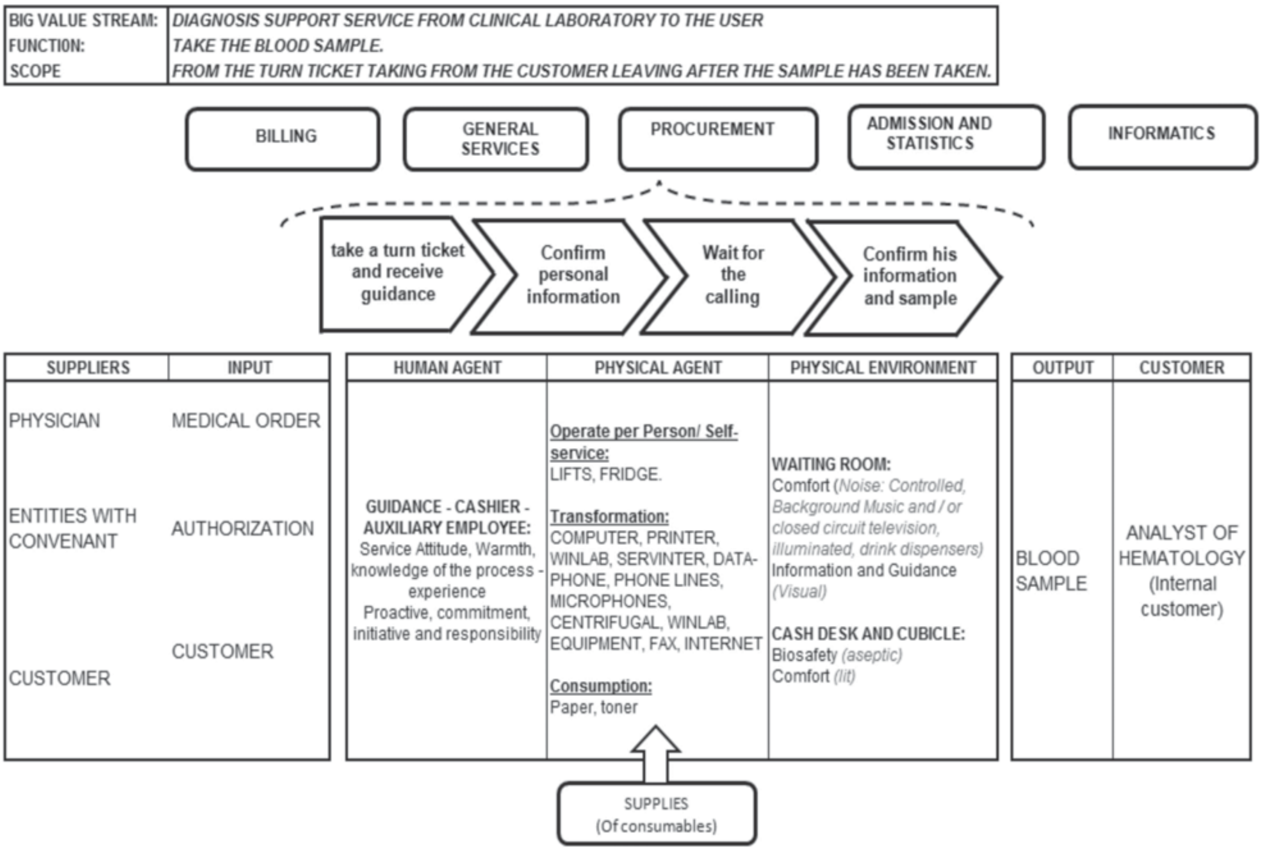


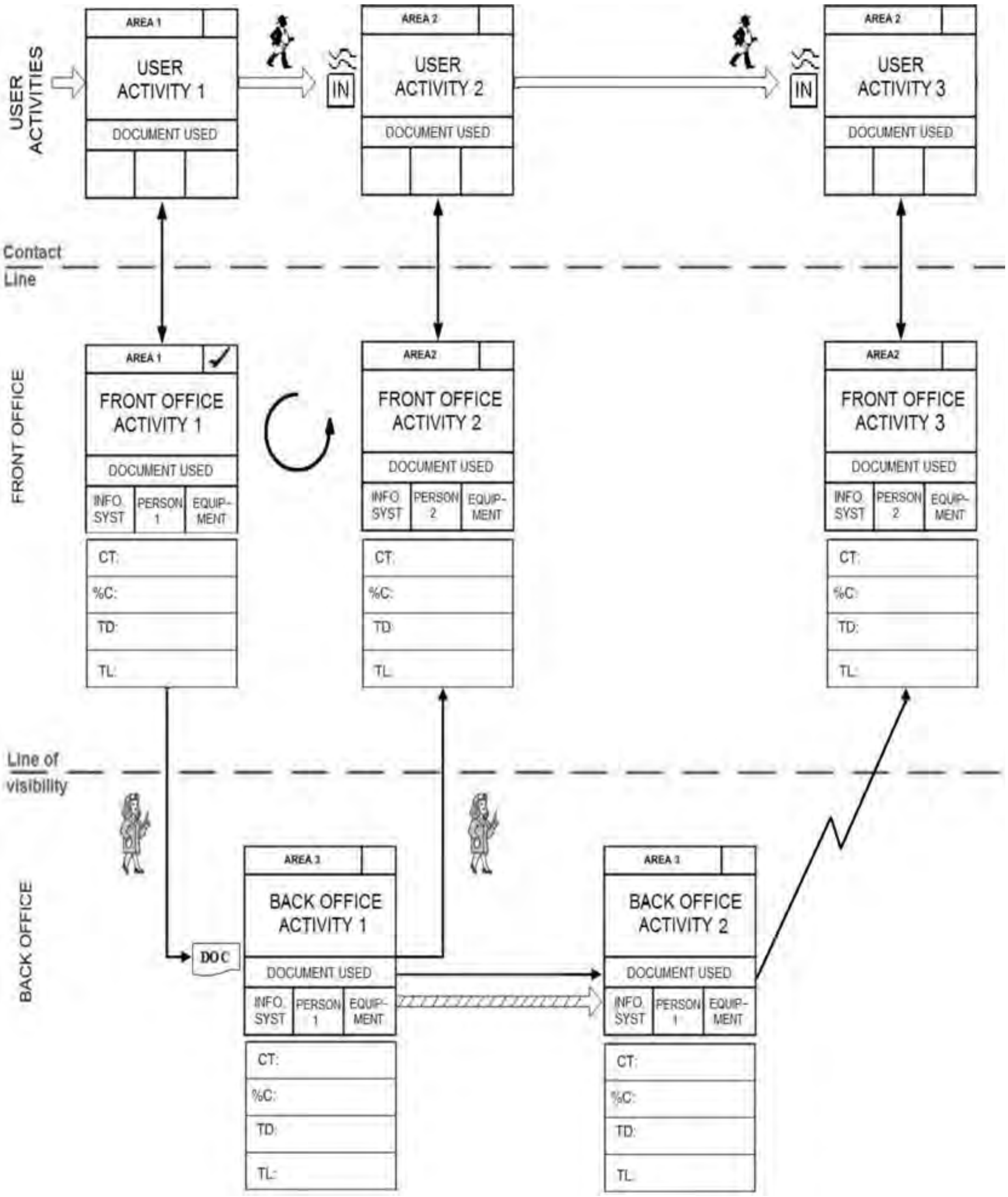
Figure 3. SIPOC for the ambulatory sample collecting value stream

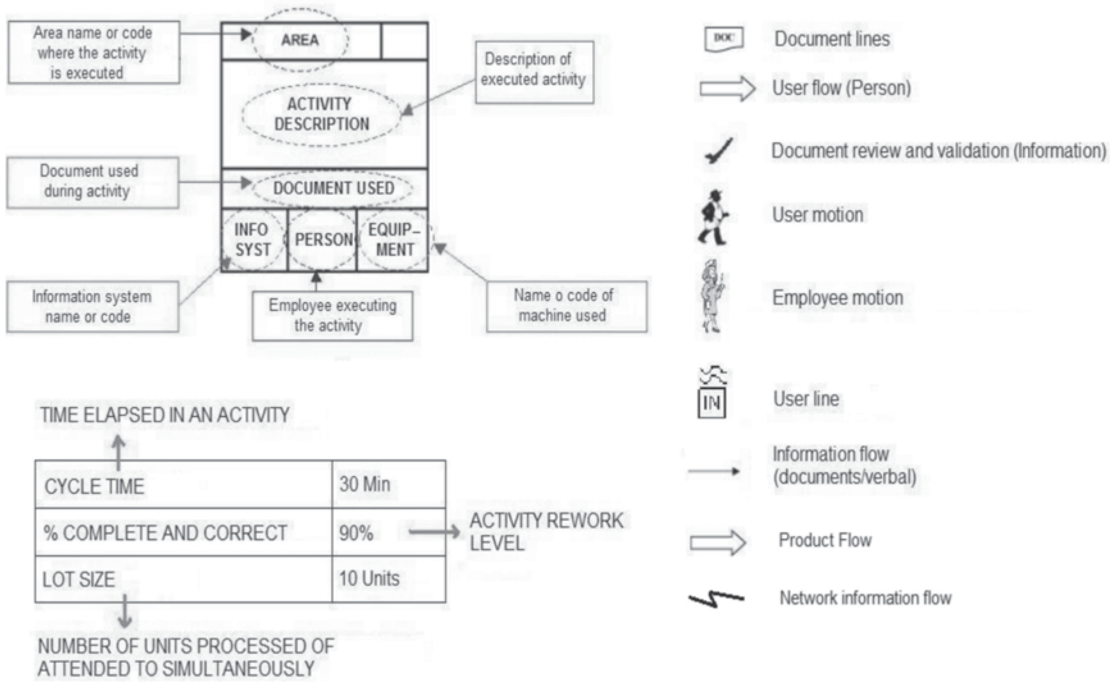


2.3 Mapping framework proposed for this application

Rubiano and Mican (2008) combined the tree approaches mentioned above, proposing a circular generic structure (figure 4) for applying the system service value stream mapping tool. This structure is composed of levels according to the degree of contact between the customer and process operators.

Figure 4. Structure of system mapping for a sample collecting value stream





According to Shostack (1984), these levels are marked by “physical dividing lines” that define the front office and the back office, through which all the service loops flow. Each loop is a value stream for which the following definitions apply:

- **Front Office:** It is the space in which contact employees carry out activities in front of or interacting with the customer/user that has arrived requesting a service.
- **Back Office:** It is the space in which operators carry out activities that are not visible to the customer/user or that have no person to person interaction.
- **Contact Line:** A line drawn to differentiate the actions executed by the customer and the actions executed by front office contact employees.
- **Line of Visibility:** A line drawn to differentiate the actions executed by front office contact employees and those executed by back office operators.

2.4 Current System service Value Stream Map

Information was obtained to draw the current system service value stream map by observing and interviewing the customers directly from their arrival to the medical laboratory. A group of customers was tracked along with their respective blood samples. The exact activities executed by contact employees and customers, as well their interactions were mapped. This map also shows measurements of the customer's experience (sample collecting times, delays, reworks) in each permanency moment inside the system and/or each interaction with the contact employees. Mapping appropriately, exactly and efficiently the customer as well as his documentation and sample, is one of the key contributions of this research. Another key contribution is the circular representation of customer flow to ease the identification of leverage points and the understanding of the value stream as a whole. Circular representation also improved the proposal of local changes with global impacts. Figure 5 shows the result of this stage.

Using the current state analysis some wastes were identified, characterized and measured. The total service lead time obtained was 27 minutes of which only 1% adds value from the customer's point of view. This value (very small in this case) is the Process Cycle Efficiency, which is a metric that helps to identify how much of a value stream is actually value-adding. The time for the entire value stream is the global lead time, which is the flow metric. To calculate the Process Cycle Efficiency the value-adding time is divided by the global lead time for the value stream. A more correct name for this metric would be Valued Stream Lead Time Efficiency. The identified wastes were correlated to errors, delays, unnecessary movements, customer accumulation in the sample taking area and time lost due to disorder and dirt.

2.5 Future System Service Value Stream Map

From the characterization of the identified wastes, improvement actions focused in the time-based competition were formulated. By using techniques for identifying problems causes (five w's, brainstorming, system cause-effect diagrams, relationship charts and added value analysis), a desired future state that elevates customer satisfaction levels was outlined. Figure 6 shows the proposed future state map.

2.6 Improvement actions

Concrete improvement actions were determined for their implementation to eliminate or minimize the identified wastes, these are of two types: immediate and remedial to increase flow in the short term, and preventive requiring longer implementation times and whose purpose is increasing flow avoiding recurrent waste. These preventive actions were the following flow increment programs for the first improvement cycle: 5S (Bekaert consulting, 1998), visual management (Greif, 1993), kanban (García, 1998), layout (Dileet, 2001) and poka yoke (Grout, 2007). These high-priority programs were those required by the identified wastes.

The definition of the implementation plans included giving answers to questions such as who, when, how, where, and others related to the necessary resources, existent barriers and budgets. The schedules included people responsible for specific activities such as: a) Determining the information to be gathered during the execution, b) obtaining the necessary approval, cooperation and support from upper management, c) assuring that all the people taking part in the implementation of the actions or programs knew what they had to do well and how they should do it. This required the implementation of an agile communication system and a training plan in Lean techniques for the people that participated in the implementation (cashiers, bacteriologists, pathologists, sample transporters and assistants).

For improvement impact assessment and measurement, a relationship causal tree was built with 4 levels: five implemented flow gain programs (level 1, tools), flow gain program deliverables (level 2, deliverables), customer value attributes (VOC) and value stream attributes (CTVs) (level 3, impact on customer and valued stream attributes), and impact on the strategic organization goal assuming a financial goal (level 4, financial impacts). The causal tree is presented in Figure 7.

3. Results and discussion

The improvement projects were developed by applying a Define, Measure, Analyze, Improve and Control Improvement cycle DMAIC. In principle DMAIC is the fundamental pillar of the Six Sigma methodology, focused on reducing the variability of the processes, eliminating the defects. Six Sigma is a very useful methodology for planning and executing various types of improvement projects, however, the application of the DMAIC cycle doesn't require the same statistical rigor as a Six Sigma or Lean-Six Sigma project.

3.1 Plant Layout program

The major structural change was redrawing the productive service plant within the value stream of the laboratory, however, the implementation service cells was not possible due to the diversity of samples required by the customers. With the application of this tool it was possible to a) Define an effective work flow and personal traffic mark standards (combined with 5S and visual management), b) Increase communication and support agility, c) decrease employees motions and customer and sample transport, d) gain flexibility in employees and customers flow, e) decrease sample inventory and customer queues (combined with kanban) and f) generate an impact on employee morale, safety and job satisfaction while using the available space effectibly.

Figure 5. Current System Service Value Stream Mapping for the ambulatory sample collecting value stream

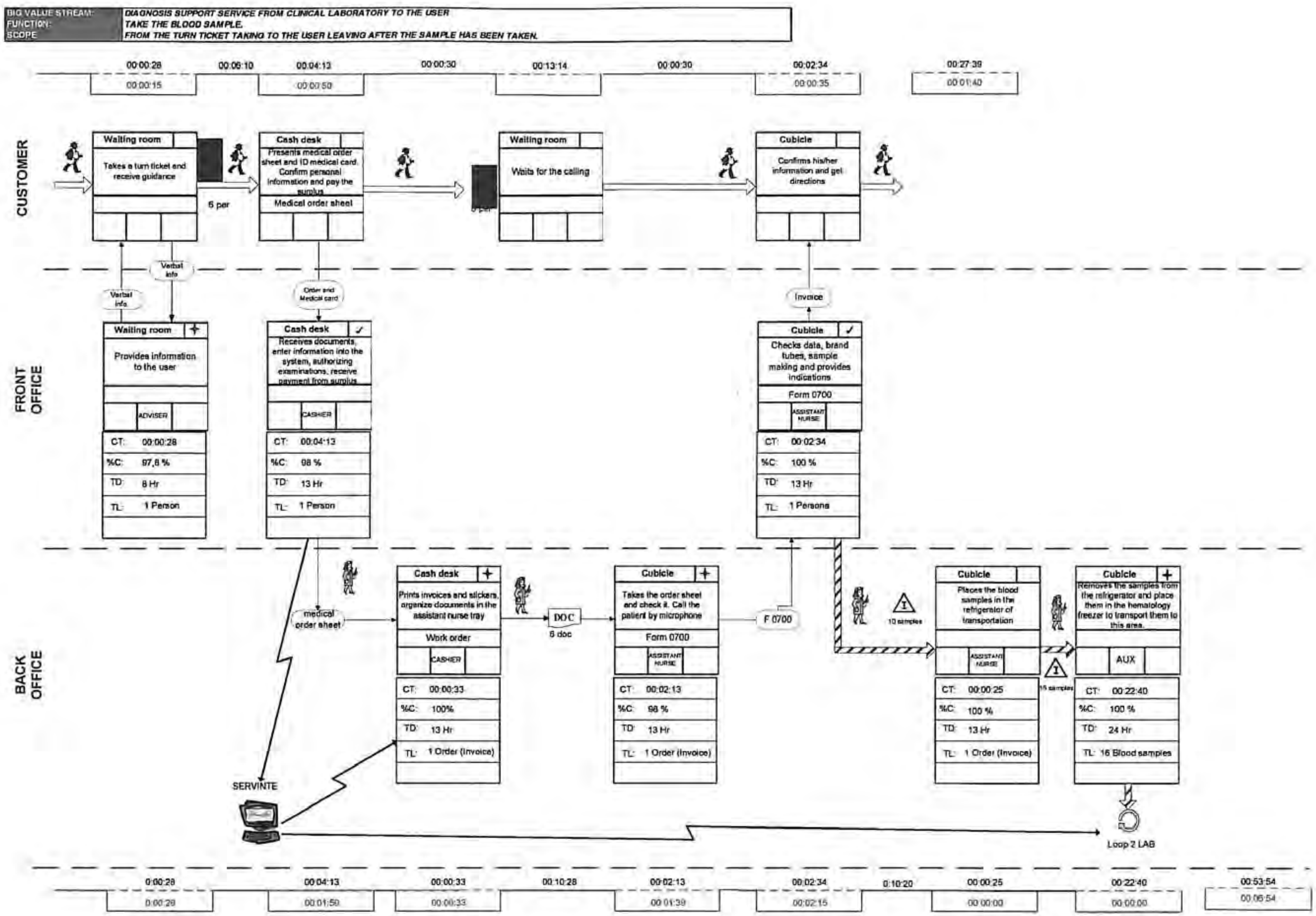


Figure 6. Future System Service Value Stream Mapping for the ambulatory sample collecting value stream

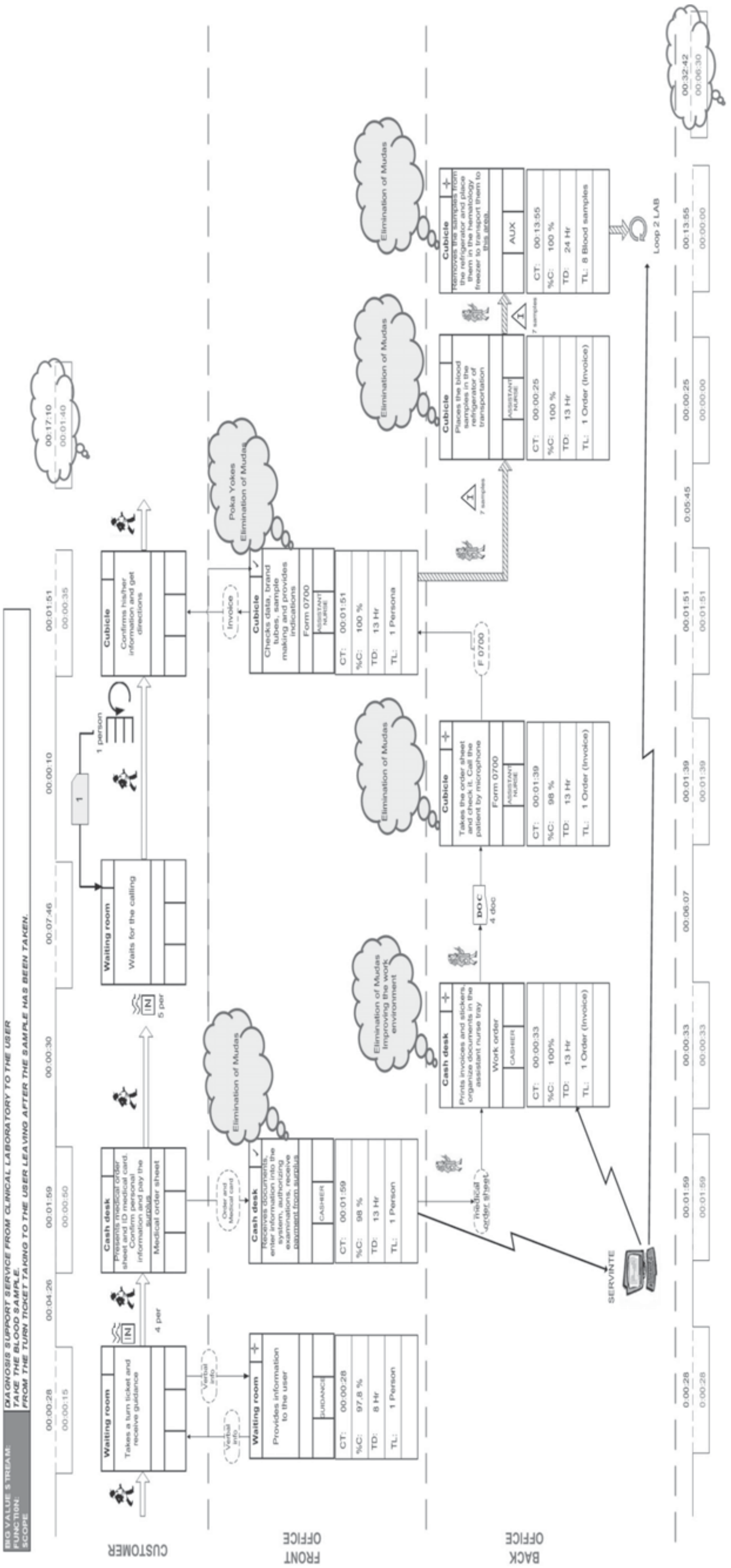
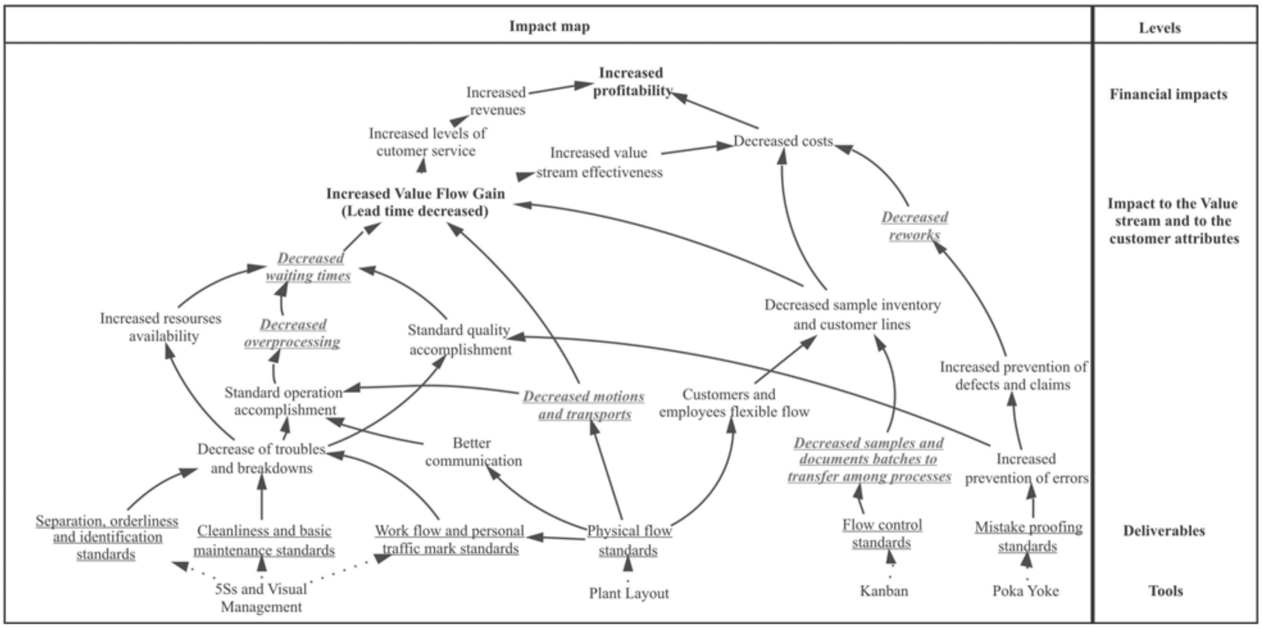


Figura 7. Relationship causal tree between the flow gain programs and the goals at different impact levels



3.2 5´s and Visual Management program

This program improved the efficiency in pilot areas when establishing a set of classification, relocation, elimination, organization and cleaning standards to: a) eliminate 60% of the elements that were not used and slowed value flow to the customers, b) signpost the areas, c) permanently show the area yield, d) create employee discipline with the motto "clean to inspect", e) create a more reliable work environment, f) contribute in a decisive way to the execution of quality and service standards for productive processes (combined with plant layout and poka yokes) and, g) contribute to the organization, security, self-control and decision taking processes in a better flowing work environment.

The direct impact of 5S and visual management on the superior levels is not easy to quantify. An evaluation was performed to force a check list on the current state before implementing the program formally and applying the same evaluating instrument after its conclusion. The evaluation produce the results shown in table 1. The evaluating instrument consisted of 31 questions that assessed the state of each one of the 5S (Seiri, Seiton, Seiso, Seiketsu, Shitsuke). The achieved improvement in the cashiers area was 31% while in the cubicle area it was 9%.

Table 1. Results when applying the 5S check list

Área	Current state score	Future state score
Cashiers	54%	85%
Service cubicles	75%	84%

After implementing these tools, a smoother work flow was observed with the achievement of new standards in the work place, as well as the implementation of customer kanban signals in the sample taking area.

3.3 Kanban program

A visual kanban was implemented in the sample taking process. The goal was defined as having no more than three customers inside the sample taking area, two of which are waiting for the service while a third is being assisted. When the sample taking employee finishes the sample taking process the customer leaves the cubicle and the next of the two waiting customers enters the cubicle to be assisted, in that moment the sample taking employee activates an external light to inform the following customer in the queue (formed by customers already assisted by a cashier) that its his or her turn. This guarantees that the sample taking employees don't lose time waiting customers to enter the sample taking area, since in some cases they are distracted and are late to act on the notification. This method improved the response capacity, by knowing the service requirements of each customer once he or she enters sample taking area and enabling the set-up of the necessary instruments and tool ahead of time.

Kanban was most beneficial in peak hours characterized by high arrival rates. Since customers enter the sample taking area some time before they are going to be served there is a waiting time in the sample taking area. Kanban gave the employees increased flexibility for responding changing service demand. Now they can quickly switch between different kinds of samples as demand for various services changes. A cross-training program was pending for implementation in order to gain even more response capacity, however the sample taking area was eliminated as a bottleneck. In the future state the problems will quickly be visible and corrected.

With this new control standards combined with a new plant layout it was also possible to: decrease sample and document batch transfer between processes, sample inventory and customer queues.

3.4 Poka yokes program

Starting from the Clinical Laboratory incident analysis, frequent errors data gathering from primary sources (those responsible for the processes), construction and analysis of a potential errors map and the application of the AMEF tool to the value stream, defects were identified. It became necessary to implement mechanisms that eliminated or minimized the roots causes. In some processes changing operations was enough, in other processes such as customers registration of and sample taking the risk of human error persisted therefore mistake checking devices were implemented. Most of these devices were visual signs that for example, eliminated previous validations when registering customers and test results data in the information system, as well quickly consulting the customer when the order information was incorrect.

The application of the all the previous flow gain tools reduced the service lead time from 27 to 18 minutes, an improvement rate of 33%. One of the flow blocking wastes was errors in user data entry for service order and invoice generation. The error proofing mechanisms contributed to a 50% improvement in user data entry reprocessing and service order generation. This quality improvement influenced service time advancement by increasing time based competition groundwork consistency. The flow gained in customer service helped the team reduce desertion rates from 7 users/day to 3 users/day, an improvement rate of 57%. Finally, the efficiency was elevated from 79% to 88%.

3.5 Quantifying impacts

The results achieved when applying solutions by means of the different Lean improvement programs, contributed to improving the flow of the value stream, which is directly reflected in lower service times and therefore higher level of satisfaction of users or customers. In consequence, from the shareholder point of view, when decreasing service times, the laboratory was able to serve more customers with the same resources. This can be financially evaluated from two perspectives: the first one corresponds to the value of the profits the laboratory may receive when serve additional customers, and the second approach corresponds to saving coming from capital would have had to invest in increasing its service capacity of attention at the levels achieved (only taking into account the human resource cost and excluding the costs that this service had been incurred in adjustments physical). Both perspectives represented an important opportunity cost for this business billing hundreds of thousands of dollars per year.

Conclusiones

- Lean Thinking has been developed per years in the companies manufacturers, being obtained good results, but in health care sector in Colombia its development is in learning and growth stage. In this applied research, it was possible System Thinking and Service Blueprint complement Lean Thinking in order to propose a System Service Value Stream Mapping model aiming to improve the value flow, and in a same way, the improvement system in the Clinical laboratory of a Health Care Organization, and.

- When identifying the underlying system structures in the value stream, as well as the activities that didn't add value (wastes), it was possible to formulate systemic and systematically flow gain actions and programs in order to eliminate or to reduce such wastes in the service loop in the clinical laboratory.

- This research promotes and validates an appropriate tool for mapping appropriately, exactly and efficiently a) the customer as well as his document and his sample flow and b) the interaction among the customer and all the system, in order to evaluate all the activities in terms of its value added to customers. This mapping was proposed from searching and combining concepts about System Thinking, Value Stream Mapping and Service Blue Print.

- The application of both this resulting circular value stream mapping and Lean tools for this healthcare case, contributed to achieve both economic value to shareholders and aggregate value to customers.

- Finally it is validated that the symptoms of problems perceived in a value stream should be analyzed in first instance under a systemic approach in order to see the value stream as a hole of flows and interrelations, and to understand the root of the problems and the consequences of the improvement actions or programs.

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