COMBINING TIME-BASED COMPETITION AND CIRCULAR THINKING TO IMPROVE THE AMBULATORY ATTENTION LOOP IN A CLINICAL LABORATORY

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Abstract

The study and improvement of process management in service companies continues to be a dilemma because in spite of the efforts that are made using the current documentation and improvement methodologies, these continue to have gaps in representing both customer's actions and their interactions with the entire service system, as well as in the internal interactions between contact employees and system operators. In this paper, we propose a hybrid methodology that integrates two approaches to understand and improve flows and productivity for the ambulatory attention value streams in a clinical laboratory. These approaches are: Circular Thinking (fundamental for system thinking) and Lean Thinking. The application of the hybrid approach reduced customer ambulatory attention times, improved service quality, reduced customer desertion and improved the work environment.

***Keywords*: System Thinking, Lean Thinking, Healthcare, Process Loop.**

Resumen

El estudio y mejora de la gestión de los procesos en las empresas de servicios, aún continúa siendo un dilema, puesto que por más esfuerzos que se realicen con las metodologías de documentación y mejora actuales, estas siguen presentando vacíos en la forma de representar tanto las acciones de los clientes como sus interacciones con el sistema de servicio como un todo, así como las interacciones internas entre los servidores y operadores del sistema. En este artículo se propone una metodología híbrida que integra dos enfoques para entender y mejorar los flujos y productividad de las cadenas de valor de atención ambulatoria, en el caso de un laboratorio clínico. Estos enfoques son: el Pensamiento Circular (fundamental para el pensamiento sistémico) y el Pensamiento Lean. La aplicación del enfoque híbrido permitió reducir los tiempos de atención ambulatoria de los clientes, mejorar la calidad del servicio, reducir la deserción de clientes y mejorar el ambiente de trabajo.

Palabras clave: Pensamiento sistémico, Pensamiento lean, Cuidado de la salud, Bucle de proceso.

1. Introduction

During the last few decades, well known techniques for the improvement of productive systems have been disseminated in the business world. However, the development of similar techniques and methodologies for the service sector has not reached the same magnitude. (Miyake et al. 2007) (Hadfield et al. 2006) (Womack et al. 2005).

The challenge for service organizations is not only to deliver quality and time value attributes but also reliability, flexibility, cost and contact employees and equipment suitability (Lederer et al., 1997, Chase et al., 2004).

To deliver these value attributes in order to obtain and keep customers, service organizations require a management system with a solid response capacity and human talent with a strong capacity to continuously improve the service management system. Within these management systems, the quality system is responsible for standardizing and documenting the productive processes for the organization's primary function (Kosanke et al. 1999). One of the standardization instruments is the diagramming models or systems. This paper proposes combining the application of two thought approaches to contribute to the building of a documentation and process improvement system with a holistic vision that orients value flow towards customer.

One of the approaches applied in a Colombian healthcare entity to document and improve the service processes was the **System Thinking** (Andrade, 2001) which allowed the clinical laboratory personnel to develop the capacity to understand the value stream as a whole, the processes and how the interrelations between them lead to the achieved results.

Another necessary and complementary approach to improve the value stream and the laboratory's response capacity was **Lean Thinking**. The lean concept includes a set of principles and tools that when applied systemically enable the understanding of the value stream, and the identification and elimination of obstacles that impede the flow of value to customers thus improving processes which then surpass customer's expectations (Womack et al. 2005). In this study, this leads to the challenge of integrating and applying these approaches in the healthcare service sector.

In the following section of this publication some relevant circular thinking concepts are presented exemplifying decision taking under this approach. Section 3 has a broad description of lean thinking and its principles. In section 4, the connectivity framework for circular thinking and lean thinking is documented as a hybrid approach to increase flow in the value stream. Section 5 presents a critical analysis of traditional process diagramming systems and describes the advantages as well as limitations of the best known process diagramming practices. Section 6 contains the characterization of the system in this study going from a brief sketch of the organization to a description of the process and ending with the concepts used in the process flow measurement. Section 7 is focused to the systemic exploration of the value stream and the situation presenting the demand performance pattern as well as the causal relations and the reinforcing and compensation loops that are present in the Clinical laboratory's management system. Section 8 is dedicated to the analysis and discussion of the results generated by the tools selected from the proposed hybrid documentation and improvement approach, and which were applied to the clinical laboratory's ambulatory attention loop. Finally, section 9 presents the conclusions.

2. Circular Thinking

The circular perspective of viewing problems differs from a lineal one in that the cause-effect relations go beyond the linearity of temporal space (Valero, 2008, Senge, 1994). With circular thinking, the perception of connections poses a greater value than the knowledge itself (Newes 2008). This means that effort is concentrated on finding the root factor generating the situation being analyzed in order to find the system's leverage point. This point is key for the system's efficient operation, thus a leverage point is the link or process where an intervention is focused and where it has a global impact.

In circular thinking, decisions and their execution on a system link will affect other links and finally they will generate future situations for the initial link and therefore new decisions and actions (O`Connor, 1998). The characteristic unit in circular thinking that creates this chain of effects is one of the properties of systems: "feedback" (O`Connor, 1998). This means that every decision affects the decision maker in the resulting chain of effects at some point in time. These results are then used by systems to regulate a new decision.

A example of decision making under the circular thinking perspective begins when a process manager understands the global value stream as a whole. The manager understands how the interrelations between the processes generate circular flows that help in "mapping" his/her decisions and in evaluating their impacts. It is the case of carrying out or delaying scheduled maintenance for some equipment and he/she is capable of visualizing the decision's effects on the equipment's availability level to meet commitments with customers. The systemic manager *decides* not to delay the preventive maintenance despite the pending accumulated work since the time used for the maintenance is an investment that guarantees its future availability by assuring the equipments reliability (Figure 1).

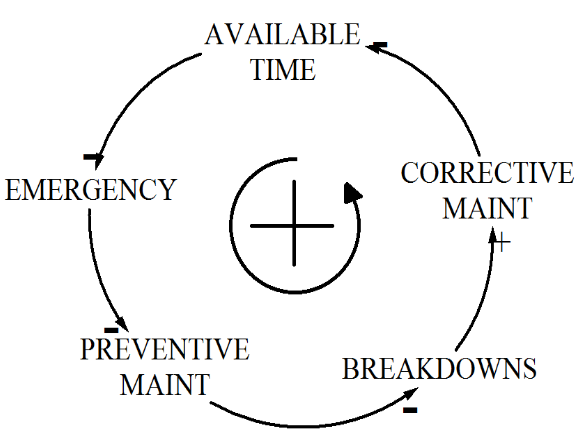


Figure 1. *A case of resistance to policies.*

In the previous example it is possible to observe that the analysis of a system consists of dissecting it to identify its parts and which of these are having problems. However, the mere analysis of a system is not enough to understand its behavior. We need to understand how the parts interact or interconnect to generate circular flows, how these flows constitute the system's structure and how they integrate (Aracil 1995).

3. Lean Thinking

Lean thinking also known as Time-Based Competition (TBC) is based on the Toyota Production System (TPS). It was initially adopted by car companies and later by various companies from other manufacturing sectors and service concerns (Womack et al., 2005).

Presently, lean thinking is considered a Continuous Improvement philosophy with a core point that is cycle time reductions. Companies that apply it eliminate obstacles that limit materials, products and services from flowing along the value stream thus improving their processes and reducing costs. These obstacles are known as waste (mudas in Japanese) and eliminating them leads to an increase in value attributes, customer satisfaction, as well as reaching profit margin goals (Melton T., 2005).

Specifically, lean thinking as an improvement approach adds value to customers because it (Melton T., 2005):

- Reduces delivery times (on-time delivery), by eliminating or reducing the necessary steps, or improving the necessary ones.
- Increases speed (fast delivery) by eliminating lot processing of customer orders and reduces process variability by reducing reprocessing and avoiding errors.
- Builds low cost operations without affecting efficiency by reducing idle capacity and unnecessary operations.

- Increases agility of global information management by eliminating the obstacles to information flow in offices.
- Reduces the costs of losing sales by improving communication with the points of sale.
- Improves flexibility in the product and service mix due to the contact employee or human agent poly functionality.

Similarly, lean thinking adds value to the company since it:

- Permanently seeks perfection in product and information flow.
- Reduces the necessary space on the production floor and improves capacity utilization.
- Creates robust operation systems.
- Creates agile materials delivery systems.
- Improves installation layout to increase speed and flexibility.

3.1. Lean thinking's 5 principles

Lean thinking is governed by five principals proposed by Womack and Jones (Womack et al.l 2005). They are:

1. Define value from the point of view of the final customer as a tailor-made solution for the customer's needs, for example a tailor-made product instead of a generic one. This is done for a selected product family.
2. Identify the value stream for the product family: Identify all the necessary and unnecessary steps (wastes) executed to produce and deliver products and services from the order to delivery. Challenge each step. Why is it necessary?.
3. Make the product flow: Have all steps in the value stream's processes flow continuously and directly from one step that adds value to another, from the customer's arrival to his/her satisfactory exiting from the system through the elimination of activities that do not add value.
4. Have the customer "Pull" value from the value stream: once value is obtained response capacity is gained.
5. Pursue perfection while managing: Once a company attains the first four steps, it becomes clear to those involved that it is always possible to pursue global efficiency.

4. Traditional Process Diagramming Systems and Critical Analysis

The most common techniques or methods to diagram and design work procedures are: flowcharts, block diagrams, cooking recipes and flow diagrams like the ones proposed by the conventional ASME code (American Society of Mechanical Engineers) for industrial processes (American Society of Mechanical Engineers, 1947). Some Academics and Practitioners agree that these methods have advantages (Faculty of Economics and Management, University of the Republic -FCE website) such as:

a) Applying a name to each office activity which will be repeated eliminating ambiguity.

b) Facilitating the evaluation of the whole procedure.

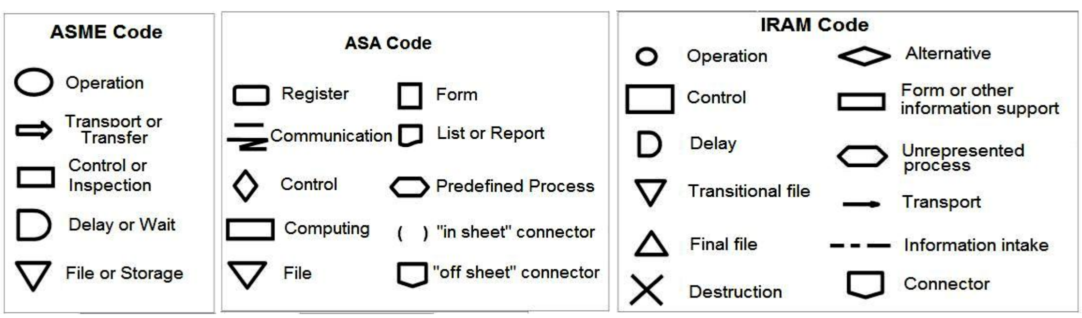
c) Avoiding differences in interpretation.

d) Contributing to improving the processes.

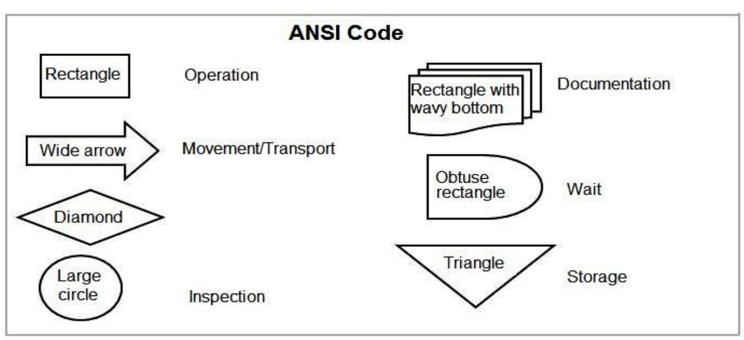
However, the authors of this research observed that these advantages may not offer sufficient elements so that these diagramming systems enable the auscultation, in a holistic way, of a productive system and the identification of change opportunities with a global impact. For example, advantage "b" only mentions the procedure and not the system. The system operators and even the users do not obtain a global interpretation of all the flows generated from either the administrative processes or the productive processes, thus promoting a segmented vision of the system. Additionally, advantage "d" is, in a best case scenario, just partial since the possible improvement opportunities that may be identified cannot be structural and thus they are not holistic because these systems only study the operations related to execution processes and not the system's global structure and for this reason they do not assure making the changes at the real leverage point. Similarly, flow diagrams do not include indicator boxes in their structure process nor do they aid in identifying at a glance customer and supplier processes in a loop or the input and output products and documents flowing between the processes.

Other well known diagramming systems are the ASA code (American Standard Association), developed for the description and analysis of information processing problems (ANSI website, FCE website) and the IRAM code (Instituto Argentino de Normalización y Certificación) developed to regulate the graphic representation of administrative procedures (IRAM website, FCE website).

Finally, this critical analysis presents another well known symbology the ANSI code (American National Standard Institute) implemented in electronic data processing oriented diagrams for the purpose of representing the flow of information (ANSI website). Some of these symbols have been widely adopted for flow diagrams in the diagramming of administrative procedures (Jiménez, 1996). All these systems, which are also visual, enable the identification of improvement opportunities (Harrington, 1991). However, they have similar weaknesses and due to this there is a risk that they will be considered



(*a*) (*b*) (c)



(d)

Figure 2 (a, b, c and d) *show the symbols used to diagram processes with the aforementioned systems.*

Source: American Standard Association (ASA); American Society of Mechanical Engineers (ASME); American National Standards Institute (ANSI), Instituto Argentino de Normalización y Certificación (IRAM.).

as complex because they are difficult to read and. this affects a unified interpretation of procedures by persons at all levels in the organization. Therefore, interest in systematically reading them may be lost and these may quickly become outdated.

Though these diagramming systems are widely used in different applications, it was observed that they do not show the systemic structure of the analyzed value stream which is identified through the interrelations and flows among a) the customer and system human agents (operators and contact employees) and physical agents (equipment and tools), b) between the customer and the system's internal environment c) between the human and physical agents in the system, and d) in fact, they do not include icons for neither the customers nor the human and physical agents in their diagramming standards.

Many organizations especially the service sector have adopted documentation models such as the cooking recipe type in which each step and its responsible is described (Harrington, 1991). Though this diagramming model offers certain flexibility for processes that are difficult to standardize, it does not offer many opportunities to identify improvements.

Other organizations have adopted the block diagram model for processes in which each process step is placed in a box and the boxs are joined by arrows (Harrington, 1991). Yet this model also does not incorporate indicator blocks or interactions between operations agents.

Finally, another common characteristic of the traditional systems is that the fundamental focus is on operations carried out in the departments or functions and the flow of steps between them (Harrington, 1991). Therefore, steps taken by the customer are not included and in service systems these are parallel to the activities carried out by the human agents that have contact with the customer.

With this background, Rodríguez Cervera (2005) states that despite the wide acceptance that these symbologies have had, there are no process documentation methodologies that have satisfied all needs and have become recognized (Rodríguez Cervera, 2005).

There are other approaches to representing non-traditional processes and systems, such as the methodology IDEF0 (Integration Definition for Function Modeling) and Petri Nets. The IDEF0 methodology is based on a set of rules that define a methodology for the representation of functions modeled (Ang et al. 1995). These models consist of a series of hierarchical diagrams along with some texts and cross-references between the two that are represented by a rectangle or a series of boxes and arrows. One of the most important aspects of IDEF0 is that as a modeling concept is gradually introducing more and more levels of detail through the model structure (Ang et al., 1995). Separately, Petri Nets, though they are a powerful tool to analyze and evaluate systems, its Application is dedicated mainly to the modelling of systems, to the analysis of these systems and to the resulting discernment on the system modelling (Guasch, 2002). The purpose of this paper does not extend to critical analysis and comparison of the proposal made in this paper with these non-traditional systems of study and evaluation of processes and systems, since their objectives are different to those sought by this proposal.

With the lean-systemic hybrid approach all the production and service delivery agents can be included in a diagramming system including the customer, especially when the character of the service's productive processes include the customer as another agent in the planning and execution of the processes.

5. Proposed Framework for Lean Thinking and Circular Thinking's connectivity

A uniting principle between Lean thinking and Circular thinking is: *Optimize everything that improves the whole value stream performance not isolated process parts.* Figure 3 graphically illustrates the connectivity framework between circular thinking and lean thinking to gain flow along a value stream. Here the meaning of the interrelations between the elements is explained.

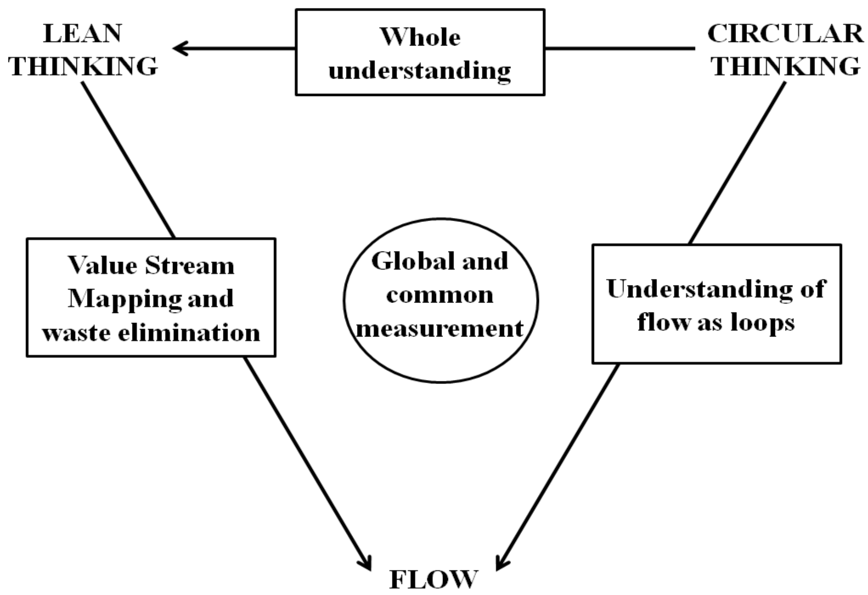


Figure 3. *Connectivity framework between circular thinking and lean thinking to gain flow.*

5.1. Connectivity: circular thinking ➔ lean thinking

At first, to recognize and define problems in a value stream, a key requirement is to understand the value stream as a whole. This can only be understood if there is a global vision of the integrating processes in the value stream as well as how they interact. This promotes the identification of the multiple circular flow value streams formed by the physical transformation and information processes in which some processes are a part of one or more value streams and where each value stream as a whole will have clearly defined customers and internal or external suppliers.

A concept examined by the Circular thinking ➔ Lean thinking relation is "management by processes", which has not yet clearly posed in its methodology, an improvement alternative to a segmented management of the value stream, or to the problem of horizontally managing flows and at the same time vertically managing resources even with a predominance of hierarchical control for resources in each value stream process. In short, circular thinking allows the decision maker to prepare the way to carry out effective improvement of the goods or service productive system as a whole.

5.2. Connectivity: circular thinking ➔ flow

Continuing with the previous relation, when the productive system is understood as a whole as well as the causal relations (supplier→customer) among all its processes, the circular chains for physical and information flow can be identified. Thus the process sequences are distinguished as a set of circular cause→effect relations. This is the main base for the Circular Thinking ➔ Flow relation. It helps to *map the operational decisions* and those with greater scope in the organization. An example of this mapping is illustrated in the previously mentioned Figure 1 which shows the flow of effects caused by the decision to do or not do a scheduled preventive maintenance. The described interdependency set brings forth the understanding of flow in loops, which is nothing more than the flow of a value stream that starts with the information about a customer's needs and ends with the satisfactory delivery of a product or service (Figure 4).

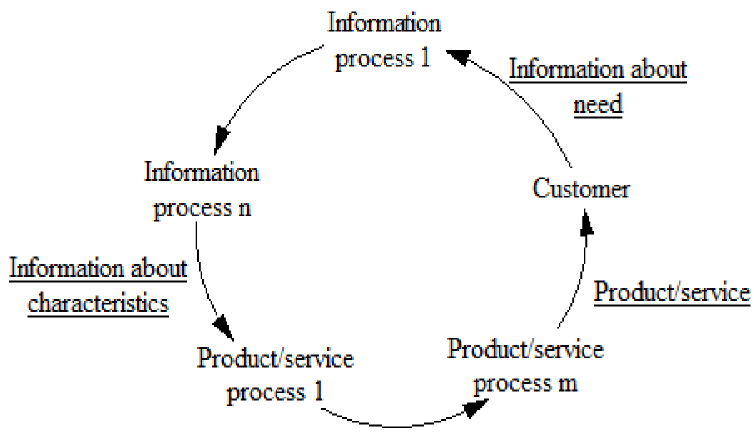


Figure 4. *Conceptualization of a service value stream as a loop.*

5.3. Connectivity: Lean Thinking ➔ Flow

The lean thinking ➔ flow relation enables the showing of information and physical flows in the ambulatory attention loop, and the manner in which processes and persons (customers and contact employees) interact. The tool called "system mapping of the service value stream" (SMSVS) is proposed in this paper in order to reach a similar scope to "value stream mapping" (Rother and Shook, 1999) for manufacturing systems and adapted to the "service blueprint" structure proposed by Shostack (1984). Figure 5 illustrates the tool's generic structure which is composed of levels according to the degree of contact between the customer and process operators.

These levels are marked off by "physical dividing lines" that define the "front office" and "back office" through which the service loop flows and this loop itself is a value stream in which:

- **Front Office:** It is the space in which contact employees carry out activities in front of or in interaction with the customer/user that has arrived to request a service.

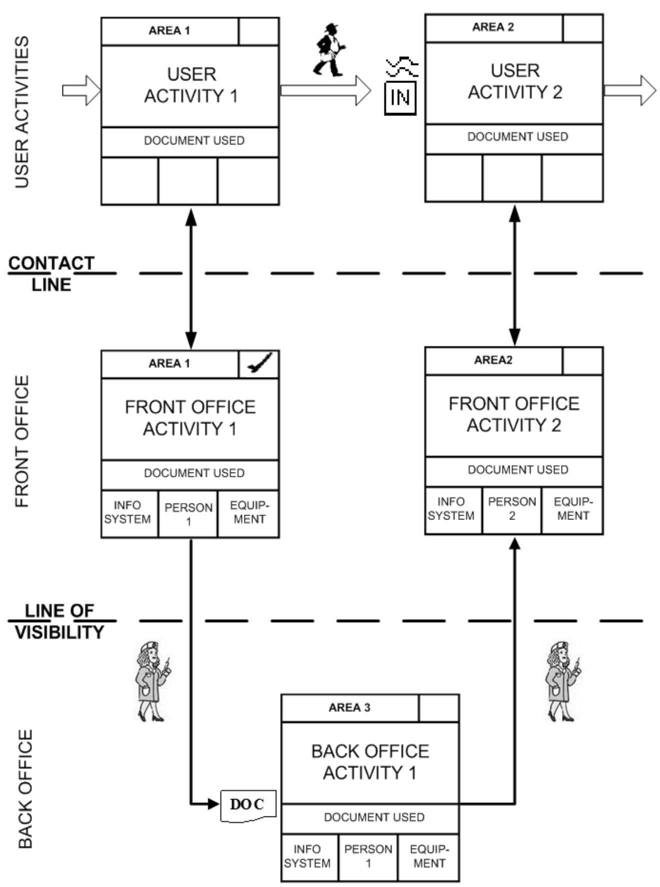


Figure 5. *Generic structure of system mapping for an attention service value stream.*

- **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 set off the actions executed by the customer and the actions executed by front office contact employees.
- **Line of Visibility:** A line drawn to set off the actions executed by front office contact employees and those executed by back office operators.

Figure 6 shows the icons used in the systemic mapping of the service value stream and their meanings.

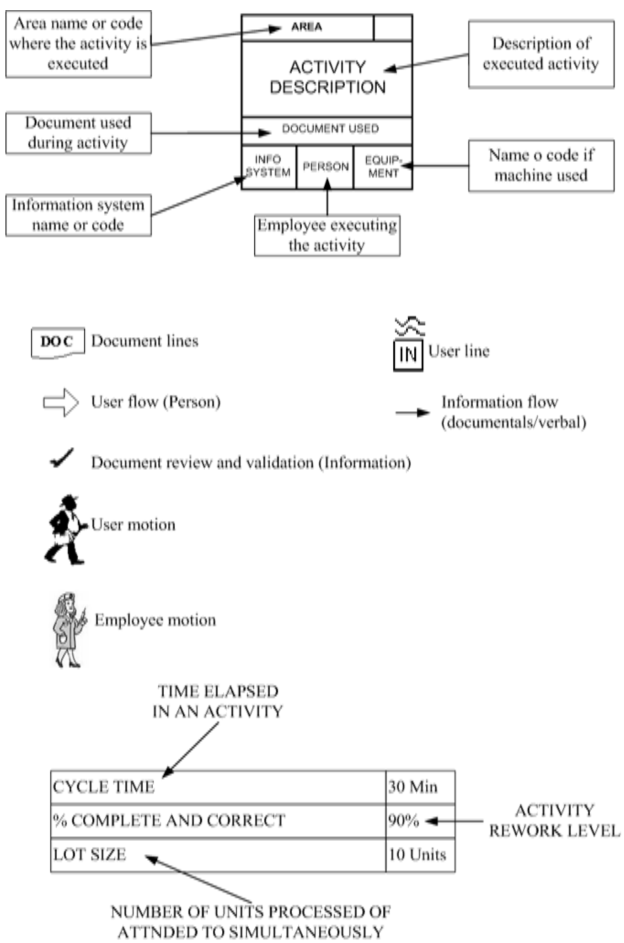


Figure 6. *SMSVS symbols*

The second key use for this tool is that it represents the application of the previously described loop concept with the purpose of identifying all the activities that add or do not add value from the customer's view. Hence, lean thinking leads to the application of a series of tools focused to eliminating activities that do not add value and which are known as waste. The eight wastes defined by the Toyota production system are (Ohno, 1998).

- Reprocessing
- Motion
- Transportation
- Over-processing
- Waiting (for information or physical)
- Inventories
- Overproduction
- Under utilized human talent

5.4. Global and common measurement system

Three concepts from the proposed hybrid model are: a systemic vision of the value stream and its measurement, systemic efficiency and global productivity. Measurement is based on value stream global and common performance indicators, which are preferred over local ones thus promoting team work.

Efficiency under a systemic vision is focused to optimizing key performance variables that contribute directly to customer service variables. The objective is to make the best use of resources to reach the value stream's global operational goals. The following equation illustrates the idea.

Systemic Efficiency = Global goals / Actual results

Productivity is more than a ratio of production and utilized recourses. It directly relates to the business' profitability, i.e. the ratio of profitability and total real costs and investments. This vision of productivity contemplates rethinking accounting costs from the perspective of costs incurred to do things right (to add value) versus the costs of doing things wrong (waste). This demands the identification of all hidden costs which are a drag on the financial results of many organizations.

With this vision, management and its measurement begin from a definition of objectives that are not only global but also common. A global sense is reached by defining objectives that point towards the organization's financial goal. Commonality is reached by the deployment of global objectives and indicators driven by the operational goals and indicators of operational loops. The deployment consists of defining objectives and operations indicators that are inductors of the financial objectives and indicators (**Figure 7**).

Figure 7. *Deployment of objectives and indicators.*

6. Characterization of the clinical laboratory system

The organization under study is a non-profit entity that provides healthcare 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 (Instituto Colombiano de Normas Técnicas). It has recently achieved accreditation in health and has been recognized for its high technology both soft and hard.

6.1. Identification of the clinical laboratory's ambulatory attention loop

The ambulatory attention value stream in the clinical laboratory starts with the arrival of a user to the installations. This user is attended to and guided by a customer service clerk who also assigns 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 authorization for the exam or medical test and makes the corresponding payment. Then the user *walks* to a waiting room and *waits* to be called by one of the laboratory assistants to a cubicle (place where the laboratory assistants take the medical exams).

While the user *waits* in front of the payment area, the cashier carries out some administrative tasks. When these are completed, the he/she *transports* the service order to the cubicles where the order becomes part of the in-process *inventory* until a lab assistant is available to take and *check* it. If the cashier generated information does not coincide with the order, the lab assistant *walks* to the cashier for it to be *reprocessed* for correction. 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 finally takes the samples required for the laboratory analysis in the medical order. After, the user leaves and later returns to pick up the results on the assigned date at the corresponding counter.

6.2. Flow measurement

The clinical laboratory service measures its processes in terms of:

- Logistic supply (total lead time).
- User satisfaction (waiting time, service time, service friendliness and user complaints).
- Reprocessing indicators for customer or user data entry, and in the taking of samples.
- Customer desertion.
- Laboratory employee satisfaction.

6.3. Process diagramming with traditional approaches

For a later comparison, **Figure 8a** shows the diagramming of the described process with the ASME methodology. Similarly, **Figure 8b** shows the diagramming of the same process with the ANSI methodology.

Company:						Deparment:	Procedure				
Division:						Section:	Time (Minutes)				
No.	▽	⇨	○	□	D	DESCRIPCIÓN	▽	⇨	○	□	D
1			●			User reception and service number assigned			0,2		
2			●			Receive documents billing and collection			3,2		
3		●				Locate order in lab assistant´s tray		0,5			
4					●	Waiting for orders					3
5		●				Take order from lab assistant´s tray		0,5			
6			●			Validate information and call user		1,5			
7			●			Take blood sample and give stub to pick up results later			4,5		

8. a. *ASME Code diagram for the process.*

RESPONSIBLE	SYMBOL	DESCRIPTION
	START	
CUSTOMER SERVICE CLERK	USER RECEPTION AND SERVICE NUMBER ASSIGNED	RECEIVE THE USER, VERIFY USER HAS MEDICAL ORDER AND ASSIGN SERVICE NUMBER
CASHIER	SERVICE BILLING AND COLLECTION	REQUEST MEDICAL ORDER FROM USER AND ENTER DATA IN SYSTEM, CALL FOR SERVICE APPROVAL BY MEDICAL INSURANCE
CASHIER	REQUERIMENTS FULL FILLED? NO	
CASHIER	YES MEDICAL ORDER AND BILL	PRINT BILL AND ATTACH TO MEDICAL ORDER
CASHIER	LOCATE MEDICAL ORDER AND BILL IN TRAY	WALK TO TRAY AREA AND LEAVE DOCUMENTS IN TRAY
LAB. ASSISTANT	TAKE MEDICAL ORDER AND BILL FROM TRAY	WALK TO TRAY AREA , TAKE ORDER (AND BILL), CALL USER
LAB. ASSISTANT	TAKE BLOOD SAMPLE AND GIVE STUB	ASK USER FOR BASIC DATA, TAKE BLOOD SAMPLE AND GIVE STUB TO USER TO PICK UP RESULT LATER
	END	

Figura 8*. Process diagramming with traditional approaches for the study case.*

7. The Problem and the System View of the Value Stream

The problem that motivated this research and the development of the proposed model was (Figure 9): When there was an increase in demand for the service the waiting time increased, especially during peak hours. Due to this, there was an increase in the total service time which at the end resulted in more customer complaints leading to a negative effect on the demand itself. (Figure 10).

The problem and its symptoms were the starting point to carry out the causal analysis among the factors and agents causing them.

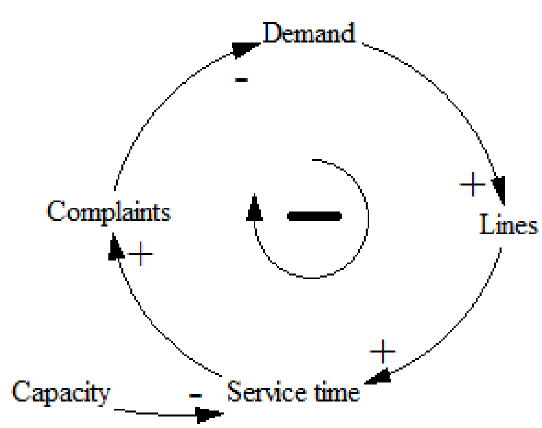


Figure 9. *Simplified causal loop.*

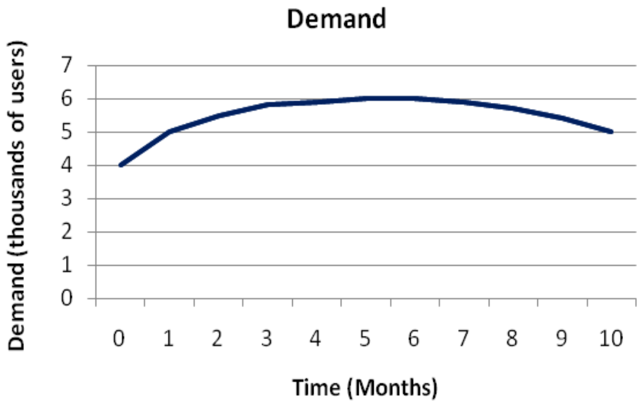


***Figure 10**. Demand performance diagram of the problem.*

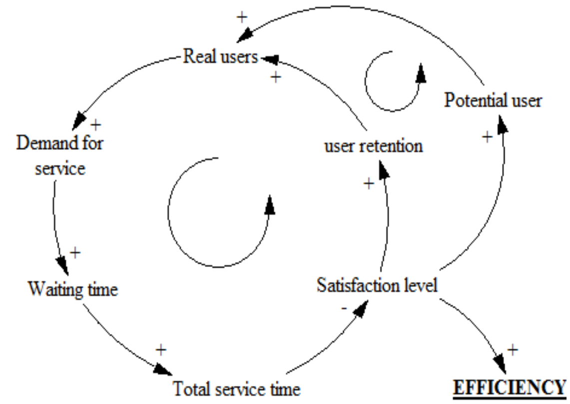


Figure 11. Level 1 zoom of the causal details. Impact on efficiency at the customer satisfaction level.

Using the 5 whys technique detailed cause-effect relationships were found in the laboratory's management as well as other loops that took part in affecting demand and customer service**.** Figure 11 shows a partial view of the detailed circular cause-effect relationships that explain the problem. This enabled a more precise understanding of the system's performance.

Notice that the increase in the level of satisfaction brings forth two additional effects. The first is the increase in potential users and the second is the increase in user retention. As a result of both effects, there is an increase in real users which leads to demand growth that under stable conditions generates and increase in waiting time leading to an increase in total attention time. Finally, an increase in waiting time generates a drop in the level of satisfaction.

This cause-effect relationship cycle creates two negative feedback loops in the laboratory's management. The loop variables to be stabilized are precisely the waiting time and the customer satisfaction level in order to generate an impact in efficiency. A second level of detail for the existing cause-effect relationships that are part of the laboratory's management are obtained through the 5 Whys technique. It reveals an impact on a second element which in this case is financial: the system's profitability (Figure 12).

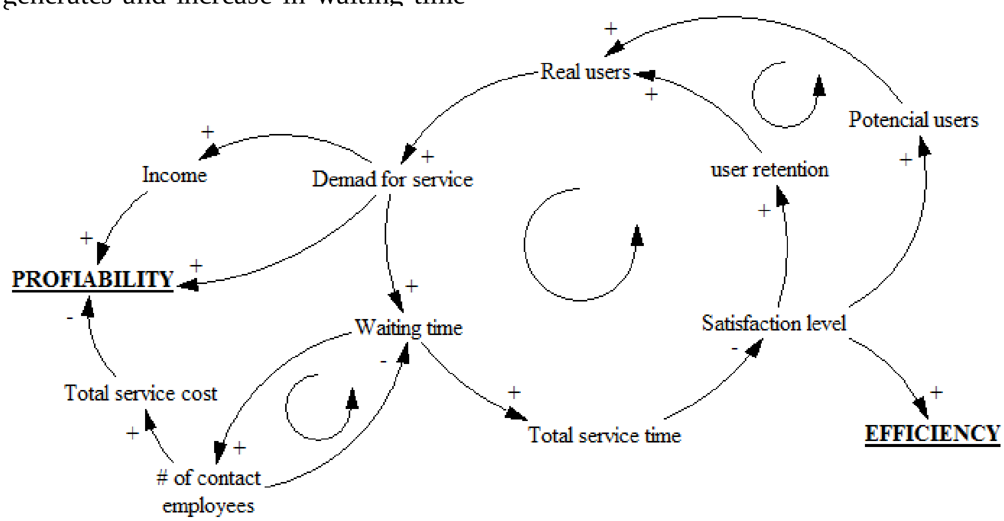


***Figure 12.** Level 2 zoom of the causal details, impact on profitability.*

The increase in demand leads to an increase in income which then results in a positive effect on profitability. Additionally, the waiting time increase caused by greater demand brings along the need to increase the number of contact employees (in this case cashiers and lab assistants), in order to positively impact the reduction in waiting time. However, an increase in the number of contact employees implies higher costs which then generate a negative impact on profitability.

These new relations show the existence of a new negative feedback loop that at a specific time balances the number of contact employees in relation to the waiting time and indirectly with demand.

The present analysis leads to an understanding of the value stream as a whole and a view of the effect that future improvement decisions in any system element will have on the performance of the system itself.

8. Value Stream Flow Improvement in the Clinical Laboratory's Attention Loop

In the following sections, the focus is on Lean thinking's second and third principles analyzing the value stream under the perspective of circular thinking.

8.1. Systemic mapping of the laboratory's ambulatory service value stream

Applying Lean thinking's second principle, the systemic mapping of the value stream was done with the determination of the customer, the diagram substructure levels and the value stream processes (Figure 13).

- Customer: User who requests service at the clinical laboratory.
- Front Office: run by cashiers and assistants that attend to customers.
- Back Office: run by cashiers that go to drop off service orders in the lab assistant's tray at the cubicle, and the movement of the assistants to pick up the service orders.

The customer service loop starts when the user takes a service number then it moves on to cashiers and cubicles and ends when the user leaves the system once a medical test sample is taken.

Note how the mapping registers the customer and contact employee actions and the interaction between them.

8.2. Waste identification and elimination

To achieve this purpose, we highlight the mapping's recording of waste incurred and mentioned (in cursive and underlined in 6.1) for the present state of the value stream.

The application of Lean thinking's third principle lead to the identification and elimination or reduction of this waste to improve flow in the customer service loop. The wastes identified in the customer service loop through the mapping are:

- User waiting time (to be called to the cashier and the cubicle).
- User movements (from the waiting room to the cashier and the cubicles for the taking of samples).
- Service order inventory (between cashier and cubicles), due to the traditional order lots.
- Order reprocessing (wrong data entry by cashier).
- Transport of the orders (by cashiers and lab assistants).
- Inappropriate processes at cubicles (wrong form is filled out).

After the complete systemic study is done, a set of Lean thinking tools are applied to eliminate waste and gain flow. The tools applied to the value stream at this time were:

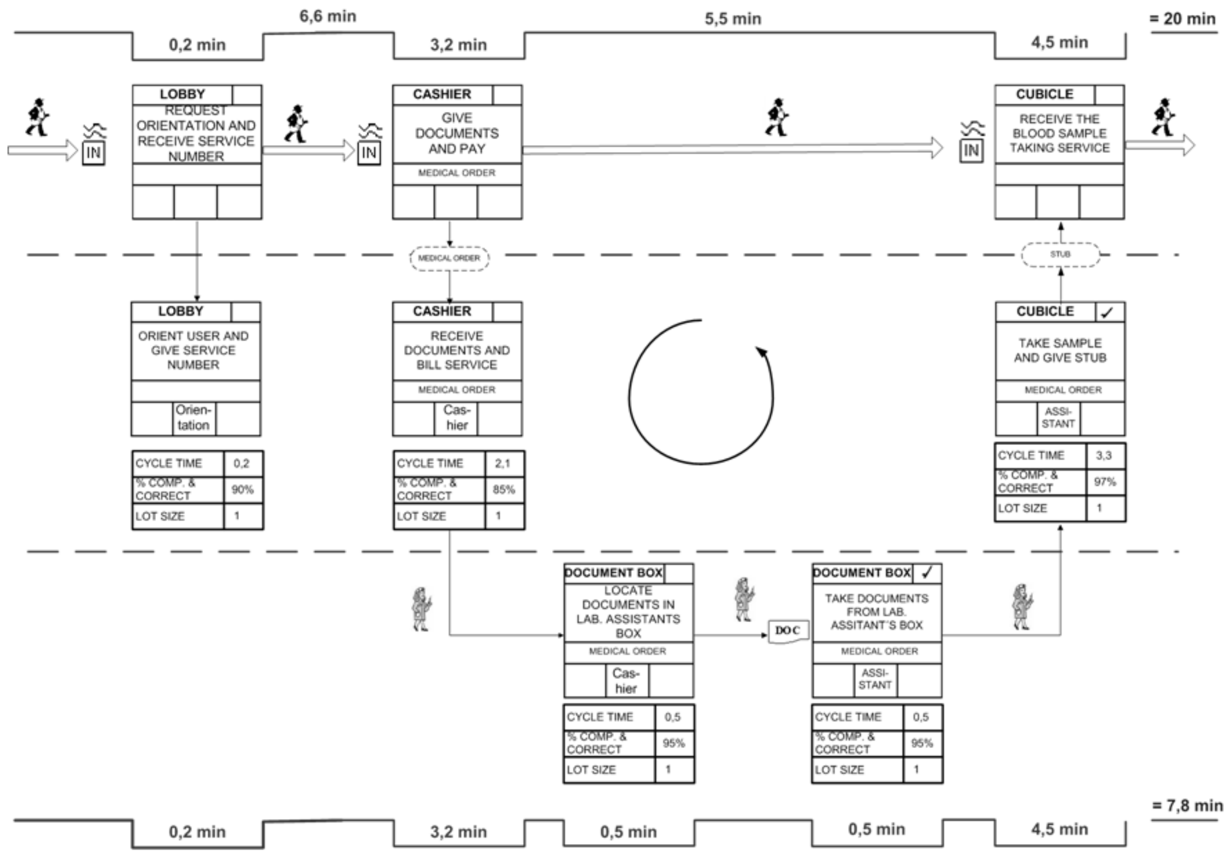


Figure 13. *System mapping of the ambulatory service value stream at a clinical laboratory.*

- 5S (to improve the work environment eliminating wasted time and making better use of human talent).
- Plant Layout (to eliminate unnecessary movement).
- Poka Yoke (to avoid errors and reduce complaints).
- Kanban (to handle inventories flow control).

The four previous tools were accompanied by a fifth one for the direct elimination of waste and it was focused to waste that was not eliminated by the previous tools. This toll was precisely: eliminating mudas.

8.3. Results and discussion

With the application of the improvement tools, the flow in the laboratory's ambulatory attention loop improved:

- Initial total time: 20 minutes
- Improved total time: 16 minutes
- Improvement rate: 20%

As to quality, one of the wastes that blocked flow was errors in user data entry to generate the service orders and the invoices. The "foolproof" mechanisms contributed to a 50% improvement in user data entry reprocessing and service order generation. Undoubtedly this improvement in quality was reflected in the service time advancement which comes from being consistent with the time based competition groundwork.

In relation to the customer desertion problem due to long waits, the flow gain obtained in customer service helped reduce the desertion rate. This improvement is shown in the following indicators:

- Initial customer desertion: 7 users/day
- Improved customer desertion: 3 users/day
- Improvement rate: 57%

Additionally, there were improvements that were not quantified but they were expressed by the value stream operators and they included a drop in stress due to accumulated work, the strengthening of team work, a better distribution of work loads an in general an improvement in the work climate.

9. Conclusions

In this study a hybrid approach using Systemic thinking and Lean thinking was applied for the improvement of a laboratory's ambulatory service value stream for a healthcare entity in Colombia.

The analysis of traditional diagramming methods showed that said methods do not contribute sufficient analysis elements so organizations, in this case from the service sector, may carry out a holistic management of its productive systems. These methods do not contribute to evaluating the systemic structure of the value stream in a whole manner; they only sum up.

The proposed hybrid approach and the identifying of value streams as loops rooted in the reading of "supplier-customer" relations in the process interrelations lead to proposing improvements in methodological gaps that still affect how processes are documented and improved in the service production and delivery systems. Similarly, it was possible to show tangible improvements in service times to customers and users. The identification of underlying systemic structures in the value stream as well as non value adding activities lead to the systemic and systematic posing of improvement tools for eliminating or reducing these wastes in order to gain flow in the laboratory's ambulatory service loop.

The identified and reduced wastes were: user waiting, user movement, service order inventory, service order reprocessing, service order transportation and inappropriate processes in the cubicles.

The implemented improvement tools were: 5S, plant layout, poka yoke and kanban. The flow advancement was not only seen in total customer service time but also a better work climate and higher process quality (i.e. 20% drop in the time from when the customer enters the system until he/she leaves completely satisfied). Some of the achievements were:

- An appropriate methodology for process documentation.
- Greater process visibility and quality.
- Improved customer service response time.
- A holistic vision of service supplying systems.
- Better understanding of service systems in connection to customer behavior and how they interrelate with it and the manner in which they flow in the system.
- Better understanding of flow problems in service systems.

With this approach there is an appropriate tool for mapping not only physical and information flows throughout the system such as decisions made in it but also the customer with the objective of evaluating all activities in terms of contributing or not contributing added value to customers.

This study's process diagramming methodology proposal had differentiating elements in comparison to recognized process diagramming systems. These differentiating elements (other forms of physical support for the information such as videos, photographs and layouts are excluded) included: a) shows the performance indicator for processes that make up a value stream as a loop thus displaying it usefulness as a decision taking instruments, and b) simultaneously plays a role as a diagramming system, and a visual identifier for improvement opportunities oriented to flowing value to customers. In summary, it determines how to create value for customers.

Finally, the problem symptoms perceived to be in a value stream should first be analyzed with a circular approach so that the system is seen as a set of flows and interrelations. Additionally, the origin of problems and the consequences of decisions and improvement steps should be known.

The proposal presented in this publication is being refined through modeling followed by dynamic simulation in the studied system.

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