VALUE STREAM MAPPING OF THE ARCHITECTURAL EXECUTIVE DESIGN IN A GOVERNMENTAL ORGANIZATION

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ABSTRACT

This paper presents a study to investigate the development of the architectural executive design of low-income housing projects at Habitafor, which is part of the City of Fortaleza administrative organizations. In FY-2009 Habitafor managed a budget of approximately $100 million dollars allocated to the design and construction of new projects (~ 20,000 new homes), as well as the improvement of existing communities (~ 20,000 home improvements). The authors hypothesized that this process is plagued with inefficiencies that in turn result in long product (plans and specifications) lead times. In order to confirm this hypothesis and make the attributes of this process visible, the authors used Value Stream Mapping (VSM) to analyze the process activities. This study has found evidence that supports the working hypothesis, and proposed recommendations that, if implemented, would cut a third of the total lead time for the process. The authors believe that processes like the one presented in this paper are performed under similar circumstances in various parts of the world. Therefore, they encourage others to conduct similar studies to reveal and banish wasteful practices that consume taxpayer money but do not generate the services they need.

KEY WORDS

Value stream mapping, Public sector, Architectural executive design, Housing.

INTRODUCTION

The sheer volume of work performed by most public agencies, and the benefits they bring to the society, calls for better ways to develop their processes and improve the efficiency of how their resources are used. This study aims to contribute to the use of scarce resources employed to develop housing projects through the implementation of Lean solutions and advance the knowledge on the use of Lean in the public sector.

In order to provide better and more efficient services with lower costs to the end user, public agencies have been looking for Lean solutions to banish inefficiencies and improve the use of their resources (e.g., LIPS 2009). Along these lines, this paper presents a study to investigate the development of the architectural executive design (AED) of low-income housing projects at Habitafor, which is part of the City of

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Fortaleza (COF) administrative organizations. This is one of the key processes for Habitafor and for any organization with similar goals (i.e., providing housing for low-income populations). The AED is a key component to obtain funding for the project to and develop construction plans.

In FY-2009 Habitafor managed a budget of approximately $100 million allocated to the design and construction of new projects (~ 20,000 new homes), as well as the improvement of existing communities (~ 20,000 home improvements). The projects developed by Habitafor have peculiarities such as community participation during the development phase and the need to abide by laws related to public financing. Thus, the design and specifications have to meet requirements related to funding organizations (i.e., Inter-American Development Bank), and special city codes and regulations related to these projects. The organizations that finance and oversee the projects act as suppliers (information, resources) and internal clients of this process.

The authors used the following working hypothesis: *the process is plagued with inefficiencies that in turn result in long lead times for the delivery of the AED*. In order to confirm this hypothesis and make the attributes of this process visible, the authors used the Value Stream Mapping tool (VSM) to map the process activities.

LEAN IN THE PUBLIC SECTOR

Governmental agencies all over the world strive to deliver services with limited resources and tight budgets, and for many of them this translates into a trade-off between money and quality of services. The use of Lean in the public sector contradicts this trade-off as it allows organizations to deliver quality services under tight budgets (Bhatia and Drew 2006).

Few studies have focused on office-related construction activities (e.g., bid preparation and proposal, design activities). Office activities are repetitive and common to all projects and include, but are not limited to, design and specification of buildings, estimating and preparation of budgets and schedules, accounting and finance. Recent research has acknowledged information flow produced in the office as a critical constraint in on-site activities (Gann & Salter, 2000). Therefore, any improvement in office activities will impact the performance of the entire organization because essential parts of all projects (e.g., design, bid, accounting, financing) to some extent flow through the office.

Lean Thinking has been considered a way to reach cost savings in the public sector without compromising the quality of its services and a way to promote efficiency gains in different processes (Radnor and Walley 2008). Numerous examples of the opportunities and gains associated with the implementation of Lean in the public sector in the construction industry can be found in the proceedings of the International Conference Lean in the Public Sector (LIPS, 2009). A review of the initiatives underway in different countries, presented at the LIPS conference, highlights the efforts of research institutions, public agencies, consultants, and industry practitioners to change the way contracts and documents are defined in the construction industry. A common feature in these initiatives is the use of tools to make the processes visible, and increase its transparency, to all participants.

However, despite all the benefits Lean can bring to the public sector its implementation faces some challenges, e.g., taking the customer perspective, managing end-to-end processes, freedom to expose problems (Bhatia and Drew

2006). The first challenge is to make public servants understand what the customer expects from the organizations they work for and set up tasks in such a way to deliver value to the end customer. Each process should be clearly defined from start to finish, the performance of each task should be evaluated from the customer's standpoint, and throughout the entire flow of work. Another challenge is to encourage people to expose waste without the fear of being blamed for not adequately taking care of the public money, as this is the only way waste can be identified and banished. Along these lines, this paper used VSM to investigate a process in the public sector and make attributes of the process visible to those involved.

VALUE STREAM MAPPING (VSM)

According to Rother and Shook (2003, p.3): "A value stream is 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 customer, and (2) the design flow from concept to launch."

In an office environment the value stream is closely related to the flow of information exchanged between tasks. Keyte and Locher (2004) suggest that mapping a value stream in an office includes documenting the activities performed, identifying the people in charge of each activity, the batches (volumes and types of information and documents) exchanged in the process, documenting preparation time, processing time, and waiting times for each activity (Keyte and Locher, 2004). Tapping and Shuker (2002) recommend an eight-step value stream management process for office activities:

1. Commit to Lean – management as well as all other workers who will execute the activities which are part of the value stream should be committed to a process that will analyze the value stream and implement ideas based on Lean Thinking.
2. Choose the value stream – A starting point is to address customer concerns and target value streams that have major impact on customer satisfaction.
3. Learn about Lean – the organization should come up with a learning plan to disseminate Lean concepts, principles, and tools that will be used in the process.
4. Map the current state – 'go and see' the workspace where the work is being carried out, collect information, and use it to visually represent how the value stream works in a current state map.
5. Identify Lean metrics – they have to be meaningful for those involved, and promote transparency so that wasteful practices can be identified and eliminated.
6. Map the future state – this map indicates a target condition to be achieved and where changes can be implemented to improve the value stream.
7. Create kaizen plans – Kaizen plans help managers to communicate how and when incremental changes will be implemented and support continuous improvement.
8. Implement kaizen plans - People should be informed about the changes being implemented and be called to participate on kaizen events.

The steps suggested by Tapping and Shuker (2002) are along the same lines of those proposed by Rother and Shook (2003) for value stream mapping in organizations.

However, the method described by Tapping and Shuker and their detailed recommendations are focused on attaining a Lean office.

Seddon (2008) points out that the mapping of office and service processes, as the one presented in this paper, has to take into account that not all tools and indicators used in a manufacturing environment suit the office and service environments. Many service tasks performed in the public sector basically deal with information; therefore, the process analysis should try to unveil wastes related to lack of, wrong, or lost information; badly designed forms for data collection; standards that require more information or procedures than necessary to deal with simple cases and tasks, amongst others. Seddon (2008) also makes a distinction about the demand placed on services as value demand and failure demand. The former is related to delivering value to the customer right at the first time, and the later is the demand generated due to a failure to serve the customer right at the first time, generating a new round of interactions between the customer and the organization.

RESEARCH METHOD

The method used to carry out the study presented in this paper addressed specifically steps 2, 4, 5, and 6 in an office environment for the Construction and Project Cell (Célula de Projetos e Obras - CPO) at Habitafor, which is an organization in charge of providing housing to low income families, managed by the City of Fortaleza (COF). The working hypothesis used in this study was the following: *the process developed by CPO is plagued with inefficiencies that in turn result in long lead times for the delivery of the Architectural Executive Design (AED).*

Steps 1 and 3 were not used as this study was not carried out by the organization or developed upon its request. At the time of the study, the organization was not committed to implementing Lean in its processes. One of the authors (internal client), who worked for Habitafor during the time of the study, indicated that this was an important process to be mapped as it triggered numerous other tasks at the organization, specially the application for funding and development of construction plans. For the same reasons, steps 7 and 8 were not implemented; however, recommendations related to potential kaizen plans were proposed in this study, as indicated in the future state map. Therefore, the focus of this study was mapping the process to unveil wasteful practices, and proposing recommendations to improve the process performance.

The VSM process started with a definition of the stream to be mapped, the attributions of each individual and their tasks, and the main processes which were part of the value stream. The researchers interviewed CPO professionals, who are part of the value stream, in their workspaces in order to gather information about the tasks they performed, their internal and external clients, and estimated times for the tasks.

The next step comprised drawing a preliminary current state map which was presented to the professionals interviewed during the data gathering phase so that the current state map could be validated by those who performed the tasks. The researchers used two main metrics to analyze the times reported as necessary to complete the tasks: Lead Time (LT) and Processing Time (PT), respectively the time a process takes to be completed (including value-adding and non-value-adding time) and the actual time people spend to perform tasks (considered here as value-adding time). These metrics were adapted from the work by Fontanini e Picchi (2005).

The future state map was proposed after the current state map was validated by CPO professionals and analyzed by the researchers. The analysis of the current and future state maps relied on input from the professionals at the CPO at Habitafor and on the authors' own experience. One of the authors of this paper has worked for four years at Habitafor as a manager for new project development (funding, concept, and design) and had a bird-eye's view of the value stream analyzed and several other value streams that interface with the scope of this study.

VALUE STREAM MAPPING AT HABITAFOR

The study was carried out at the CPO-Habitafor to investigate the development of the architectural executive design (AED) of low-income housing projects. In addition to designing and supervising the construction of housing projects for low-income families, this organization is in charge of re-locating families from risky areas, and providing basic infra-structure and housing improvements to existing low-income communities. The requirements projects developed by Habitafor are set by their funding agencies, which bring variation to way the tasks are developed. However, the overall process used to develop all projects is similar and faces similar problems.

The project for which the VSM was developed was an integrated urban design to relocate 606 families, who lived in a slum in the same area, to 3-story apartment buildings. Also, the related infra-structure was developed (sewage and water systems, power lines and distribution, drainage, paving, a water channel) totaling 38.915,00 m^2.

CURRENT STATE MAP (CSM)

The CSM (Figure 1) revealed that the long lead time to complete the architectural executive design (AED) of this project was due to several problems that plagued the value stream. The value stream starts from a demand defined by the Habitafor's Social Service. A document with information about quantitative and qualitative social and economic data, number of families and members with special needs, age distribution, origin, and the local infra-structure for the project characterizes the demand for a new project. This document is submitted to a project manager who assigns an architect to look for an appropriate piece of land to develop the project. The team responsible for developing the project design meets and the project manager assigns responsibilities to all involved and shares the funding criteria and requirements that will nurture the project development.

The architect starts the search for the land based on information available in a 'land bank', which contains properties owned by the city (COF). This land bank does not provide the architect with all the information necessary for the decision making process (e.g., property documentation, urban characteristics). If the adequate location for the project cannot be found in the properties owned by the COF, the architect starts a search for privately owned land that matches the project needs (e.g., size, location). The documentation about a privately owned piece of land potentially available for the project is sent to the project manager, who sends it out to SEINF (Urban Infra-structure Agency). SEINF defines the price that the COF will pay to the owner for the expropriation of the land in which the City intends to develop the new project. The project mapped in this study used land that belonged to the COF as well

as land adjacent to the project. Habitafor's legal department took care of the expropriation of the land for the project.

The architect develops an urban analysis for every option considered to evaluate the feasibility of the area and how well it meets the project's demands. The architect also requests official documentation from the notary where the land and its ownership are registered and this information is submitted to the project manager. Once the area is defined, the project manager contacts SEINF to obtain advice about the urban and infra-structure codes and regulations the project has to abide by (AOP document); and to request that the land be surveyed and the results submitted to the project engineers.

Notice that there is a long delay (90 days), from the time these items (AOP and surveying data) are requested to SEINF and the time they are delivered respectively to the project manager and engineers. SEINF is understaffed and there are not enough professionals to carry out all of its surveying activities and analysis of project requirements. The AOP document is necessary to obtain the environmental license for these projects, and without it the project cannot start or sometimes it may start illegally without all the licenses and approvals (setting a bad example for other projects developed in the city). Also, the lack of a specific budget allocation for conducting the search of privately owned land registered at the notary organizations delays the project. These organizations only start the search of privately owned land in their databases after the COF pays for their services.

In many cases, like the one presented here, the design progresses without all the information necessary (AOP, surveying data, land documentation), resulting in rework and suboptimal solutions along the way. Teams have to develop these projects under very short lead times between the approval of the resources by financing institutions and the definition of the design and specifications for the project. Often times, construction starts without proper documentation and sufficient analysis due to the lack of planning in terms of when resources for specific projects will be available. Teams make-do with whatever resources they have so that they do not lose the opportunity of having the funding for projects so badly needed by the population.

While some of these requests are being processed, the architect keeps working on developing different project typologies, the basic design, and defining the urban layout of the project. The architect submits the basic design to the local utilities (water, electricity) for approval once the basic urban design and the location of the buildings are defined. Before the basic design is set the architect and social workers meet with community leaders and families to present the design and gather suggestions for improvement. Then, the project team works on the changes suggested by the community. The team tries to balance and match the community needs with legal and financial constraints defined for the project.

After this phase of adjustments in the design, the architect submits the design to the project engineers who work on the design of additional plans and specifications necessary to complete the development. The architect also submits the basic design plans and specifications to the project manager, who sends these documents to the procurement/purchasing department. The procurement department then prepares the request for proposals and solicits bids for the project. Once the engineers complete their design for the project, they submit the documents to the architect for coordination, and for preparation of the final version of specifications and details which comprise the architectural executive design (AED).

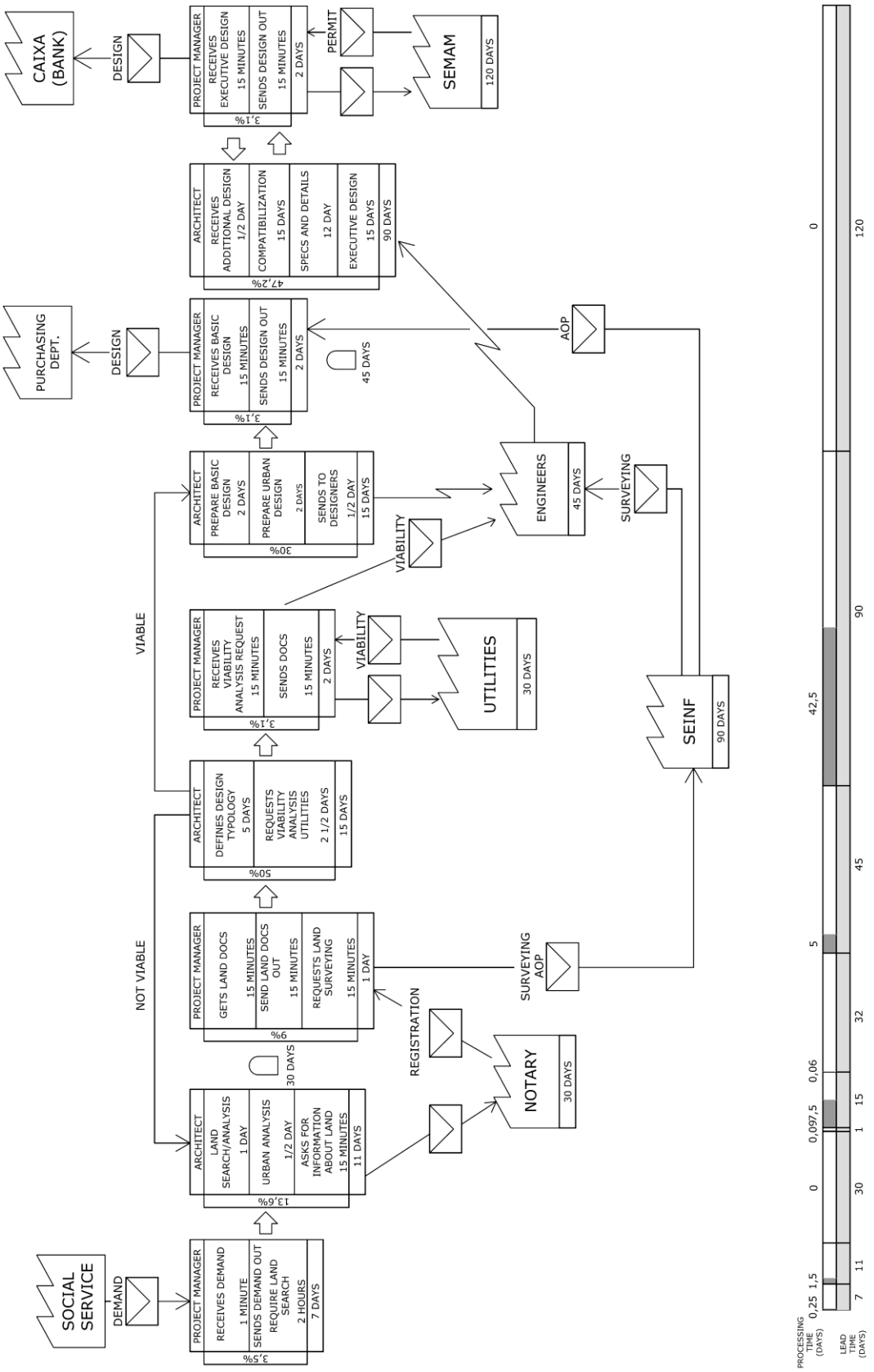

Figure 1: Current State Map

Finally, the AED is submitted to the project manager who requests the environmental analysis and license from SEMAM (Environmental Agency), and presents the project to CAIXA (federal bank) which manages funding provided by the Brazilian government and from sources such as the Inter-American Development Bank. For the sake of simplification, CAIXA was defined as the final client of this process (owner's representative) because it approves and pays for the design and construction hand-offs on behalf of the owner (the source providing the financial resources).

Figure 1 does not show all the loops the AED goes through until all requests from its clients are addressed. Many tasks take so long to get completed and approved that there are many occurrences of rework, loss of graphic material, low morale of the project team, and ultimately a long delay to deliver the product to the end user.

The total lead time for the process is close to a year (351 days), whereas about 56.9 days (16%) are considered processing time. Researchers observed that the architect spent too much time doing non-value adding tasks that could be performed by some other person (e.g., printing and organizing paper plans, gathering signatures, proving information to other departments). The professionals working for the AED multitask between different tasks and compromise the terminality of tasks. In addition to these problems, the long lead times to obtain information, documents, or approvals from agencies that work for the COF also contribute to a suboptimal use of resources and ultimately to the long lead time to complete the AED.

FUTURE STATE MAP (FSM) AND RECOMMENDATIONS

After the analysis of the CSM, the researchers designed a FSM (Figure 2) and proposed changes that would reduce the total lead time for the AED process. The researchers estimated that should the proposed changes be implemented the lead time would be reduced from 351 to 231 days (a 34% reduction), due largely to the reduction of the non-value adding activities from 294.1 to 174.1 days.

The information about the land owned by the City of Fortaleza should be made available in an online database so that architects would be able to easily pull information from this database whenever they need. A staff should be designated to perform auxiliary activities where the lead architect is not needed. This would allow the project architect to focus on value-adding activities to complete the project.

A value stream manager should be designated to plan, supervise, and coordinate different activities performed at the CPO-Habitafor and externally (e.g., interface with funding agencies, approval offices). Also, engineers responsible for different plans and specs for the project should work closely with the lead architect, in production cells, to promote the exchange ideas and reduce the time to solve problems.

The lead architect and other professionals at Habitafor could define standardized typologies for the projects usually developed by the organization and keep them in a library. This would represent a safety resource (S/S), e.g., design library, and would reduce the time to develop new projects. The design library would work as a supermarket from which standardized design plans and specs would be pulled once the land for new projects is defined. The supermarket would represent a push-pull interface: upstream the design is pushed based on the commonalities found in these projects; downstream, the design serves as a basis for the new projects and adaptations are made to account for the differences in the projects site. Finally,

standardization of documents required by organizations like SEMAN and SEINF would reduce the time spent dealing with misinformation and "failure demand".

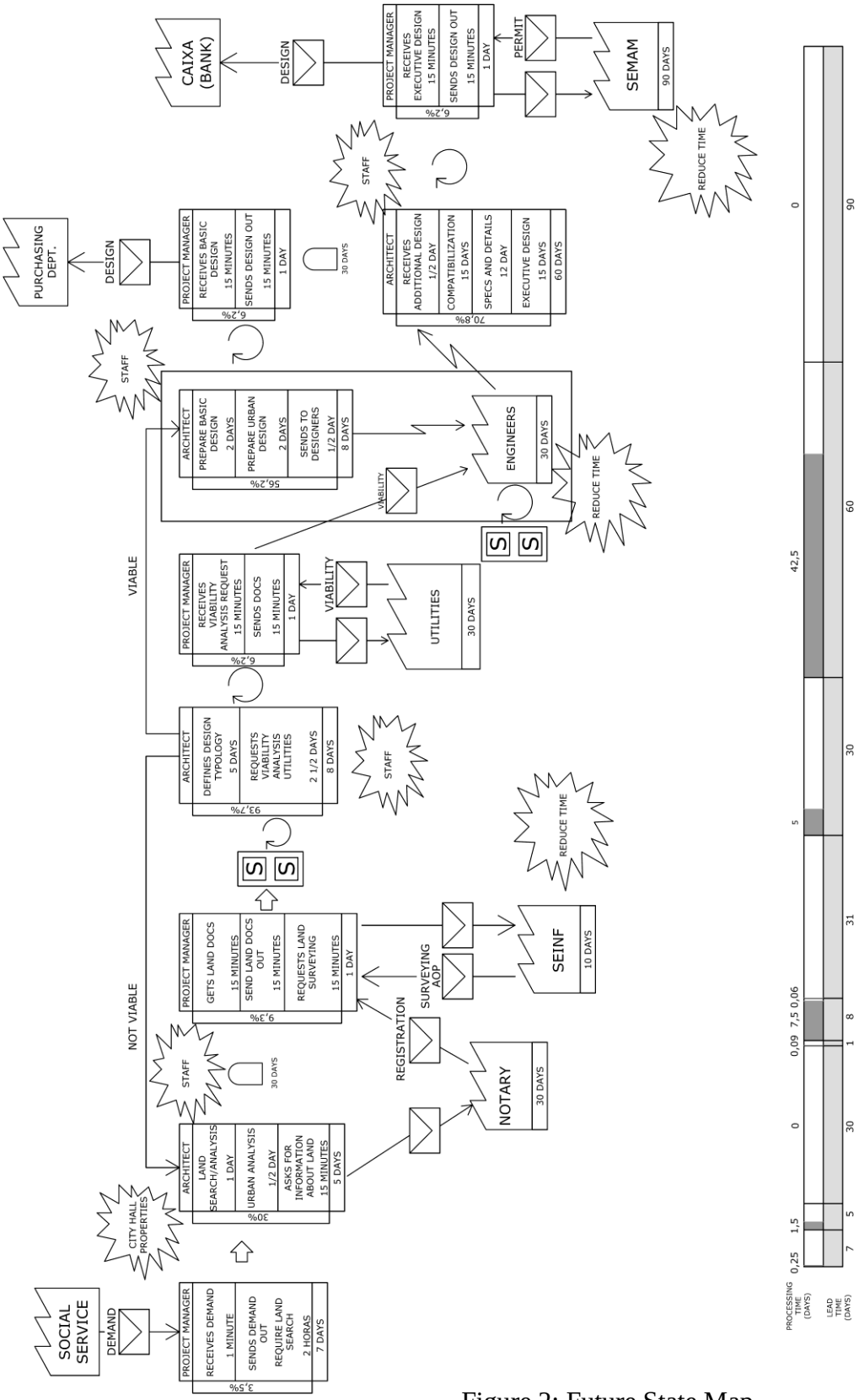

Figure 2: Future State Map

CONCLUSIONS

This study investigated the process to develop the Architectural Executive Design (AED) for low-income housing projects in the City of Fortaleza (COF) and has found evidence that supports the working hypothesis, which stated that the long process lead time was due to inefficiencies that plague the process.

The study revealed that resources that should employed to generate value, i.e., architect and engineers, are used for supporting activities that could be performed by a staff. The CPO professionals work frantically to meet deadlines, and have to make do with incomplete information, so that project funding is assured to serve the population. Often times, projects are delivered in suboptimal conditions and later have to be reworked, originating failure demand which consumes more time and effort of already scarce resources. The use of the VSM tool, adapted to map process activities, revealed the wasteful practices in the AED process, and allowed the researchers to propose solutions that, if implemented, could cut one third of the current total lead time.

The authors expect to have contributed to the literature about the use of Lean to improve public services. The authors believe that processes like the one presented in this paper are performed under similar circumstances in various parts of the world. Therefore, they encourage others to conduct similar studies to reveal and banish wasteful practices that consume taxpayer money but do not generate the services they need.

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