

# **Application of Lean Thinking in Angolan Industrialization Process: The PROFIR Case**

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## **Abstract**

The application of Lean thinking in organizations, particularly in the industry sector, has been of great value to assist in reaching the organizations' objectives, creating the necessary goals links between the government and the science in the project designing. In the case of the industrialization process is consisted by the optimization of the activities and the resources, starting with the identification and subsequent exclusion of the wastes from the project creation stage until the final stage. This work is related to the Program for the Promotion of Rural Industry (PROFIR), which is one of the actions of the Angolan government through the Ministry of Industry within the industrialization process. Therefore, this research evaluates the PROFIR in the design stage of the project, using the Lean thinking tools to identify the waste resulting from the project design stage, recommending an optimized solution of the used resources. The methodology in use is the documentary research focused on the PROFIR case study where it was found that there is a considerable quantity of waste in the industrialization process considering the PROFIR, revealing as well that the PROFIR projects' staffs suffer a lack of knowledge and culture in the Lean thinking philosophy.

## **Keywords**

Angolan industrialization, Lean thinking, process improvement, PROFIR, value stream mapping.

## **1. Introduction**

Lean thinking in the industrialization process can be considered as an element set of the Lean philosophy aiming to optimize the industrialization process based on the wastes' elimination, which is composed of five basic principles. The Lean thinking in the industrialization process project is a key factor in the design and determination of the product, where the focus is to eliminate possible wastes from the production process, through the inclusion of costumers' loyalty techniques, feasibility analysis conditions, such as the summarized in the economic feasibility analysis, the operational feasibility and the technical feasibility (Pfaffenzeller, et al., 2015):

- The organizations' ability to support the expenses and generate benefits from the project,
- The capacity of the involved personnel in operating the project to avoiding wastes and responding promptly to customers' needs,
- The organizations' capacity in the acquisition and installation of relevant state-of-the-art equipment, and,
- The personnel's ability to master the new production technologies associated with information and communication technologies.

Lean development in the industrialization process structure is based on six main components, with different sub-characteristics, which are derived from the Lean thinking, and applied to the development of new products, namely: customers' value, product and market knowledge, continuous improvement strategies, the stabilization and standardization, and the improvement of Lean culture (Welo, Ringen, 2015).

Thus, the project implementation phase considering Lean thinking in the industrialization process is based on the Lean production principles, e.g., the standardization process, zero defects goal, employees' orientation and management by objectives, paying attention to the flows, the pulled production system, among others (Dombrowski, et al., 2016). Lean thinking has been used in the industrialization process, having multiplicity applications in different organizations types (Caldera, et al., 2017), (Alkhoraif, et al., 2019).

Some organizations' examples where Lean thinking has been applied are for example in civil construction (Pfaffenzeller, et al., 2015), (Tezel, et al., 2018), industrial chemistry (Jilcha, Kitaw, 2015), textile industry (Manfredsson, 2016), food supply industry (Vlachos, 2015), healthcare industry (Kovacevic, et al., 2016), among others.

Nonetheless, the available studies about Lean thinking applications are focused on case studies located in European countries, (Möldner, et al., 2020), (Secchi, Camuffo, 2019), (Dong, et al., 2019), (Hasibul, et al., 2018), (Lugert, et al., 2018), (Chirumalla, et al., 2018), (Sousa, et al., 2018), Asian countries, (Pipan, 2018), (Brocal, et al., 2018), (Natarajan, Venkatesan, 2018), (Heravi, Firoozi, 2017), (Fu, et al., 2017), (Ozawa, et al., 2017), (Chai, et al., 2016), (Salem, et al., 2016), American countries, (Ramos, et al., 2018), (Bekdik, et al., 2016), (Martinez, et al., 2015), being more scarce the application of Lean thinking applications in African countries (Lin, Omoju, 2015).

For instance, (Martinez, et al., 2015) have emphasized the adoption of Lean thinking applied in building construction. Acting as a practice of design process standardization, and acting as a correlation with the production flow, it was proved that Lean thinking is the best option to increase production, reducing the costs. Considering the Lean thinking applied in the chemical industry perspective, some successful applications should be highlighted.

In (Jilcha, Kitaw, 2015) have shown the benefits and barriers of Lean thinking implementation in the chemical industry in Ethiopia, where it was found an impressive amount of waste in this sector, especially regarding energy expenses. The proposed study also has shown that such a situation could be improved and mitigated with the Lean thinking application, despising the implementation barriers.

In (Manfredsson, 2016) has applied Lean thinking in the textile industry where the effects of Lean application were exploited in the related small and medium enterprises' management. The results have shown the positive effects on the waste's identification and characterization, on the cost reduction, and team performance. Moreover, (Belvedere, et al., 2019) have also stated that regardless of the level of the product complexity and the industrial nature, the waste elimination process can play a very relevant role in the industrial process improvement.

Considering the previous state-of-the-art, and for the sake of elucidation, the Authors will focus their attention, with relevant information, about the main features and influences related to the industrialization process level in Angola. The main contributions of this work are as follows:

- Application of Lean thinking tools to improve the industrialization process in Angola, i.e. the PROFIR case study,
- Identify the industrialization process wastes considering the PROFIR case study, aiming the processing time reduction and its bureaucratic complexity,
- Demonstrate the knowledge importance about Lean culture in the project design staff,
- Disseminate the Lean culture in emerging countries, as is the Angola case,
- Contribute to the paradigm shift of the Angolan industrial sector, promoting the economic growth and organizational sustainability.

## **2. Angola Industrialization Process**

From the different societal domains, associated with technological development, and together with the improvement of academic training and technological research, it is evident that Angola needs a reliable and sustainable strategy for the training process of technical staff for upper and middle-level positions. Furthermore, there is an emphasized urgency in implementing industry development for a sustainable and robust economy.

The Angolan industrialization process has not been carried out strategically, nevertheless, it has been based on the rather interests and know-how of foreign organizations that have been invested in the Angolan market. Such investments are important for Angola, but the same investments are not sustainable since such investments aim for a quick profit from organizations without structural return for the country.

Hence, it is in these contrasting scenarios that some Angolan organizations have starting to participate in the industrialization process. These Angolan organizations are using the knowledge, technology, and the experience gained from observing the practices of other foreign companies. To face the non-industrialization process, the Ministry of Industry of Angola has developed several programs for the short, medium, and long-term, among which is the PROFIR program “Program for the Promotion of Rural Industry”. It is in this Angolan re-industrialization context that it seems opportune to study the Lean philosophy integration and analyze how it can contribute to greater efficiency in the PROFIR implementation (Ministério da Indústria, 2015).

The industrialization implementation process in Angola is the main mechanism for the Angolan industry development in the mid-term. In this sense, the Angolan government has been taking several measures to mitigate the oil prices' reduction effects in the Angolan economy, based on two vectors, which are the increasing non-oil revenues, and diversifying the Angolan economy incomes. Some investment programs were created based on the Angolan strategic objectives and targets, delimited by the government, in line with the reforms and priority measures through the creation, evaluation, and implementation of public and private investment projects. The different phases resulting from the projects' implementation can be seen in Figure 1.

In the Angolan strategic targets, PROFIR appears to be a way to restart the industrialization process through public investment, since it is a public mechanism for creating or qualifying organizations following the government strategies, diversifying and reindustrialize the country. The industrialization process is composed of several phases; each phase consists of a set of activities that employ physical and human resources, as can be seen in Table 1 (Belvedere, et al., 2019).

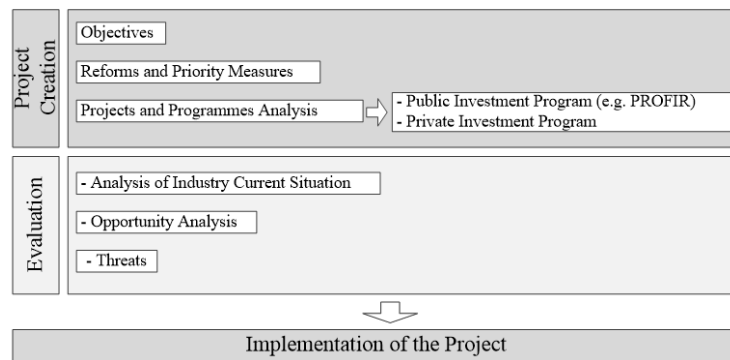


Figure 1. Concerted model for the creation of industrialization projects in Angola.

Table 1. PROFIR processes phases (based on Belvedere, et al., 2019).

Phases Descriptions	Industrialization Process Description
<p><b>Creation of the project (1<sup>st</sup> Phase):</b>                      Registration and requalification of candidates</p>	<ul style="list-style-type: none"> <li>- Objectives and Targets.</li> <li>- Reforms.</li> <li>- Measures.</li> <li>- Priorities, analyses of the public project investments (e.g. PROFIR and private investments).</li> </ul>
<p><b>Project assessment (2<sup>nd</sup> Phase):</b>                      Legalization of the project by IDIA, ED, GTI by Local Government</p>	<ul style="list-style-type: none"> <li>- Current industry situation analyses.</li> <li>- Opportunities analyses (Threats and Strategic guidance).</li> <li>- Articulation with the national strategy.</li> </ul>
<p><b>Implementation (3<sup>rd</sup>, 4<sup>th</sup> and 5<sup>th</sup> Phases):</b>                      Material purchase, management, stock management, distribution, formation</p>	<ul style="list-style-type: none"> <li>- Technical and economic assistance.</li> <li>- Installation and equipment assembly.</li> <li>- Maintenance plan.</li> </ul>

It is possible to observe that five different phases have been identified. The first phase is the projects' creation. The interested candidates should apply for the registration to open an organization or recover it, and these candidates are selected according to the local needs.

The process is completed online by the Industrial Development Institute of Angola (IDIA). In the second phase, the IDIA process validation is performed by the technical group, called GTI-PR, and by the Entrepreneur Division, which oversees the commercial licenses and other documents. The local government participates by presenting the local needs and with the projects' approval. The subsequent phases are related to the material to be supplied, stock and logistics management, training, and project implementation.

### **3. Industrialization Process Description and Lean Thinking Application in PROFIR Case Study**

Based on the PROFIR, it is necessary to design the Lean thinking tools to apply to this process, with the goal of PROFIR's system improvement process. In this sense, it is necessary to identify the existing gaps in the Angolan industrialization process through the Ishikawa diagram, which assists in visualizing the problem causes.

In Figure 2, it is possible to observe the cause-effect diagram resulting from the Angola industrialization problems. Such problems can have several sources: financial, energy, human resources, infrastructure, management product and distribution, lack of raw materials, among others (Ministério da Indústria, 2015).

The set of problems summarized and other ones make the industrialization process in Angola a real challenge, by combining the different areas that make-up the diagram that describes the development of new organizations in Angola, in the different activity sectors. Moreover, it is possible to find out the main wastes from the Lean thinking perspective, which are summarized next:

- Overproduction existence,
- Several industries projects opening waiting for their real realization,
- Activities excesses, long processes, material excesses, and human resources,
- High costs in the realization of the project,
- Long waiting time for starting the project, with several stops due also to the phases' changes and the documents processing authorization,
- Existence of several entities involved where the projects are sent for approval,
- Inaccurate information processing due to the control lack of employees that have weak or over-passed information technologies,
- Inventory excesses, i.e., projects accumulation due to lack of material conditions and financial resources to follow up,
- Unnecessary projects movement, i.e., projects go through various phases where unskilled employees are doing jobs in unrelated training areas, among others.

Value stream mapping (VSM) is one of the Lean techniques' tools, developed for manufacturing quality analysis, but it can also be applied to other activities. It consists of the careful observation and annotation process of the occurrences throughout the information flow, material flow or other flow types, in order to verify the activities' performance, removing all the elements that do not add any value (Heravi, Firoozi, 2017).

In this work, the VSM tool shows the procedure used in PROFIR processes presented in detail in Figure 3, and it is divided into five phases: application phase, legalization phase, the business' design plan and implementation phases in the fourth and fifth phases, respectively, which were previously summarized in Table I.

The first phase is the organizations' registration process, where new organizations candidates, or old organizations, submit their applications, for new registration, or qualification, according to the local government's needs. At this stage, the applications are analyzed from the feasibility of the project perspective, the organization's experience in the activity to be developed, and the collection of further information about the project. This creates a stock of processes for the second phase. The entire first phase is done at the Industrial Development Institute of Angola entity.

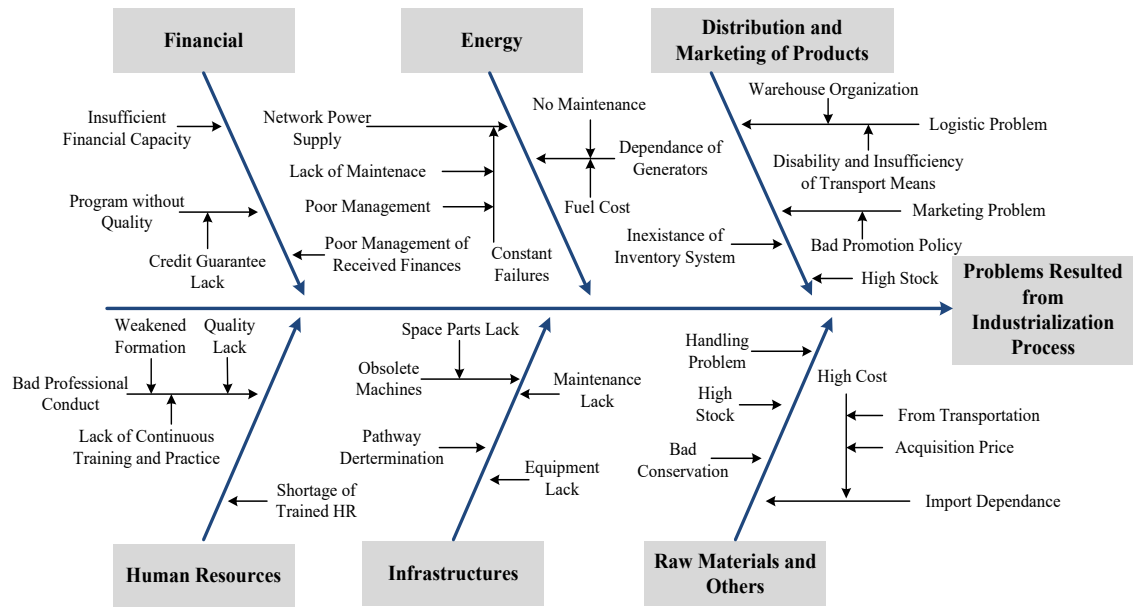


Figure 2. Problems resulting from the industrialization process in Angola.

The second phase is the processes' legalization in which the Industrial Development Institute of Angola entity, through PROFIR technicians, promotes the legalization of the approved processes. These processes are sent to the Entrepreneur Division, which is responsible to evaluate the processes, assigns the number of agents, assigns the commercial license for the activity, and creates the legalized stock of processes for the later phases.

The third phase is related to the business' plan, involving three different institutions, the Industrial Development Institute of Angola, the National Institute of Innovation, and Industrial Technology (INITI), and the local government. Thus, the training is first given in the business area, enabling business' plan creation, which is then analyzed and validated by the different entities and monitored by the local government.

The fourth and fifth phases start after the applications' approval, with the organizations' creation and installation, equipment installation, and with the acquisition of the raw materials, most often coming from seaways of Europe, Asia, or America. Between the request and raw materials receipt, the time frame is at least four months. When raw materials arrive in the Luanda Port, Angola, raw materials are transported to the warehouses, waiting for the verification and distribution to the organization. Before the activities starting, technical assistance is provided (monitoring and projects' implementation, accounting support, financial guidelines), and the final report is issued.

#### 4. Industrialization Process Description and Lean Thinking Application in PROFIR Case Study

##### 4.1 PROFIR Processes Wastes Identification Using VSM Tool

In this study, the VSM tool was used to identify and improve the Angolan industrialization process by identifying the most significant wastes found in the PROFIR structure. Figure 4 shows an illustrative point-of-view where the improvements may be made using Lean thinking techniques, and several types of wastes are summarized in Table 2. As previously described, the critical types of wastes identified in PROFIR are related to overproduction, defects, waiting times, transportation, inappropriate processing, and excessive inventory.

Based on Table 2, it is possible to observe the current state of the Angolan industrialization process, and, from a preliminary point-of-view, it is already visible that the application of a Lean thinking approach regarding the current PROFIR process, it can bring several improvements. Overproduction wastes come from numerous projects that have been approved in the short-term to medium-term, where the approved organizations' performance indicators are not reaching the expected levels, leading to the belief that more tighten criteria should be used once that this industrialization mass is not generating the expected effects.

Other wastes are related to previously identified defects, such as over-information, a too-wide range of activities, or too long processes in the different phases. Hence, complementary wastes with the previous concerns are related to the waiting times due to the stops between the several phases of the procedure or stops by documents lacks. In the transportation, or logistics fields, projects must be submitted to several entities, and the same process comes and goes the same entity several times along the way, which some of them are unnecessary.

Also, many of the approved projects do not fully comply with the regulations in the different stages, leading with wastes' increment, such as the previously mentioned overproduction. Furthermore, human resources and technical conditions lack leads to a deficiency in the follow-up of the approved projects, combined with the employees' stimulation and creativity lacks. The wastes lead to the waste of skilled employees, which are covering areas that could be covered with another kind of employee, more suited to the duties to be performed.

Therefore, the identified wastes highlight the needs to improve the PROFIR structure process, which can be obtained by acquiring an adapted Lean thinking culture through the implementation of a Lean agent to promote the Lean thinking strategy, in the different phases and processes that PROFIR includes. As the widespread information evidenced, the Lean agent is emphasized; in the PROFIR case, it is a selected individual in functions on the projects in hands, to take specific actions, and to cultivate the Lean thinking culture.

The Lean agent can be externally contracted, in which the main functions are focused on the customer's value, process value, flow value, chain value, and continuous flows. Also, the Lean agent's aims for the projects' perfection, concerning strengthening Lean initiatives and promoting Lean thinking in the different phases and areas that comprise the project.

## **4.2 PROFIR Improvement Proposal**

Based on the identified wastes previously, the current section proposes an improvement based on the promotion of Lean thinking implementation in the different phases of the PROFIR process. This improvement proposal is based on considering a Lean agent in the PROFIR structure process; in detail, a selected individual to take specific actions about the Lean thinking culture in all the steps.

Therefore, the proposed industrialization improvement process in PROFIR case study, it is composed of three phases and might occurs in three periods, monthly, quarterly, semi-annual or annual, where the idea is to have the shorter execution time to avoid the wastes, and it is detailed summarized in Figure 5, showing the PROFIR three phases structure, while Figure 6 shows the improved PROFIR value stream mapping process.

In the first phase, the formation of the Lean team is considered (Kovacevic, et al., 2016), where the Lean agent is indispensable in the industrialization process to take Lean thinking actions (Vlachos, 2015), i.e., identifying the wastes, the customers' value, the flow value, applying the pull production system and making continuous improvements.

The second phase is based on projects' preparation with the processes already registered and legalized. These projects are then evaluated considering the consumer satisfaction variables (Manfredsson, 2016), including consumers' needs survey, the quality of service according to the standards, the projects' feasibility through the economic feasibility study, to verify the projects' financial capacity and their implementation as a key factor in the decision-making process (Gan, et al., 2017).

Moreover, in the second stage, it is necessary to evaluate the projects' operational feasibility conditions, in terms of material resources and human resources, and, finally, it is necessary to analyze the projects' technical reliability, which evaluates the involved projects' technologies requirements. Finally, in the third phase, a market study is carried out considering the penetration and performance of the projects' final products, as well as the materials' supply strategies required by the projects.

Furthermore, in the third phase, and considering the projects' preparation stage, the updated process in the process considers the constant technical and economic assistance, the equipment installation and maintenance plan, and the projects' continuous improvement process. The improved PROFIR value stream mapping process presented in Figure 7, which represents the culmination of the entire and improved PROFIR process considers the operation of the solutions found to minimize, or even mitigate, the wastes detected in the current PROFIR version, always taking into consideration the Lean thinking values, interconnecting all the processes involved through a continuous flow.

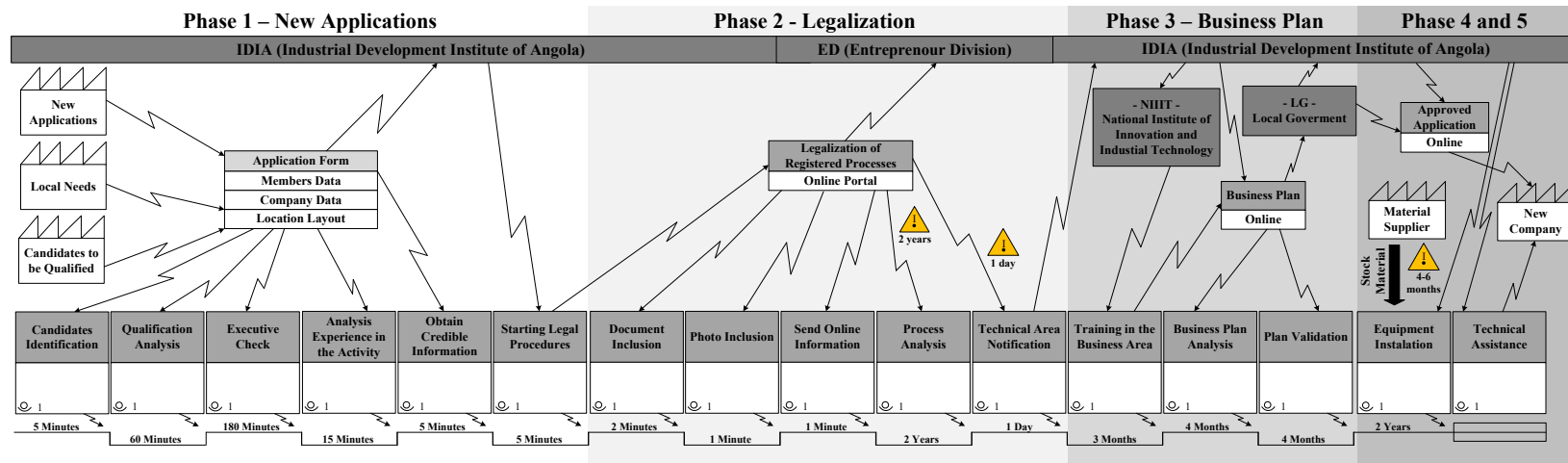
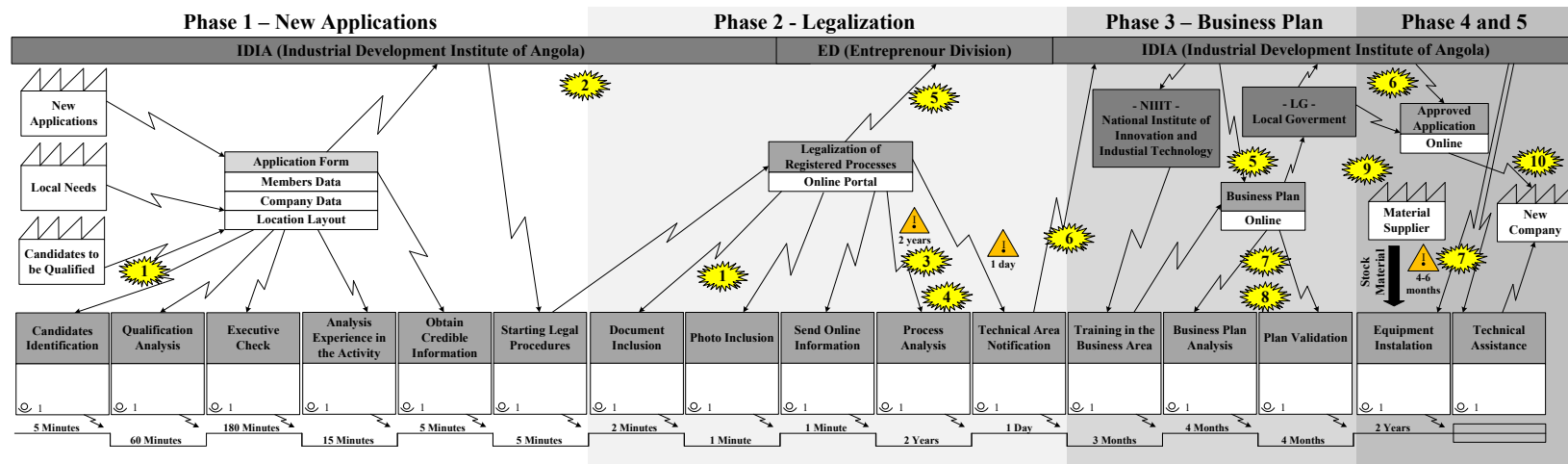


Figure 3. PROFIR value stream mapping process phases' details.



1- Unnecessary projects' movements in the phases; 2- Too many phases; 3- Projects' accumulation; 4- Specialist working on non-matching areas; 5- Projects sent to several entities for approval; 6- Waiting/Stopping due to phases changes; 7- Long processes; 8- If the step is done by the same professional, the time can be saved; 9- Need to diversify suppliers to minimize the need for stock time; 10- Overproduction (several projects awaiting for implementation).

Figure 4. Value stream mapping analysis in PROFIR's structure: Improvement opportunities.

Table 2. Identification of the current PROFIR wastes.

Waste Types	Types of wastes on the industrialization process
<b>Overproduction</b>	Many of the concluded industrialization projects (short-term and medium-term) are waiting for their effectiveness implementation.
<b>Defects</b>	Excessive information, excessive activities, long processes.
<b>Waiting</b>	Stops are due to the changes in the procedure phases; Stops are due to the documents' authorization processing.
<b>Transportation</b>	Submission of projects in several entities for their approval.
<b>Inappropriate processing</b>	Compliant with the regulations according to the steps and to the documentation process.
<b>Inventory excess</b>	Projects accumulation due to the raw materials lack; Human resources conditions lack to follow-up raw materials.
<b>Unnecessary movements</b>	Unnecessary projects' movements passing through various phases.
<b>Non-use of employees' creativity</b>	Specialists doing work in non-compatible areas with their training.

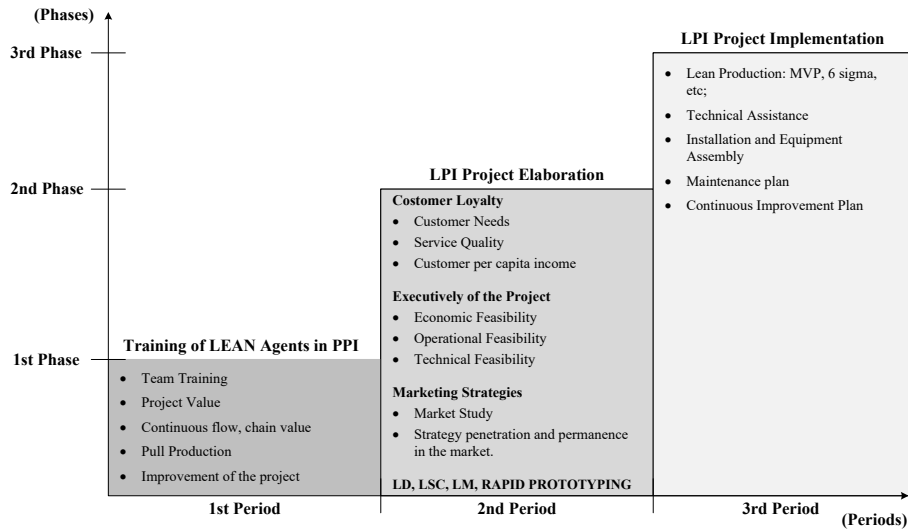


Figure 5. New PROFIR improvement proposal.

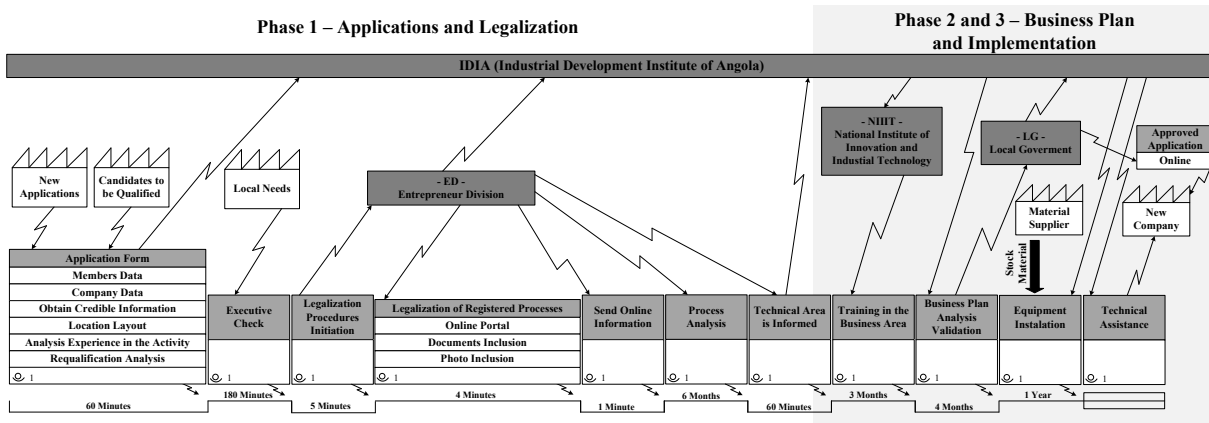


Figure 6. Value stream mapping results proposal for the updated PROFIR structure.



## 5. Conclusion

In this work, the adoption of Lean thinking is presented as one of the ways to eliminate the wastes from the projects' conception to the implementation, considering the PROFIR structure, responsible for the industrialization process in Angola. The proposed implementation of Lean thinking in the industrialization process consisted of the PROFIR activities and resources optimization, starting with the identification and subsequent exclusion of the wastes from the project creation phase until the final projects' implementation phase.

The developed solution, considering VSM tool proposes an approach with a determined sequence, resulted from the current industrialization process stage in Angola, and later, in the proposal of an updated approach, aiming the wastes' mitigation that was detected in this work, and also introducing in PROFIR structure the principles of Lean thinking guiding.

The proposed approach has led to the improvement of the industrialization process in Angola where the Lean culture is still only taking the first steps and discussed in this work. The application of Lean thinking in the industrialization process will allow the Angolan industry-based on Lean principles and tools, to promote organizations' competitiveness that will lead to the requested economic growth and the desired organizational sustainability.

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