

# The Importance of the Programmable Logic Controller “PLC” in the Industry in the Automation Process

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**Abstract** - *It is human nature to always seek to improve the processes of its activities, in which process automation has enabled industrial automation to make a major technological advance. In view of this, the paper aims to describe the importance of PLC in the industry in the automation process and its role during the fourth industrial revolution. Most industries are responsible for most of the percentage of GDP (Gross Domestic Product) movement in industrialized countries, at a time when companies seek to maximize their processes in an increasingly competitive market, always having to adapt any and all procedures with a view to technological advances, making a particular industrial process cleaner, which is of great importance to maintain the consumer market. The result is the benefits of using the PLC, decreasing hard work, repetitive work and jobs that brought major problems to employee health. Moreover, the implementation of the PLC has made this technology easily accepted by the job market, bringing optimization, increased productivity, generating more profits, making a highly profitable investment. Therefore, the PLC is responsible for the major technological breakthrough and will be part of industry 4.0.*

with its innovations, and ratifying the process of capitalism formation.

Before the industrial revolution, the productive activities were done manually and by hand, using simple machines, most of the time being a single craftsman responsible for the entire process, from obtaining raw materials to the end of the product for commercialization. All this work was done in the craftsman's own house, where there was his workshop and where professionals mastered all stages of the production process.

The first industrial revolution began between 1760 and 1840, emerging through the creation of railroads and the technological invention of the steam engine which revolutionized industry by starting mechanical production [1].

Also according to [1], the second industrial revolution began at the end of the nineteenth century, entering the twentieth century and, through the creation of electricity and the production line, provided mass production.

The reason of the second industrial revolution was the invention of combustion engines, the creation of hydroelectric plants, the discovery of oil, among others. This set of discoveries favored flexibility in industrial activity, the second industrial revolution revises the focus on following large industries.

The third industrial revolution, also known as the Informational Revolution, had its beginning in the twentieth century, with the emergence of electronics, starting from the industrial modernization that occurred after World War II. Robotics featured prominently in this revolution, as well as information technology, telecommunications, among others, where studies of these areas have changed the entire production system, aiming to produce more, in less time, applying these new technologies.

Thus, technological developments in the control system and industrial automation processes have always focused on improving the process in an automated manner, eliminating or minimizing problems that occurred in the previous process. In every activity that implements a new process, the

**Key Words:** automation, industrial, technology, innovation.

## 1. INTRODUCTION

At the beginning of our civilization the industrial procedures were done completely by hand, requiring operational labor, in any condition and / or activity to perform it. The first step for process control systems was deployed in pneumatics, installed close to the objects to be controlled, since then industrial automation and process control that evolving fast, undergoing technological restructuring, increasingly generating advantages in their use.

The word revolution characterizes a sudden and radical change in our social organization where revolutions occur as new technologies and new ways of understanding the world cause a major change in social structures and the economy [1].

The industrial revolution resulted in a time of huge technological advance, beginning in England in the second part of the seventeenth century, affecting the whole planet

goal is to obtain more and other advantages, most of the times, aiming at higher productivity.

Most industries account for most of the percentage of GDP movement in industrialized countries. At a time when companies are seeking to maximize their processes in an increasingly competitive market, there is always a need to adapt any and all procedures for technological advancement. Making a particular industrial process cleaner, which is of great importance to maintain the consumer market.

Automation is increasingly used in our daily lives, especially in the industrial environment which has been expanding its use to improve various processes. According to [2], automation is the use of programmable logic controls and mechanized equipment to manually replace operators 'activities that involve the need for human decision and command'.

This controller is a computer with characteristics similar to the conventional computer, with the application dedicated to process automation in general [3].

There are countless equipments that belong to the framework of direct and indirect automation, where the PLC stands out. This equipment emerged in the 1960s, where by the end of the decade, according to [4], the controllers at that time were huge, taking up a lot of space, roughly equivalent to a cabinet, using electromechanical relays with several kilometers of wires. Especially when there was a need to change its mode of operation, a great job, because of the physical change of materials.

The programmable logic controller was developed from difficulties encountered in the automobile industry, aiming to succeed relay control panels, becoming one of the most used equipment in the implementation of systems automation. Over the years, software and hardware aspects have been incorporated into the original idea, making PLC one of the main industrial automation solutions [5].

A PLC is an industrial computer that can perform control functions from a programming, this programmable logic controller greatly reduced the necessary wiring connected to circuit control to a conventional relay, with ease of programming and installation, high speed control, network compatibility, defect checking, and high reliability [6].

Also according to [6], the PCL is designed for the organization of abundant inputs and outputs, extended temperature ranges, protected against electrical noise and reluctance to vibration and impacts, it is essentially a digital computer designed for machine control but unlike from a conventional computer, it is designed to work in an industrial environment, equipped with unique input / output interfaces with control programming language.

In a first moment the PLC was used to replace the logic relay, but after its increasing evolution through a range of functions, it began to be used in much more complex applications.

The PLC is a microprocessor that was made for the industry with versatile features in its programming environment. It has the logical, mathematical, integer and binary numbers, floating point, trigonometric, arithmetic, transport, data storage, comparison, timer, count and sequence [4].

Thus, according to the same author, he explains that the basis of PLC programming is the analogy of electrical contacts, where the main language of the PLC is ladder, known as the language of contacts. The PLC is no different from another digital system, which works with receiving digital words.

Thus being born one of the most versatile and user-friendly equipment in the industrial environment, which is constantly improving, constantly seeking efficiency, diversifying its application in the industrial sector and its applications, reaching an estimated world market of 8 million dollars.

This article aims to present the importance of PLC in the industry, given the automation process, conceptualizing the evolution of PLC, analyzing in which situations it should be used, and highlighting its importance in industrial evolution.

## 2. MATERIALS AND METHODS

Methodology is understood as a subject that consists in studying, understanding and evaluating the various methods available to create an academic research. At a determined level of applicability, the methodology examines, describes and evaluates study methods and techniques that provide the gathering and verification of information, aiming at forwarding and solving problems or research questions [7]. A bibliographic research was first developed, according to [8], which seeks to explain a problem through published theoretical references, so as to have a basis and substantiate the project.

Descriptive research was also used, which observes, records and analyzes phenomena or correlates facts [8].

## 3. RESULTS AND DISCUSSION

The Programmable Logic Controller (PLC) can also be called in some places Programmable Controller (CP), commonly known in the industry as PLC (Programmable Logic Controller).

The first programmable logic controller began to emerge when in the auto industry it began to need the assembly line with greater dynamics. When Bedford Associates appeared, it decided to come up with a solution for General Motors, it was

a device that would do the most diverse operations at once, and was easy to program. Getting known as MODICON (Modular Digital Controller) [4].

According to the same author, in the 1970s the PLC underwent a redesign, being attached to a CPU and a processor. In 1973, when the communication between PLCs began to take place, receiving the name of Mod bus, and from that moment the technological evolution of PLC began, now being able to control remote machines and to use analog voltages for sensors.

In 1990, IEC 1131-3 came standard, which standardized languages internationally. With the IEC 61131-3 standard, the PLC is programmable in 4 modes, with the most commonly used ladder, block diagram, instruction list and structured text, where these four (4) modes are suitable for most manufacturers.

According to the Brazilian National Association of Technical Standards (ABNT), the programmable logic controller (PLC) is a digital electronic equipment with software and hardware compatible with industrial applications.

According to the National Electrical Manufacturers Association (NEMA), the programmable logic controller is a digital electronic device that uses a programmable memory to store instructions and to implement specific functions, logic, sequencing, timing, counting and arithmetic, manipulating through inputs and outputs, various types of machines and processes. In a historical analysis the programmable Logic Controller can be divided into five generations:

In the 1st generation of the PLC, the programming used was Assembly with the need for the programmer to have complete knowledge of the hardware, as well as its electronic components; In the second generation, the mid-level languages appeared with the creation of programs that converted to the machine language, the inserted program; In the 3rd generation, PLCs now display a programming input enabling the keyboard or handheld programmer to be connected; Incremental 4th generation with an input for serial communication, allowed its programming to be done directly from the computer with this evolution it was possible to test the program through the software installed on the computer, even before transferring it to the PLC; The 5th generation has a standardization of its communication protocols to simplify the interface with the various manufacturers and supervisory systems.

The PLC is basically classified by its number of inputs and outputs. The first classification is the nano and micro PLCs, with up to 16 inputs / outputs, regularly composed of a single module. Midsize PLCs feature up to 256 inputs / outputs, which can be a single basic module or expandable. The large ones have up to 4096 modular inlets / outlets.

No common computer can be used to perform the function of a PLC, and the reason is the easy response due to the nature of the work and the different factory setting. Distinctly from conventional computers, the PLC since its inception was designed to work in an industrial environment, subject to the most diverse types of agents harmful to common electronic equipment.

Despite the wide range and variations of models and types of PLCs, all have a common structure, the basis of it. The power supply is of great importance to the PLC, it usually needs to work all day, and any kind of variation or instability in its power can generate a disruption in the production line causing losses.

CPU and memory should be set as required for work and logical processing which will depend on the work complexity of the machine. Its inputs and outputs, which need more if they are too many equipment to be connected to the shop floor.

According to [9], the PLC acts through its outputs, by the program recorded by the user in its memory, the PLC output variables, valve actuation, motors, light indications, among others, depending on the process.

Second [10], the PLC can be programmed in 5 ways, which are 5 different programming language types having consensus among current manufacturers (Table 1).

**Table -1:** Types of Languages and Their Main Features.

Languages	Types
Textuals	I. IL – Instruction List.
	II. ST – Structured Text.
Graphic	I. LD – Ladder Diagram.
	II. FBD – Function Block Diagram.
	III. SFC – Sequential Fuction Chart.

**Source:** Adapted [10].

The PLC is a very important equipment in the industrial environment, in relation to automation, but the PLC works in conjunction with other equipment. The equipment that is used with the PLC is usually the sensors and actuators [11]. PLC is the main control component of an automation process which works in conjunction with other field components, which aim to inform the circumstances of the variables they contain in the process. So a triggering action can be performed or shutdown through its outputs.

According [12], sensors are devices that aim to inform the PLC when a state change occurs, either as permanent or temporary variation, provided it is a state change. There are a huge range of sensor types and models, the most common and most commonly used in the industrial environment are: level sensor, pressure sensor, presence and position.

Actuators are components capable of changing the control variable, they act upon receiving a command signal from their controller in a controlled process. As well as sensors, actuators also come in many types, the most widely used being valves and cylinders, pneumatic and hydraulic, relays, stepmotor motors, synchro, servo motor, and solenoids.

According to [13], actuators are equipment that can change a variable that is controlled by a signal emitted by the PLC, acting on the controlled process, which can be pneumatic valves, hydraulic valves, relays, cylinders, motors and others. When using a PLC, a well-defined requirements definition and process control must be done, bringing great benefits when used correctly. PLCs can be used in a wide range of processes and applications, which make use of open sequencing, relay closing, and solenoid valve feeding, it exists to automate processes with sequence, interlocking, process control, it is widely used in manufacturing automation as in continuous process areas such as electrical and building. At the time of the creation of the PLC, its objective was to replace the large inflexible electromechanical relays that had to change all their contact and interlock logic when the process had to be changed, which was a great waste of time. They had a very high operating cost, they took up a lot of space, maintenance when needed was slow, and fault-susceptible electromechanical parts.

The advantages are that the PLC can bring great profitability, as it enables the use of many types of machines, can be applied different and specific mass actions, reducing the cost of operation. In an industry that does not use the PLC, it will need to have an individual controller per machine, individually configuring each one, when all these activities are concentrated in the PLC, all adjustments can be made from it giving agility to all production.

The great flexibility that the PLC carries with it, changes required before its arrival, were time consuming and costly, with the PLC it can be operated by a single person, controlling several machines at the same time.

Space optimization and security with high reliability, especially in configuration and result analysis processes, which are more accurate and reliable from an automated switchboard.

With the PLC, productivity increases because there is no need for a large number of intermediaries in connection with the machinery, operating in a small space and being able to take advantage of new equipment and its easy reconfiguration, the industry gains in cost savings by reducing processes, freeing up employees for other, more necessary activities.

Programmable logic controllers are primarily applied where machines are running, in the automotive, food, energy, process and other industries (Table 2).

**Table -2:** Programmable logic controller and its different applications.

PLC in the Industry	
I.	Control of process variables such as flow, pressure, temperature and level.
II.	Belt systems and material handling.
III.	Speed control and other functions.
IV.	Chemical process control.
V.	Dosage of products for the packaging process.
VI.	Control of electric motors, pumps, machines of all kinds.
VII.	Positioning of materials.
VIII.	Inventory control.
IX.	Temperature control.

**Source:** Own authorship (2019).

The PLC can be included to improve the process of any industrial activity requiring controlled parameters.

The importance of PLC for the industrial sector is given by the great benefits in which its implementation provides, from its processes, increasing efficiency, to improvement in the final product, and can mean survival in the market, maintaining competition.

A major highlight of the PLC is the competitiveness it provides to the labor market, reducing labor costs through equipment, reducing physical efforts previously needed, lowering the value generated by faster-responding inventory. PLC offers implementation advantages that easily exceed your purchase cost.

Compared to industrial computers, which are also used in industry equipment, the PLC is still the best option, because of its higher speed and robustness, the possibility of incompatibility with machines using the PLC is lower, presenting better measurement performance in pasta.

The success and widespread use of PLC in the industrial environment speaks for itself, its large amount of benefits becoming essential for industries seeking competitiveness and their maintenance in the market.

Industry 4.0 is the fourth industrial revolution, and it comes to further reduce its production costs by increasing its production, this concept encompasses the latest technologies available in the world, it aims to transform the industry into "smart factories".

According to [14], the great potential of industry 4.0 lies in the ability to further accelerate decision making and adaptation in industries. Thus the PLC will continue to be of great importance with the arrival of industry 4.0, where it is already widely used in supervisory systems (SCADA), which aims to monitor machine parameters at all times.

According to Azevedo [15], the PLC should only go through an improvement in industry 4.0, which will eliminate the need to purchase high cost Human Machine Interfaces (HMI).

It will be aligned with the Internet of Things (IOT), the industry's premier 4.0 concept, which consists of networking all embedded electronic devices. All PLCs have the possibility of ethernet connection, and have protocol for data exchange with equipment and systems of other manufacturers.

### 3. CONCLUSIONS

After a survey, it was realized the importance that automation has in human life, always seeking improvements in their lifestyle, facilitating the different branches of activities. In an attempt to solve the problem of industries with electromechanical relays, one of the most important equipment for technological advancement was created, which is essential for industrial automation, the PLC.

The benefits of using the PLC go far beyond what was thought of in its creation, being the replacement of relay panels, resulting in a range of improvements in all industrial environments, such as the quality and space optimization that is used.

The insertion of the PLC in the industrial environment, brought benefits to all, reducing hard work, repetitive work, which brought major problems to the health of the employee.

It can be concluded that the PLC was created in the 60's to replace electromechanical panels, is responsible for the great technological advance and will be part of industry 4.0.

The accomplishment of the study contributes to the professional of the area, deepening the knowledge about the determined subject for agenda, knowing better about the subject of its area of operation, knowing terms that are part of its experience.

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