Cost Reduction in Soybean Production Through Automation of the Water Capture System Using the M2M Communication Protocol

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Abstract— *Waste water is a much debated problem, for various reasons such as economic, technological, political and political causes, involving different stages of production. This article has as main objective the analysis of the automation of the system of abstraction of water through the communication protocol M2M in a food company of the state of Minas Gerais - Brazil. The study is based on production line data before and after the application of the tool. The choice of the process of propitiate a better quality of life for the users is justified by the modernization of the relationship between man and machine. Analyzing the obtained results, it is concluded that the main one of the work was also prosperous, having been possible the implantation of M2M data protocol of Industry 4.0 and its branch in the process of production and reduction of cost.*
Keywords— *Industry 4.0, M2M, Soybean juice production.*

I. INTRODUCTION

This article describe the concepts of Industry 4.0 and the steps taken to implement the procedure, through studies and results obtained in a company of the Industrial Pole of Minas Gerais - Brazil. presents an automated system of water abstraction in the production of soy juice in the plant through the M2M (Machine-to-Machine) communication protocol.

Before without this information of water levels in the reservoirs, the company stored water in trucks kite generating unnecessary costs. Now with the M2M communication protocol providing the necessary data in real time, the inventory was excluded from the cost planning and the purchase is only carried out in cases of production above the capture capacity.

The benefits achieved with automation are clear, real-time decision-making by production engineers is more effective because data capture, use and storage are available simultaneously, so the predictability of water purchase becomes decisive element in the reduced cost of production.

In this direction, the general objective is to analyze the efficiency in the implementation of the automation system that communicates through the M2M protocol in a food business. In addition, its specific objectives were: Describe the implementation process of the M2M communication protocol; To understand how the process of reducing the cost of water abstraction for soybean juice production through the M2M communication protocol.

II. METHOD

The research presented here has as basic assumptions to describe about the industry 4.0, the 5W2H and PCDA methods; the M2M communication protocol and the soy juice manufacturing process, as well as other concepts within this contextualization, themes that are present today.

According to [1], the fourth industrial revolution has started and firms are running out of time to be part of Industry 4.0. The industry scanning process includes a physical network with connected devices, tools and platforms with features that involve technology to share intelligence with each other and communicate with the outside environment and with people.

2.1 METHOD 5W2H

5W2H is a methodology used to elaborate action plans, being objective and simple in orientation to action, being very applied in Business Analysis, Project Management, Strategic Planning, Elaboration of Business Plans, and in other management disciplines. The main purpose is to establish that all activities to be carried out, be programmed in an objective way, enabling the execution in a totally organized way.

According to [2], the 5W2H tool allows to detect the most relevant routines of the project, process or even of a production sector. It also makes it possible to verify who is who within the organization, what it does and why it performs such activities.

2.2 PDCA METHOD

The PDCA Cycle is a management system widely used by companies. According to [3]. Generally represented as a circle, formed of four stages which represent: "Plan" - to plan; "Do - do; "Check" - check; and "Act" - actuate or adjust.

In an interesting approach, [4] approaches the use of quality tools in the food production process and the execution of audits as a way of maintaining and improving the system.

According to [5], the PDCA Cycle is a tool used for the application of process control actions, such as establishing the "control guideline", quality planning, maintenance of standards and alteration of the control guideline, and to make improvements.

2.3 M2M COMMUNICATION PROTOCOL

The M2M is a protocol of communication between man and machine, with the purpose of controlling production processes remotely, using instruments of last generation, that internally have converters of signals that use its protocol for data exchange, which allows the control in real time of all the equipment that are interconnected in a communication network through a pair of cables.

According to [6], M2M presents a flexible scope and with some defined limits. It describes M2M as follows:

The role of M2M is to establish the conditions that allow a device to exchange information (bidirectionally) with an application over a communication network, so that the device and / or application can act as the basis for this exchange of information [6].

The M2M communication protocol is transmitted by an equipment connected to one or more machines, forwarding information in real time. The data is collected and controlled by the worldwide ETERNETH computers network. Unlike the process of telemetry, where everything is done wireless, the M2M system can be used chips, drivers and among others, diversifying according to the priority and goal to be achieved by the company.

[7] Acompanhado por uma tentativa de classificação de pesquisas existentes sobre M2M, propõe uma exposição de desafios e oportunidades de pesquisa aberta que abrangem as diversas facetas da comunicação M2M. [8] Destaca a aplicação do m2m na aplicação da internet das coisas, aborda temas em que os usuários relutam em confiar no sistema centralizado para suas informações privadas, garantir a privacidade sem um sistema confiável é uma propriedade essencial do sistema de reputação, um sistema de reputação descentralizada que preserva a privacidade é proposto; o sistema garante privacidade e correção em modelos de ameaças padrão.

[9] em uma pesquisa sobre ameaças e soluções de segurança da informação para comunicações Machine to Machine (M2M), destaca uma análise detalhada das ameaças e soluções de segurança da informação para comunicações M2M; desafios de pesquisa e questões de pesquisa aberta em comunicações M2M; e uma revisão do padrão oneM2M. [10] em seu trabalho tecnologias de comunicação sem fio máquina a máquina para a Internet das coisas: taxonomia, comparação e questões abertas, pretende organizar as abordagens e tecnologias M2M existentes em uma estrutura consistente que forneça uma visão aprofundada das principais tendências, direções futuras e questões abertas.

[11] propõe novo protocolo de consenso de confiança e sistema de avaliação de confiança baseado em blockchain para serviços de aplicativos M2M. [12] em seu trabalho fornece uma revisão abrangente do potencial robótico que é previsto pelos pesquisadores na criação de uma futura fábrica de alimentos. Destaca que configuração atual de manuseio e embalagem de alimentos é limitada em capacidade e produção devido ao processamento manual.

2.4 PROCESS OF MANUFACTURE OF SOY JUICE

Soy juice is a beverage produced from soybeans, and it adds flavor essences planned by the company. The juice is derived from soy milk, which is a good source of protein and fiber, easily digestible, containing less fat than cow's milk and cholesterol-free. It is very consumed by people with high cholesterol, by the juice does not contain cholesterol, by vegans, people intolerant to lactose, diabetics, by possessing low content of carbohydrates. In making this beverage the soy beans are inserted in water and ground. Then the dough is cooked to destroy the toxins that make it impossible to absolve the proteins. After fermentation is filtered and soy milk is obtained. After the feat is inserted the essence of varied flavors.

III. EQUATIONS

The research used a qualitative approach, since there was a need for interpretation of the phenomena and attributions of meanings.

3.1 PARTICIPANT

The case study happened with an employee of approximately 38 years of age, who works in the area of Engineering and Maintenance. The same experienced the process of implementation of the project, from the automation of the water system, whose new technology interconnected via optical fiber and M2M protocol. All data from the water collection and reservoir system were

concentrated in a central PLC (Programmable Logic Controller), and in this central PLC, a closed-loop PID (Proportional Integral or Derivative) control logic was placed, which from the consumption of the final customer of the soybean juice sector, accelerates or decelerates the water pickup pumps.

3.2 TECHNIQUE FOR DATA COLLECTION

An interview with open questions was used. According to [13], the interview is configured as a conversation between two people, with pre-established purposes. It is still a very important form of communication, giving a unique meaning to verbal language.

By the possibility of interaction between the interviewee and the interviewer and depth about certain subjects, the semi-structured interview was chosen. For [14], interview allows the interviewer to get closer to the interviewee and favors a much closer and more affective relationship between both parties, thus allowing the collection of sensitive and complex issues involving the participant.

As part of this technique, an interview script was prepared previously, whose questions were directed so that through the participant's speech it was possible to answer the research questions.

3.3 PROCEDURE

The research was carried out in the first half of the year 2019. Through the implementation of the automation of the water system from the interaction of M2M data in the soybean juice manufacturing process, in a food company. In the dialogue that took place between the parties, a semi-structured interview was conducted, with open questions directed, the interview was recorded, and later transcribed, to facilitate the analysis of the data.

IV. RESULTS AND DISCUSSION

From the data collected in the interview with the collaborator, the description of the implementation of the M2M protocol was made, as well as, from the reports, as well as through tables, demonstrates the effectiveness of the protocol of communication of data M2M, in the reduction of cost in the manufacture of soy juice at the company surveyed.

4.1 IMPLEMENTATION OF THE M2M PROTOCOL

After reports of workers concerning the difficulties encountered in their functions, the PCP (Production Planning and Control) sector together with Production and Development Engineering, went to the market to find technologies that would help them to maximize water abstraction from the groundwater , due to an excessive expenditure and several interruptions in the production line, whose raw material depends exclusively on a large reservoir of water.

Thus, production engineers came to the conclusion that they needed a real-time information system to aid in decision-making, quantity production and water supply.

In this context, a joint study of the Quality, Engineering and PCP sectors was carried out, and they concluded that they needed to change the existing technology in the company's electrical panels, since the same one came from industry 2.0 (production in mass-technology totally electric) did not have autonomy of operation, that is, the water intake was only activated when the reservoir was low and later, it activated a sensor in the bottom of the water reservoir thus losing two (02) of abstraction to each reservoir.

In this perspective, the main objective of the company was to switch from the technology of panels previously based on Industry 2.0 to Industry 4.0, where the equipment communicates in real time through an M2M protocol.

Deployment occurred by the following steps:

Step 1 - All existing technology was changed, which consists of the implementation of PLCs and signal converters with the communication capability via Ethernet (M2M) in the electric control responsible for the activation of the pumps in both the wells and in the boxes.

Step 2 - Afterwards, the electric buoys were moved by a pressure sensor in the boxes. This allows the immediate sending of the boxes ($180m^3$ and $360m^3$) through the signal sent via optical fiber. These sensors with the communication capability via Ethernet (M2M) can detect a change in millimeters (mm) at the level of the boxes. Previously it was only possible to check the full box signal and the empty box.

Step 3 - Next, the flow sensors were installed at the water outlet for the final sectors (consumption) with the communication capability via Ethernet (M2M).

Step 4 - Installation of an optical fiber was performed by connecting all panel converters, thus closing an Ethernet (M2M) communication network and interconnecting in the central computer.

Step 5 - Lastly, Rockwell's Software Studio 5 was installed on the central computer to receive all data from the network and connect to the supervisory control system of the company.

It is noteworthy that in the company surveyed, the experience and experience of some employees who know about the reality of the work, and for detecting some difficulties, sought the engineering service for possible solutions to the problems. In this perspective, the

company sector responsible for the implementation of projects, sought ways to solve the problem, and knew the benefits of the M2M protocol. So, they decided to deploy it without even applying a tool that accurately presented a diagnosis, so they only relied on the look of collaborators who know about the process.

In this context, looking from the perspective of engineering, even as a suggestion, if other companies decide to walk in this direction. For the automation of the water abstraction system through the M2M communication protocol, it is recommended that although it considers the observations of employees who act directly in certain functions, understanding and not demeaning, since it is understood that they really know about their work, its function, however, for the benefits and veracity of the results, that the companies realize the application of the PDCA cycle tool and the 5W2H method. This can be applied in stages, and is an instrument capable, along with other quality tools, to detect the possible root causes at various stages of the information gathering process, always taking into account the provenance or effective quality of the procedure within any organization. job.

In this sense, what is proposed for companies, above all, is to be applied an effective management tool, to promote and facilitate means of implementation of projects thus collaborating with the environment and above all in reducing costs.

4.2 EFFECTIVENESS OF THE M2M DATA INTERACTION PROTOCOL IN COST REDUCTION.

It was realized the need to change the technology of the panels before, based on Industry 2.0, which was an outdated and strictly electric technology, which did not allow the control of the wells concession, let alone supply 100% the demand of the production in the consumption of water for Industry 4.0. Thus, new paths were sought in 2017, because of the growing demand for production, which resulted in a high consumption of water. An obstacle occurred because the control over the concession presented difficulties for the water economy to occur, since the company acted in approximately sixteen hours of suction, for twenty-two days a month in which they were released for suction.

It was noticed that the water box buoys made it impossible to use the well efficiently because it was deactivated until reaching the minimum level of water, only activating the pumps of the wells with the level reached. However, there was the big problem, since the permitted suction flow of the wells was 39m³ and the production consumption was 90m³, when the wells were activated, the level was too low to produce, in a dilemma,

or stopped production or stocked water, there was an unnecessary cost.

Thus, with the implementation of the project in which the upgrade of the panels and sensors were present, everything connected via optical fiber to a central computer with the Studio5 software, being autonomous and with PID logic in closed loop. The output water flow sensor for the production commanded real-time pump speeds of the 180m³ box, as well as 360m³ box suction pumps, and also commanded the suction pumps from the wells.

In short, the closed-loop PID makes suctioning of the wells only happen when the end customer is using, and at the flow rate he is using. It is emphasized that it is necessary that the water boxes always stay at the maximum level or near to it, so that the water is made from the consumption. With this, it is pertinent, visible the effectiveness of the project, since since its implantation not a single liter of water was bought and also the limits of the granting, imposed by the Brazilian Institute of the Environment have never been broken. The tables below demonstrate precisely the decrease in expenses.

Table 1 – Comparation Buy x Production

	BUY WATER X PRODUCTION JUICE			
Year	Year 2017		Year 2018	
MONTH	BUY WATER IN M³	PRODUCTION JUICE M³	BUY WATER IN M³	PRODUCTION JUICE M³
jan	915	12500	0	140000
feb	920	13500	0	155000
mar	800	12100	0	155000
apr	700	11950	0	100000
mai	725	12050	0	130000
jun	830	12150	0	145000
jul	810	12180	0	155000
aug	750	12060	0	120000
sep	800	12100	0	120000
oct	920	13500	0	150000
nov	680	11800	0	145000
dec	650	11600	0	160000
TOTAL	9500	147490	0	1675000

The table 1, shows that since the implantation, there was no purchase of water, reducing the expense, there was also increase in the production of soy juice.

V. CONCLUSION

Among the various possibilities, the M2M communication protocol presents itself as an investment that collaborates and can change the culture of water waste. The automation of water systems via M2M protocol, an effective tool in cost reduction in the production of the company surveyed. It was noticed that

the implantation provided in its installation, not only the reduction of cost, but also, it generated information in real time facilitating, thus, the decision making of the engineering sector. The M2M communication protocol was a useful tool for point-to-point communication in the sectors and the sending of data.

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