A new approach on applied Information and Automation Technologies looking for industrial processes sustainability.

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Abstract: - This research intends to emphasize potash significance to humanity due to its impacts when applied as fertilizer on crops for producing food and detailing of process methods for its obtainment. Furthermore, main sustainability indicators and international models of reports considered by major potash producers were presented and analyzed. Aiming to contribute for a cleaner production in the path of science and technology, this paper presents TAIMISEP methodology, acronym for Automation and Information technologies methodology for improving sustainability indicators on potash extraction. TAIMISEP implementation aims to increase productivity and potash production, as synergic result from reducing electrical energy demand and environmental impacts mitigation. TAIMISEP methodology incorporates and adapts premises from methodologies: MAPEAS, Züge (2014) and MPCTAI, Silva (2013), integrated with research and available data on technical literature.

Key-Words: automation, sustainability, potash extraction and fertilizers production.

1 Introduction

According to Rocha and Pereira (2011), the relation between population and natural resources reemerges nowadays as a theme of fundamental importance. Brings up an old debate that permeates the theoretical basis of demographic science and population geography: the relation between population growth and natural resources [1].

For increasing agricultural productivity techniques were developed considering the use of fertilizers, which its formulation (NPK) includes potassium element. The global demand has doubled between 1973 and 2010, according to IFA (International Fertilizer Industry Association) reaching the amount of the order of 4.3 million tons per year (Mtpy). Specifically verifying potash scenario, world production will reach the level of 3.3 Mtpy by 2017, but will not be able to meet the expected demand of 5.2 Mtpy.

The use of new IT and AT technologies in the design and manufacturing processes takes decisive importance in sustainable production, reducing energy consumption and waste generation.

2 Potash Challenge, Sustainability Approach and Methodologies

All production process aims to generate a final product, but also produce waste that must be disposed in a sustainable way.

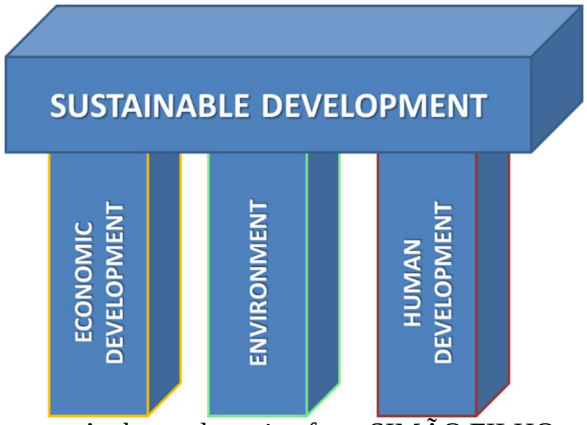
To preserve the environment, must be considered the adoption of sustainability indicators along the production chain, for monitoring energy costs, raw materials and waste production. This control is essential to achieving the sustainability indicators that can generate the identification of process improvements (ZÜGE, 2014) [2].

Also consider that “companies should seek to improve their processes, products, and also provide solutions for disposal of their products when their life cycle ends. In other words, every corporation that wants to continue to compete in the coming decades should incorporate sustainability standards in their decision making processes.” (ZÜGE, 2013) [3].

The concept of sustainability is structured on three (03) pillars: Economic Development, Human development and Environment.

Simão Filho and Pereira (2014) affirms that "In summary, the sustainable development model can be represented as a block supported by these pillars". Figure 1 illustrates the model referenced [4].

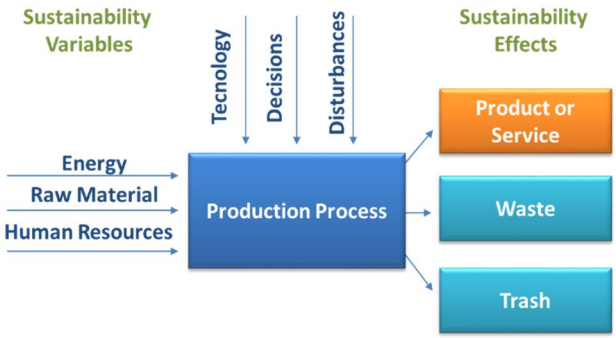
Fig. 1 – Illustration of Sustainable Development Model.



Source: Authors adaptation from SIMÃO FILHO and PEREIRA (2014).

In the search for resources to survive, the man learned to observe nature and try to reproduce, control and transform different events. Therefore, using creativity, he developed tools and artificial processes in order to achieve their goals of transformation and process control (SIMÃO FILHO and PEREIRA, 2014).

Fig. 2 – Block diagram illustrating a general production process.



Source: Züge (2014), adaptation from Pereira (2009)

The corporate procedure for sustainability reporting models that are most commonly used are: Environmental Standard ISO 26000, Bellagio Project, Ethos Institute Model, Global Reporting Initiative (GRI), United Nations Global Compact, MDG - Millennium Development Goals.

The international ISO 26000 series of standards guidelines indicates social responsibility that provides guidance to the public and private sector organizations, based on an international consensus represented by experts from key stakeholders; thus encourages the implementation of best practices in social responsibility worldwide (ZÜGE , 2014) .

The Bellagio project was conducted by the International Institute for Sustainable Development (IISD) and a group of experts and collaborators. The Bellagio project considers four aspects assessment of progress to achieve sustainable development: Vision Establishment, assessment of priorities, definition and effective actions, maintaining continuous culture of evaluation of the practices established at the beginning of the process.

Ethos indicators are a tool for the management of self-diagnosis and planning of social responsibility practices in seven topics: values and transparency, internal public; environment, suppliers, community, customers, government and society.

There are two types of reports that can be chosen according to the size of the company and also allows integration with other models such as ISO 26000, GRI G3 version, the Millennium Goals, the Global Compact of the United Nations and the SA800 standard.

The Global Reporting Initiative (GRI) aims to promote economic, environmental and social sustainability. The GRI sustainability reporting guidelines through, which is widely used by companies worldwide (ZÜGE, 2014).

By using the GRI reporting model , the company starts stating the adherence level to the GRI model was adopted from the three possible levels : A, B and C. If an external evaluator perform validation and conference application of informed report level, GRI levels become: A + , B + , C + . (ZÜGE, 2014).

Table 1 illustrates the largest potash producers in the world, report model utilized and respective revenues.

Table 1 – Sustainability models utilized by major fertilizer producer companies in the world.

Fertilizer Company (NPK)	Report Model Utilized	Revenues (2014, in Billion USD)
Potash Corp	Global Report Initiative (GRI)	7,1
Mosaic Co.	Global Report Initiative (GRI)	9,1
OAO Uralkali	Global Report Initiative (GRI)	2,8
Belaruskali	Corporate model, reference not mentioned	3,9
Yara	Global Report Initiative (GRI)	12,9
OCP	Global Report Initiative (GRI)	11,3
CF Industries	Corporate model, reference not mentioned	4,7
Israel Chemicals	Global Report Initiative (GRI)	6,1
Agrium Inc.	Global Report Initiative (GRI)	2,7
K+S	Corporate model, based in : Global Pact from ONU, ISO 26000 e Global Reporting Initiative (GRI)	4,64

Source: Authors.

Table 1 shows that most of the world's potash producers use the GRI reporting model as a reference for its annual sustainability reports.

2.1 MCPTAI Methodology

Silva (2013) has developed and applied the MPCTAI methodology, which the main objective is to promote the project planning, considering the convergence between IT and AT [5].

The macro steps of MPCTAI Silva (2013) are:
a) Presentation;
b) Definition;
c) Measurement;
d) Analysis;
e) Enhancement;
f) Control;
g) Closing;

Each macro step must be approved and after its execution should be recorded the activities carried out, in order to keep and register and progresses.

Note that the application of MPCTAI is supposed to accomplish previously these two steps:
a) The Enterprise strategy plan (PEE);
b) The strategic plan of Information Technology.

In the beginning of application, it is very important to identify the points that can be a barrier between IT and AT systems, such as for instance a lack of functionality.

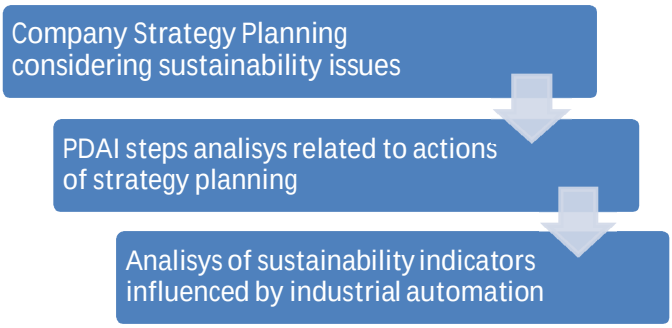
The result of applying the methodology MPCTAI is a hardware and software architecture that enables the convergence of IT and TA based on concepts such as:
a) Practicality;
b) Adherence;
c) Repeatability.

Additionally, MPCTAI enables the convergence in gradually way, since its implementation is done in steps. By this way, organization cultural impacts for implementing the methodology are minimized, while confidence is increased and also guarantees that the tasks will be performed to achieve established goals previously.

2.2 MAPEAS Methodology

Züge (2014) has presented the MAPEAS methodology, which objective is to create a methodology integrating concepts PDAI, Strategic Planning and the GRI model sustainability report, to promote sustainable development in industrial projects.

Fig. 3 – Flowchart of MAPEAS methodology analysis model.



Source: Züge (2014).

The macro steps of the analysis model of MAPEAS methodology Züge (2014) are:

1- Analysis of Strategic Planning related to Sustainability:

It performs and analyses the targets established in the strategic planning of the organization, in order to ascertain whether they are aligned with sustainability concepts and not only consider economic values.

2- Analysis of PDAI steps in relation to actions in the Strategic Plan:

A comparative analysis is performed to verify if the PDAI is aligned with actions in the strategic planning of the organization.

3- Analysis of Sustainability Indices that are influenced by the Industrial Automation:

It performs an analysis of which GRI indicators of organization (economic groups and environmental indicators) and considers in its sustainability report, which are related and or are influenced by industrial automation.

Economic growth should consider a sustainable growth, always taking the environment as an important and integral part of this development process.

Both methodologies presented MPCTAI Silva (2013) and MAPEAS of Züge (2014), have great importance and applicability according their respective objectives.

Züge et Al (2010) relates that “Action is needed in several areas of the company to achieve a high level of integration of IT and AT. The integration of these areas demands communication between various sectors, which does not happen easily” [6].

The potash production includes very specific characteristics. Note also that Brazil and other countries production is not enough to supply the demand and the implementation of new production plants require significant investments.

Thus, in the case of potash production, there is a need of support from additional methodology on decision making in automation projects that, as shown in item introduction of this work, enables:

a) Increase productivity;
b) Reduction of electricity demand;
c) Production increment;
d) Mitigation of environmental impacts.

3 TAIMISEP Methodology

In Brazil, potash consumption in 2010 reached 4.3 million tons, and about 90 %, is imported from Canada, Russia and Germany, according to a source of annual reports of the mining company Vale SA (2010). [7]

Due to that, this research aims to develop and propose a methodology with the use of automation and information technologies for manufacturing facilities potash that enables increased production sustainability.

The sustainability context considers as important the issue the working environment, in order to increase the safety of workers in their activities. Hence, Figueiredo observes that ".companies seek to improve their processes, products, and solutions also provide for sustainable disposal of their products when life cycle ends. In other words, every corporation that wants to proceed and compete in the decades ahead should incorporate sustainability standards in their decision making processes. "[8]

This importance is confirmed by Katarina Holla. (2016) “Prevention represents one of the basic pillars of preventing the crisis phenomena in the current society. In the case of the industrial accidents this term achieves still greater and more important dimension due to the possible threats for inhabitants, employees, property or the environment especially from the point of view of the most dangerous industrial enterprises.” [9]

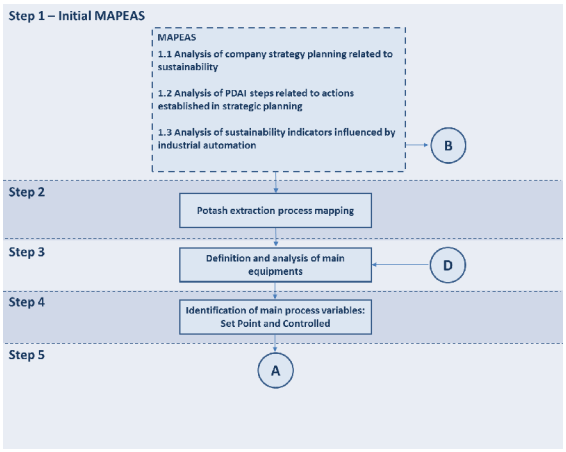
According to Martins et al (2008) the potash production in Brazil was initiated in 1985 it is restricted to the Complex Mine / Taquari-Vassouras, in the state of Sergipe, operated by Vale SA This is so far the only mine in operation in 2012, and its production meets less than 10% of the country's needs of potash [10].

The production is commonly through conventional underground mining, and the obtained by the method chambers and rectangular wells, flotation processing. There are projects in Brazil aiming to reduce

dependence on the international market with increasing production from evaporate deposits.

The TAIMISEP methodology incorporates and adapts methodologies: MAPEAS of Züge (2014) and MPCTAI Silva (2013) using the key concepts for the convergence of IT with TA and sustainability gains in the development of a specific tool and developed for plants potash extraction.

Fig. 4 – 1 of 3 Flowchart part of TAIMISEP methodology



Source: Author.

Fig. 5 – 2 of 3 Flowchart part of TAIMISEP methodology

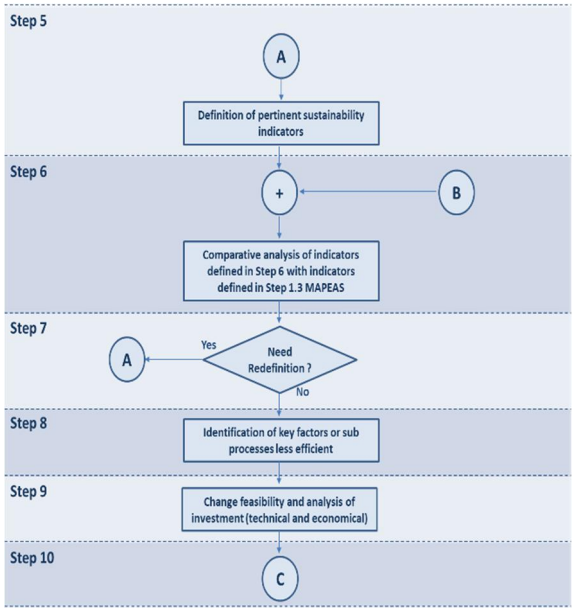


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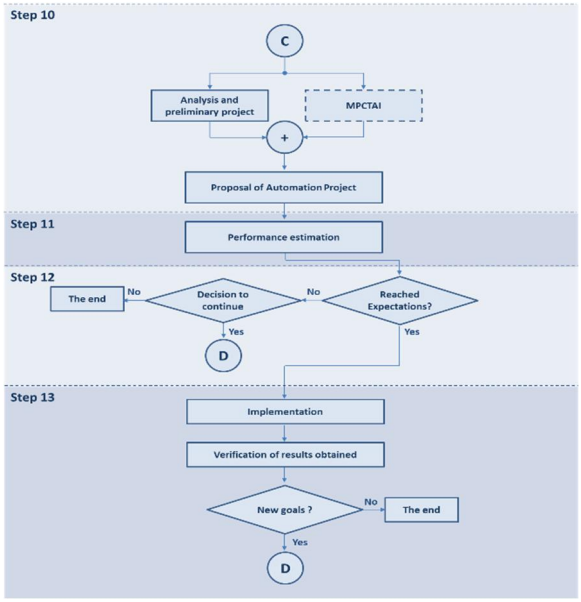
Fig. 6 – 3 of 3 Flowchart part of TAIMISEP methodology



Source: Author.

The application of the proposed TAIMISEP methodology suggests that the first step should be performed the three (3) macro steps of the analysis model of MAPEAS methodology Züge (2014).

The second step is to identify the type of extraction process employed to produce potash in the factory to be studied, as described in section 2.4 of this work, namely if the extraction is carried out by the conventional method or by dissolution. Extraction and processing are specific for each type of mineral obtained thus also important to define what it is or what minerals the plant to be analyzed extracts.

In the third step should be to define and analyze what are the major equipment that make up the plant process analysis.

In the fourth step should define the main controlling and controlled variables of production process.

In the fifth step should be to define the relevant indicators of sustainability to the factory in analysis that are important for economic support, but mainly by the impact they have on the environment.

In the sixth step is to compare the indicators defined in step 5 (five) with the macro defined in step 1.3 MAPEAS methodology, as previously described in figure 4.

In the seventh step is aimed to verify the need to redefine the indicators chosen in the fifth stage. If definition is needed, it returns to the sixth stage. If the indicators are in line with the desired one should follow to the eighth stage.

In the eighth stage, the goal is to define factors and steps which influence negatively with processes efficient and develop an automation solution that enables the improvement of production and or sustainability indicators.

In the ninth step is to evaluate the feasibility of the change possibilities identified in the technical and economic fields and IF they are compatible with the factory investment projections analysis.

In the tenth step is prepared a preliminary proposal automation project and additionally considering the steps of MPCTAI methodology Silva (2013). With the result is a proposal drawn automation project to be presented to the responsible staff of the factory under review for approval of the project.

In the eleventh step after approval of the project must estimate the expected performance to be achieved with the implementation of the proposed project for further evaluation of their effectiveness.

In the twelfth step should be to jointly assess the team's factory is the expected performance estimate meets the expectations proposals aligned with the company's expectations.

If the expectations were not fully met, the company staff to evaluate the continuity in the process. Existing interest in obtaining new performance estimate returns to the third step of the methodology.

Finally, if, after the twelfth stage the expectations are fully met, it follows to step 13 to perform the implementation.

4 Conclusion

The motivation of the methodology development arose from realization of the importance of potash for agricultural production and the need of specific methodology development for industrial production aimed at four goals: significant increase of productivity gains, potash production increase, allowing the reduction of demand for energy and mitigation of environmental impacts.

Identifying that current demand for potash located far beyond than the global production capacity, it reinforces the importance of studies to promote improvements in production units in operation, aimed at the sustainability of the processes.

This was the objective of the TAIMISEP methodology development using concepts of automation technology, information and sustainability, allowing the development of viable solutions technically and economically in production potash units. The TAIMISEP methodology incorporated and adapted methodologies: MAPEAS of Züge (2014) and MPCTAI Silva (2013).

The TAIMISEP promotes an organization and structuring of the activities, facilitating the identification of factors or sub least efficient processes at the plant being analyzed and enables solutions through an automation project.

The TAIMISEP methodology was structured to contribute to sustainable development, from automation solutions that converge the AT and IT projects applied to producing potash industry.

References:

[1] ROCHA, G.; PEREIRA, I. População e recursos: crescimento populacional e o uso dos recursos hídricos na cidade de Tucuruí/PA, 2011.

[2] ZÜGE, C. T.Y. Alinhamento do planejamento estratégico com o plano diretor de automação industrial em pró do desenvolvimento sustentável. 2014. 129p. Tese (Doutorado) - Universidade de São Paulo, 2014.

[3] Claudia T.Y. Zuge, Sergio L. Pereira, “Relationship of Strategic Planning and Industrial Automation Planning considering Sustainable Development”, Recent Advances on Environmental Science, *Proceedings of the 9th International Conference on Energy, Environment, Ecosystems and Sustainable Development* (EEESD '13, pp 161-167, 2013

[4] SIMÃO FILHO, A.; PEREIRA, S. L. A empresa ética em ambiente: a contribuição da empresa e da tecnologia da automação para um desenvolvimento sustentável inclusivo. São Paulo: *Quartier Latin*, 2014.

[5] SILVA, E.B. Metodologia para o planejamento da convergência da tecnologia da informação

(TI) & tecnologia da automação (TA) em processos industriais. 2013. 155p. Tese (Doutorado) - Universidade de São Paulo, 2013.

[6] Claudia T.Y. Zuge, Sergio L. Pereira, Eduardo M. Dias, "Integration of Information Techonology and Automation: Facilitators and Barriers", *Wseas Transactions on Systems and Control*, Issue 5, Vol 5, pp 372-380, 2010.

[7] Empresa VALE S.A. Comunicação e site institucional www.vale.com. 2013 - 2016.

[8] Aureo E. P. Figueiredo, Sergio Hoeflich, Leticia Figueiredo, Ricardo D. Carvalhal, Sergio L. Pereira, Eduardo Dias. (2016) ITS for Safety: Some Considerations on Effectiveness Analysis of New Tech for Achieving a Safer Environment. *International Journal of Environmental Science*, 1, 171-175.

[9] Katarina Holla. (2016) Major Industrial Accidents prevention in European Union and in Slovak Republic context. *International Journal of Environmental Science*, 1, 19-27.

[10] MARTINS, E. S. et al. Rochas e minerais industriais. *CETEM*, 2. Ed., 2008.