Industry 4.0: Strategy for More Sustainable Industrial Development in SMEs

Mohammed Bakkari and Abdellah Khatory

Laboratory of Production Engineering, Energy & Sustainable Development (LPESD).
Faculty of Science and Technology of Fez, BP 2427 Route d'Imouzzer 30000
Sidi Mohamed Ben Abellah University.
Fez, Morocco
Mohammed.bakkari@usmba.ac.ma
Abdellah.khatory@usmba.ac.ma

Abstract

Several key factors influence the industrial production such as the instability of the market, the short duration of the life of the product, the individualization of the product and globalization. This means that companies must adapt to the requirements of the market by improving the technical tools. Actually the automated production systems whitin companies seem less connected against the Industry 4.0 which is based on the interconnection of machines, of products and of people. This industrial revolution also represents a desire to respond to current issues related to the principles of sustainable development such as resources management and energy. This article is intended to emphasize the importance of the strategic vision of the industrial countries to the Horizon 2030, and the relationship between the industry 4.0 and sustainable development in order to ensure the sustainability of resources and its benefit for future generations. In addition, it focuses on the main conditions to migrate from the Industry 3.0 to the Industry 4.0 based on the Internet of Objects (IoT) and the cyber physical system (CPS).

Keywords

Automated systems, Industry 4.0, industrial strategy, Sustainable Development, Cyber Physical System

1. INTRODUCTION

The whole of the industrial sector is entered into a new phase of profound change which sees the digital technologies integrate into the heart of the industrial process. This is the fourth industrial revolution which gives birth to a new generation of factory, this revolution that it is called the "Real-Time-factory ", "The Factory of Things ", "Smart Factory " [1], " Innovative factory " or "Industry 4.0", this major technological rupture offers an extraordinary field of innovation, progress and growth. Fig 1 represents the Industry 4.0 which is characterized by the fusion of the virtual world of the Internet relocated and the real world of industrial installations, the Industry 4.0 becomes the essential reference for the industrial production.

The industrial strategies, adopted by the different countries, strongly encourage businesses to take the momentum toward this industrial revolution while respecting the approaches and principles of sustainable development for having a harmony between its two approaches.

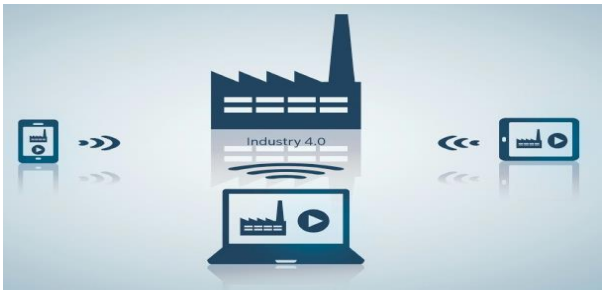

Figure.1 Fusion between real and virtual world

2.AUTOMATED SYSTEMS AND COMPETITIVENESS

2.1. Concept Of Automated Systems

The demand of the market in manufactured goods was very high because everything that was produced was not enough consumers. As the emergence of the electronic, during the first half of the 20th Century [2], the manufacturing production had increased its capacity thanks to specialized systems. The production process requires a sequence of specific and repetitive operations, therefore it is the main role of the automation that later becomes a vast field of research [3] containing different fields of application.

With the evolution of technologies, the automated system has not been able to have a single definition. Several researches in this area try to define and characterize them. According to Staroswiecki [4] the automation system is designed to check the transformations performed by the physical process. The control is carried out with the aid of sensors and actuators to the level of field.

The concept adopted by Verlinde [5] for the automated systems is based on the functions of the system which are: lead, maintain, monitor and secure. However, Bayart [6] does not take into account the operators in his model; the automation system is in this approach considered as an interface between the physical process and operators.

For Cauffriez, the automated system supports the principles of a physical system be it internal or external [7]. In addition, the online Dictionary Larousse defines the automation such as: "total or partial withdrawal of human intervention in the execution of various tasks, industrial, agricultural, domestic, administrative or science."

Despite these definitions which characterize the automated systems, Chiron introduced another definition that was adapted later on, this definition goes as follow: an automated system of production is composed of a Control Part (CP) and an Operative Part (OP). The CP contains the logic operation of the process that it wants to automate, it sends orders to the OP which carries it by using actuators and which returns information from sensors. The CP also manages the dialog with the operator through the more often supervision [2]. The concept of automated system of production has often been associated with the CIM (Computer Integrated Manufacturing) [8].

2.2. Automated Companies : Industrial Competitiveness Index

When developed countries invest in developing countries, they are attracted by the recovery of an important profit rate [9]. Whereas, in the industrialized countries, those profits are rolled by the unnecessary complications of the state in taxes and requirements of workers in the form of higher wages. Despite these investments, the industrial competitiveness index remains high in the industrialized countries compared to developing countries, and it provides a clear image on the level of the competitiveness of the industry of a country and reveals a gap in development levels between these different groups of countries.

3.INDUSTRIAL STRATEGIES OF THE COUNTRY IN THE LONG TERM

3.1. In Europe

3.1.1. The United Kingdom:

The industrial enterprises play a very important role in the British economy. All sectors of activities are involved in this economic progress, apart from the number of automated systems and robots installed in the English companies' which remain modest compared to other countries of the European Union. The number of industrial robots per million hours of work does not reach the 0.5 [11] In the United Kingdom.

To encourage the British companies to have more productivity by using automation, the government has adopted an industrial strategy to 2020 [12], to provide the support to all sectors of activities, mainly concerning the Robotics and Autonomous Systems (RAS).

The major objective of this strategy is the development of real industrial technology [12] as the Manufacturing Execution System (MES) or the management of industrial processes, and the computer integrated manufacturing (CIM).

3.1.2. France:

It has a large industrial scale in the European Union, it is characterized by a level quite remarkable of automation in the manufacturing industry in several areas of mass production such as the automotive and non-automotive [13]. This automation allows the creation of the added value and employment rate important enough at the time of its adoption, particularly by the launch of the project of Innovation 2030 which is based on 7 ambitions in very different fields which can constitute the pillars of development [14].

3.1.3. German:

The German Federal Ministry has launched a large operation of foresight which aims to understand the main technology trends, identify the scientific challenges of the next fifteen years and anticipate their potential impacts. Among the eleven priority research fields whose main axis is "learn and work in a smart world connected" [15].

3.2. In Asia

3.2.1. China:

It is without doubt the country or the economic growth that may persist. By 2030, it will have been the first global economic power, joining the top 10 other emerging countries: India the 3th rank, Brazil the 4th, Russia the 6th, Mexico the 7th, and Indonesia the 8th [16]. China has a vision of 5 essential objectives toward 2030, it is therefore imperative that it progresses in its value chain, and abandoned its basic industry while focusing on the development of an innovative industry [17].

Yet, the Chinese authorities have indicated that they have started the work in a purely technological domain to equip themselves with a space launch vehicle capable of placing in orbit the heaviest workloads and to bring men up to the Moon [18].

3.2.2. India:

Long remained in the shadow of its powerful neighbor, India seems to arouse little by little. It is part of the developing countries whose economic growth has been strongest. With a very different political system and an economic strategy, it is looming as one of the future giants of the world economy.

Its long term strategy is articulated in two points in the field of industry to strengthen its development. In a first time, it is based on the import of the new foreign technology to assist the Indian Industrial to strengthen their capacities. In the second point, she concentrated on the research and the development of high technology in order to achieve 2.4% of their GDP in 2034 [19].

3.2.3. Japan:

It is one of the most developed countries; these records are known in the world. The manufacturing industry is one of the forces of Japan, but the country got few natural resources. Therefore, Japanese companies must import raw materials, which they use for the manufacture finished products intended for the domestic market or for export. The most important industry of the country is the electronics which marked a huge progress in Japan since the last few years.

This trend has been demanded in Japan to persist in the area of the new technology and to equip the companies by the robots which will reach a million robots on the horizon of 2030 [20].

3.2.4. Russia:

Certainly that Russia remains today one of the 10 the most important economies and powerful at the international level, yet it has not posed a strategic vision regarding the civic production, it aims to be the first in protection.

3.3. In America

3.3.1. Brazil:

Brazil is today the 9th largest producer of the industrial world; this regional power is open on the world. At the outset, it is regarded as an outsider, at any of even managed to climb to the 5th place of the ranking.

The Brazilian economy is changing, and thanks to its young workforce, which is often a positive sign for an economy in good health, the production will be able to increase with the adoption of a strategic vision innovative based on five factors in order to embark on the construction of ships, aircraft and automobile [21].

3.3.2. Mexico:

In Mexico, there are two axes which will support growth. The first of the axes is the external factor, as the labor cost are rising in China, several countries are turning to Mexico for the production. In addition, the Aerospace construction has a large added value to the country because its cost is very high and requesting an intensive human capital.

The second axis is the strong links of free trade between the two economies (Mexico and the United States) which also will make a progress in economic growth in Mexico [22].

3.3.3. The United States:

It is the first world economic power according to the Nominal Gross Domestic Product (GDP) with a rate of growth which is one of the strongest among the developed countries. The industrialized country is today largely oriented to the tertiary sector and it focuses heavily on innovation. The development of high technology industries is the result of a policy of investment in basic research and development. The progress of artificial intelligence will be immediately integrated into the developments of the robotics. The avatars and robots will provide unpublished data related to touch, and to the smell. They would benefit from greater autonomy and an artificial intelligence consistent onboard. The United States is producing today the bulk of technological innovation world.

They have fully understood the strategic interest of a reflection at any scale on the developments and the associated risks.

To cope with the end of the America's domination worldwide, the United States are insisting, in the Global report Trends 2030 [23] on the launch of the production of implants, prostheses and motorized exoskeletons which will abound in all spheres of human activities using the automated systems very powerful. In addition, research institutes integrating teams of researchers in the field of systems for augmented reality in order to improve our understanding of complex phenomena real.

3.4. In Africa

3.4.1. South Africa:

Long First economic power on continent, South Africa presents economic results which place it in the first rank on the African continent. Alone, the South Africa achieves a quarter of GDP of the African continent, it is based on the mining sector, and large industrial regions are thus located in the same extraction areas, where she has developed important cities.

The rate of unemployment remains rise despite the mining industry. It is then diversified in the industry and especially the manufacturing industry in order to reduce the unemployment rate to 6% on 2030. For this vision, the South Africa sets 3 scenarios (baseline scenario, solid menirals scenario and diversified dynamic economy scenario) for 2030 in order to keep its economic place in the continent. Thanks to this vision South Africa will create more than million jobs by the industry [24].

3.4.2. Morocco:

Morocco is the fifth economic power in Africa, it seems like a relatively small country, yet it is the second emerging country the more promising for the investment behind the South Africa According to the classification established by Bloomberg [25], it is also in the list of emerging countries most promising in the world.

After deploying two main sector strategies since 2000 to know "E-Morocco" and "Morocco Numeric 2013", it also adapts an industrial strategy for the long-term up to 2030 which covers a broad scope of topics: smart cities, innovation, education and training, digitalization of the State, electronic commerce and the industry of course.

It is true that the industrial development is essential to the economic prosperity of Morocco. From this approach, it is designed in a first time the creation of 500 000 industrial jobs to the 2020 that will represent an envelope of 20 billion dirhams [26], and the construction of the industrial parks to rental vocation to facilitate access to land such as the Tangier Free Zone and Kenitra. This allocation affects mainly the automotive and aeronautics sectors which are based on the productive ecosystems.

4.SUSTAINABLE DEVELOPMENT: AN ASSET FOR THE INDUSTRIES 4.0

4.1. Origin Of Concept

The concept of development being in constant evolution, there are different points of view on this concept, the definition more close means: the qualitative transformation of an economic unit which normally accompanying the growth and resulting the possibility for a population to satisfy its needs [27]. As the character is vague and too general to this definition that some tend to clarify and update more. The term sustainable development, which follows, has been created in the years 1980 by the International Union for the Conservation of Nature. It was subsequently resumed in the Brundtland Report, prepared in 1987, by the Commission of the Environment and the development of the United Nations, which is the origin of the wide dissemination of the term: Sustainable development is "development that meets the needs and aspirations of the present without compromising the ability of future generations to meet their own needs". The two concepts are inherent in this concept: the needs' concept more particularly the essential needs of the most destitute which is appropriate to give the highest priority, and the idea of the limitations which technological and social organization impose on the capacity of the environment to meet current and future needs.

The purpose of the sustainable development is to ensure the sustainability of the benefit for future generations, while keeping the economic efficiency, social equity and environmental responsibility.

The sustainable development pillars are described as follow:

- Environmental: reduce gases emissions and any other substance affecting the ozone layer, allow a better use and better management of energy and protect biodiversity etc.
- Economic: to increase the company and the sector of activity efficiency, promote good practices and trade relations, foster innovation, promote the responsible supply etc.
- Social: Maintain and improve the working conditions, allow a transfer of knowledge and skills of all stakeholders, allow an adequate distribution of wealth, promote the anchor in the environment etc.

Figure. 2 The 3 pillars of sustainable development

4.2. Approach Of The Sustainable Development In Companies

Companies play a dynamic role as necessary elements to achieve national development goals, such as economic growth, the reduction of poverty, employment and the creation of wealth which will allow a more equitable distribution of income and the productivity increase [28] is widely recognized.

The implementing of a sustainable development approach in the enterprises is a complex process [29], which commits all functions of these companies. A sustainable development approach is carried out in several stages. Each step involves a more sustained commitment enabling an organization to become more sustainable. These steps can sometimes overlap and they are ongoing throughout the life of the company under the principle of continuous improvement. The elements of the sustainable development approach are:

- Consultation of Stakeholders: The commitment to a sustainable development approach demand an open dialog with the different stakeholders. In the company case, they are employees, suppliers, consumers. Ideally, the stakeholders should be consulted at each stage of the process in order to anchor this dialog in an iterative process.
- Vision: to launch a sustainable development measure, the company must view where it will be in a long-term, define its corporate values and anticipate its development.
- Diagnostic: the achievement of a diagnosis, that is to say the inventory of all the practices of the company, allows assessing the current level of company commitment in relation to the principles of sustainable development. On the basis of this diagnosis, the company can determine its priorities for action and to consider improvements to the actions already in place.
- Objectives: from the vision and the fault finding, it is possible to set achievable goals, quantifiable, and
- which correspond to the vision and values of the company.
- Action Plan: at this stage the company is planning the actions which is undertaking as wishes in its approach. The actions chosen must achieve the objectives previously determined. For each action, indicators are used to determine the degree of progress of the latter. The Plan of Action, which must also be planned for a specific period of time, is used to establish priorities and to organize the vision of the development of the company.
- Sustainable development report: the sustainable development measure includes the editing of a report of sustainable development that allows to assess the progress of the process and the achievement of the objectives through the use of various indicators of performance. The report is also a good way to communicate and disseminate the commitment of an organization or a company in respect of the sustainable development principles [30].

4.3. Industry 4.0: Evolution Of The Revolution

4.3.1. From the Industry 1.0 to the Industry 4.0:

The first industrial revolution is based on coal, metallurgy, textile therefore mechanics production with the steam machines. It starts in Great Britain at the end of the eighteenth XVIIIth century and then spreads in France at the beginning of the nineteenth XIXth century before to expand in Germany, in the United States, Japan and Russia.

The second, started at the end of the eighteenth XVIIIth century, finds its foundations in the electricity, mechanics, the oil and the chemistry that is mass production with the arrival of electricity.

The third revolution is the automated production with the programmable logic controllers (PLC) and robots. It produced in the middle of the twentieth XXth century whose dynamic came from electronics, telecommunications, computing. Thanks to the miniaturized materials production, robots and automation the production becomes increasingly better and the development of technologies is constantly. It started in the United States, then Japan and the European Union, the third industrial revolution has seen rise also Internet, in the twilight of the twentieth XXth century.

And now, last industrial revolution is taking shape before our eyes, at the dawn of the twenty-first century. It will be the mature earlier toward 2020. All technological bricks on which is built are there. It can be summarized by the Scan pushed to the extreme economic trade and productive.

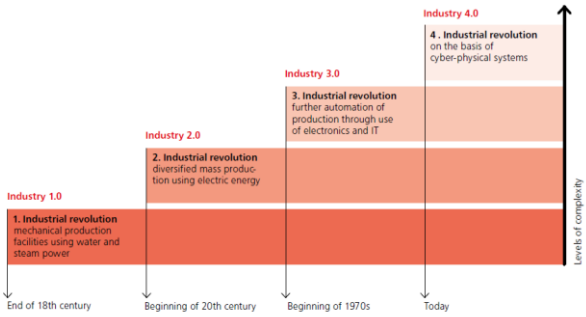

Figure. 3 The first industrial revolution to the fourth [31]

4.3.2. Physical Cyber system CPS the basis of the Industry 4.0:

The industry 4.0 is a term used for the first time in 2011 by the German research union Industry-Science Research Alliance. It refers to total scan of the industrial production. This concept describes the vision of intelligent factories [31] which is characterized by complete networking of all parts to produce that is main the real-time control of the production chain through the of information and communication techniques and also by the installation of robots which are more and more numerous in the enterprises.

To characterize the industry 4.0 several levers have been taken into account:

- High resolution real-time communication for obtaining timely sourced real time data.
- Large scale simulation assessment of impact action on alternatives optimization of chosen criteria.
- Self-forming system-of-system for adhoc linkage of dispersed resources.
- End -to end standardization of reporting for instating objective consist throughout the entire system.
- Virtual representations of physical objects for collaboration in the absence of barriers to the physical world.
- Automatic control and pre-processing of data for unburden employees from routine activities to put focus on policymaking.
- Organization drift and manufacturing plan toward Industry 4.0 will only be enabled by higher levels of
- collaboration within and outside the manufacturing cycles. [32]

In addition to the Industry 4.0, another term which is closely related to it is the cyber-physical system (CPS) where computer components work together to control and to command physical entities. The physical capacities and computing are integrated [33] such as the detection, communication and the physical actuation. The CPS will simulate and compare the options of production on the basis of instructions; it will then propose the optimal solution.

In fact, the cyber physical system CPS will allow the communication in the industry of tomorrow between three main elements: humans, machines and products [34]. To do this the CPS requires three essential levels:

- The physical objects
- Data models of physical objects mentioned in a network infrastructure
- Services based on the data available [35]

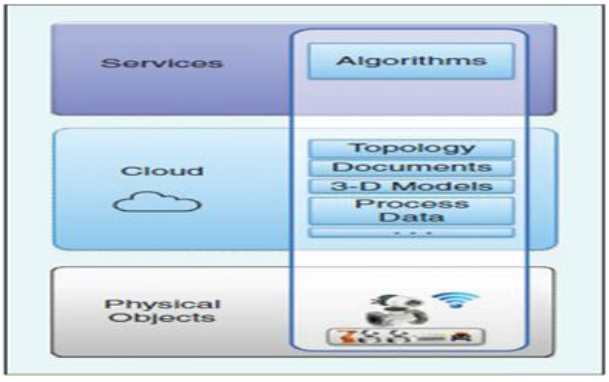

Figure. 4 The three levels which form the CPS [35]

These levels Fig.4 allow independent processes of management and the Internet of objects (IoT) to interact [36] with the virtual and real world. This interaction opens a new aspect of the production is the passage of the centralized production to the decentralized production. Customers can order their products directly via applications in real time thanks to software production, real physical objects such as work tables and the workstations as a source of information and the feedback loop between employees and clients. At each step of production customers will receive a notification in order to follow their requests in real time Fig.5.

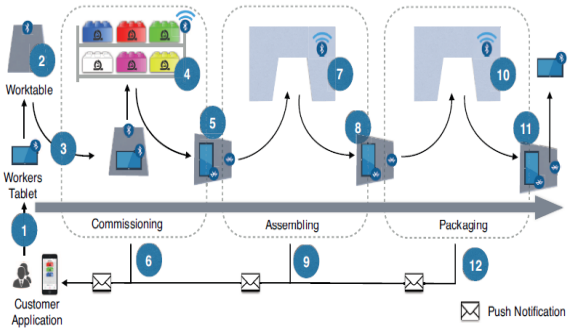

Figure. 5 Follow-up of the customers of the Real Time Control [1]

5. REQUIREMENTS FOR THE MIGRATION TO THE INDUSTRY 4.0

The question of sustainable development always remains a concern of all companies and all governments, in this approach the technological development especially the new information and communication technologies provides a wide range of computer products and industrial solutions as levers of sustainable development. The industry 4.0 is a consequence of this progress in order to maximize the sustainable development, but the passage of the industry on the basis of automated systems to the industry sustainable connected called Industry 4.0 requires three essential conditions:

The technological condition: The computer tools and indispensable industrial to migrate from the Industry 3.0 to the Industry 4.0 are already present (at least a large part, they will be mature in 2020). It remains only the industry capacities to invest massively, and the computer and automation experts communicate between themselves in easy way and intelligible. Its realization is dependent on standardization which plays a crucial role.

The cultural condition: Several countries have already got the industrial strategies in the long term, but some actors are not open enough for this change in particular sustainable development. A true ambition of all these actors and especially the politicians is a key to success. They have an important role to play in the reform and the adaptation of the training of engineers, managers and technicians in order to familiarize themselves with the industry 4.0.

The organizational condition: the old companies' organizational architecture based on the organization in silos must be substitute to go to the interdisciplinary organization, which is main the work must be collaborative between technicians, computer scientists and engineers' teams in order to move from tasks achievement to projects management.

6. CONCLUSION

Certainly those technological developments will we surprise from time to time, the Industry 4.0 is mature on our eyes. Several initiatives have been taken by the companies to build this industrial revolution such as the factory Rexroth of Homburg who has the first line industry 4.0 exploited on a daily basis and interconnected between machines and products. The proclamation signed by the mayor of Cincinnati to be the city witness of the industry 4.0.

This technological progress has no meaning if it does not improve working conditions of man. It is the role of the engineers, researchers to measure the consequences of their discoveries and their inventions, to predict at the outset the need of control, conceive of the complementarities between man and machine, to make the pedagogy. In addition, the employees themselves must acquire other skills particularly the non-technical skills and follow continuous training [37] on this new domain, in order to feel better in their workstations because the technology is a good servant but this would be a bad master.

REFERENCES:

[1] Constantin Scheuermann, Stephan Verclas, Bernd Bruegge *Agile factory - An Example of an industry 4.0, manufacturing* process, IEEE 3rd International Conference on Cyber-Physical systems, networks, and Applications, 2015

[2] Fabien Chiron. *Contribution à la fexibilité et à la rapidité de conception des systèemes automatisés avec l'utilisation d'UML*. mobile computing. Phd, Universite Blaise Pascal - Clermont-ferrand II, 2008. French.

[3] Benedict ROHÉE. *Contribution to the design of applications of pilotage of manufacturing systems*. Phd, University of Reims Champagne-Ardenne, 2008.

[4] Staroswiecki, M.Bayart, M., intelligent actuators, Hermes, ISBN 2-86601-439-1, 1994

[5] Verlinde, C., *contribution to the study of the architectures of automated systems*, Doctoral thesis of the Polytechnic Institute of Lorraine INPL, University of Nancy I, 1989

[6] Bayart, M., *smart instrumentation - Automated systems of production with distributed intelligence, Empowerment to direct research*, university of sciences and technologies of Lille, December, 1994

[7] Laurent Cauffriez. *Models and Methods for the assessment of the safety of operation of automated systems complex: Application to the operating lines of production* - Application to the design of distributed intelligent systems. Engineering Sciences. University of Valenciennes and the Hainaut-Cambresis, 2005.

[8] Damien Trentesaux. *Design of a system of distributed pilotage, supervised and Multicriteria for automated systems of production. Automatic*. Institut National Polytechnique de Grenoble - INPG, 1996. French.

[9] Pierre Seligmann, "*on the competition between industrialized countries and developing countries*," Revue Third World, t. XVIII, n°71, july-september

[10] http://www.bsi-economics.org/371-politique-industrielle-systeme-innovation-pvd availabale fabruary 5, 2016

[11] The Skaksen Kromann, Jr, a Sørensen *-the automation, labor productivity and employment - a cross country comparison*, 2011.

[12] Special Interest Group, *RAS 2020 Robotics and Autonomous Systems*, July 2014.

[13] Ministry of the Economy, Finance and the French industry, Secretariat of State for Industry "automation and computerization in the industry" n°80 July 1997.

[14] Www.business.gouv.fr/innovation-2030/7-ambitions strategic-

[15] Http://transportsdufutur.ademe.fr/2014/11/quelle-societe-en-2030-un-exercice-de-prospective-a-lallemande.html

[16] Center for Research PWC, Http://www.pwc.fr/le-centre-de-gravite-de-leconomie-mondiale-se-deplace-mais-meme-les-pays-emergents-rencontrent-des-obstacles-a-leur-croissance-selon-pwc.html

[17] Www.contrepoints.org/2015/04/10/203989-chine-5-objectifs-pour-2030

[18] Http://www.usinenouvelle.com/article/la-chine-veut-disposer-de-son-propre-lanceur-spatial-lourd-en-2030.N302172

[19] Center for Research PWC, Future of India The Winning leap, 24 November. 2014

[20] KPMG International, "future state 2030", 2013

[21] Center for Research PWC, "How to take of the momentum in the process of transformation of the energy.", 2015

[22] Http://www.forbes.com/sites/kenrapoza/2012/08/11/can-mexico-overtake-brazil-by-2022/

[23] National Intelligence Council, "Global Trends 2030: Alternative Worlds", December 2012

[24] National Planning Commission, National Development Plan 2030 our future make it work

[25] Http://www.bloomberg.com/news/articles/2015-02-11/gulf-nations-defy-oil-rout-to-top-list-of-best-emerging-markets

[26] Http://www.usinenouvelle.com/article/maroc-moulay-hafid-elalamy-annonce-la-creation-d-un-fonds-industriel-dote-a-terme-de-1-8-milliard-d-euros.N252984

[27] Web site of the Office québécois of the French language Http://www.granddictionnaire.com

[28] William F. Steel and L. Mr. Webster, How small enterprises in Ghana have responded to adjustment. World Bank Economic Review 6(3): 423-438 (1992)

[29] M BAKKARI,A.KHATORY, "Contribution of the quality of the higher education and vocational training in the development of the Moroccan companies", Conference G3 "The quality in all its states" 16-18 October 2014,Brussels Belgium

[30] Bureau de normalisation du Quebec (BNQ), the sustainable development for the benefit of the performance," the benefits of a sustainable development approach for Quebec businesses."

[31] Daniel Buhr, social innovation policy for industry 4.0, 2015

[32] Adeyeri, integration of Agent technology into manufacturing enterprise: A Review and Platform for Industry 4.0, Proceedings of the 2015 International Conference on Industrial Engineering and Operations Management Dubai, United Arab Emirates (UAE), March 3 - 5, 2015

[33] J. Lee, B. Bagheri, and H. Kao," Recent Advances and trends of Cyber-Physical Systems and big data analytics in industrial informatics", Proceeding of Int. Conference on Industrial Informatics (Indin) 2014

[34] Malta Brettel, Niklas Friederichsen, Michael Keller, Marius Rosenberg, how virtualization, decentralization and Network Building Change The Manufacturing Landscape: Year Industry 4.0 Perspective, International Journal of mechanical, Aerospace, Industrial, mechatronic and Manufacturing Engineering vol:8, No:1, 2014

[35] Rainer Drath, Alexander Horch, "Industry 4.0: hit gold hype?", IEEE Industrial Electronics Magazine, June 2014

[36] Alfredo Alan Flores Saldivar, Yun Li, Wei-NFERT Chen, Zhi-hui Zhan, Jun Zhang, Leo Yi Chen, "Industry 4.0 with Cyber-Physical Integration: A design and manufacture Perspective", Proceedings of the21st International Conference on Automation & Computing, University of Strathclyde, Glasgow, UK, 11-12 September 2015

[37] Bakkari Mohammed, Rachidi Abdelhafid Khatory, Abdellah, "Evolution of automated production systems in SMEs: What are the implications for the employees?", Xth International Conference on Integrated Design and Production, ICC 2015, December 2-4, 2015, Tangier – Morocco