

The Moroccan Mining Industry: Towards a Global Sustainable Development Management System

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Abstract—According to the technological development and that of the New Information and Communication Technologies (NICT), and the evolution of organizational management systems, as well, in front of the new socio-economic factors, and the successive deep international changes, resulting from the globalization, the organization services and structures as well as their process activities (agribusiness industry, automotive industry, infrastructure industry, mining industry...) became more flexible, interactive and virtual. Nowadays, the worldwide mining sector, especially in Morocco, marks a radical evolution as productivity and investment regards, which allows it the upgrading of a country characterized by mining vacation to a mining production country. This vision forces a sustainable strategy for improvement in order to position in a market, which is marked by a strong competition. Such a situation encourages the mining companies to cooperate deep changes of their systems of production, as regards energy optimization, quality improvement (products, works...), of safety, of knowledge, of competence, and of industrial performance, while taking account thus the environmental protection. In this paper, we present the actual position of the mining sector in Morocco, as regards production, investment, and processing, then we purpose our contribution relation to design a global Management system entitled SDMS (Sustainable Development Management System), ensuring a transition, on which allows the Moroccan companies to get a position into the international mining field.

Keywords— Mining Industry, System, Management and SDMS

I. INTRODUCTION

Mining Industry is at the base of all civilizations. Since the antiquity the mines are present in the economic system of all nations.

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Today, thanks to the technological development and the technical industrial management, the mining sector marks a colossal development regarding the investment and the global mining production. The development is ensured by the implementation of management systems in order to optimize the losses, and to improve the industrial performance, and the increase production.

In this paper, we will present an idea about the international mining activity, and then we will focus the Moroccan mining sector, on which we draw up an actual position in terms of production, processing, and structures. Then, we propose our sustainable development management system which represents a comprehensive strategy, ensuring the various aspects of transition (strategy, tactic, and operational), driving the mining companies, to the strategic positioning in the international mining market.

II. REFLECTION STUDY

A. The mining activity in the world

Thanks to the technological and industrial development, the multinational economic advancement described the mineral substances, as necessary materials to strong priority, confirming that any kind of development is related in a first place to the use of the mineral substances (Li, Sn, Zn, Pb, Cu...). This need of natural resources is expressed in terms of a strong and continuous demand, pushing towards the exploration strategies development, and mining production process. The following figure presents the geographical distribution of mining activities on a worldwide scale (2013).

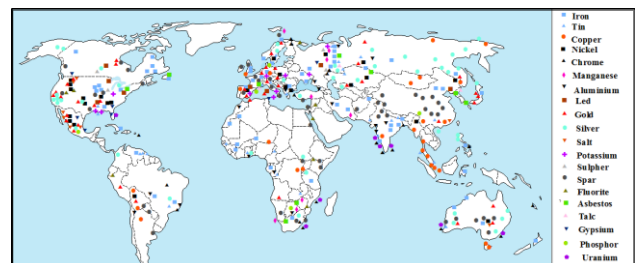


Fig. 1. Spatial repartition of the most important mining activities in the international scale [32]

B. Moroccan Mining activity, Generalities

Morocco, is a country of northwest African continent, through the ages, it's played an important fact in the North African history. Except of its cultural diversity, the kingdom is characterized by a variety of its grounds and lands, which returns to him a rich country as regards natural resources.

A mining culture was introduced into the Moroccan population during the long story of the country. Mining activity played since always a main function in the economy of the kingdom. That is explained by its contribution in terms of the effect in the gross domestic product, whereas the exports are nearly 80%, in volume and 20% in value [33], and its beneficial repercussion on regional development through the direct and indirect employments created.

The position that the mining sector occupied, is explained initially by the existence of an extremely varied geological context, as it conceals grounds belonging to all the ages an all-geological series. A context which has be marked by a succession of the Orogenesis cycles [11], start from the Precambrian basement [2], to the tertiary events [26]-[7], which support the genesis of several kinds of deposits, such as the phosphates deposits, lead, copper, silver, gold, fluorite, barite...which are distributed in the forth structural domains in Morocco. The following figure presents the spatial distribution of Mining activity in Morocco.

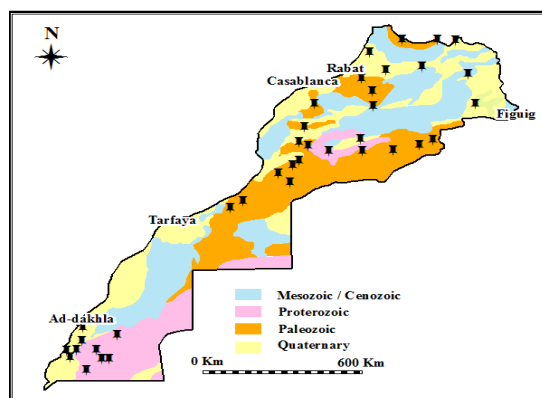


Fig. 2. Map of Mining activities in Morocco [29]

With an aim to develop the mining activity in Morocco, a various structural, organizational, and regulatory interventions are deprived and completed, as result of governmental and private sector cooperation, and contributing to the commitment of all mining sector partners. The goal is distinguished trough the efforts carried out to ensure the upgrading of a country potentially rich characterized by mining vacation, to an excellent mining production country, able to have a position in international mining market, with flexible trend face to the globalization stress [34].

The achievement of these goals is ensued by a correction and a promulgation of the Moroccan mining code, through a series of Dahirs and decrees (Dahir 1914, promulgation 1951. 1960) took place [36].

C. Mining process

Mining consists to extract the ore from the ground, in order to distribute the benefits of them to the society. The mines can practically be in all sizes. However that a mine can be profitable, the value of the ore must be higher than the costs of extraction (Feasibility study).

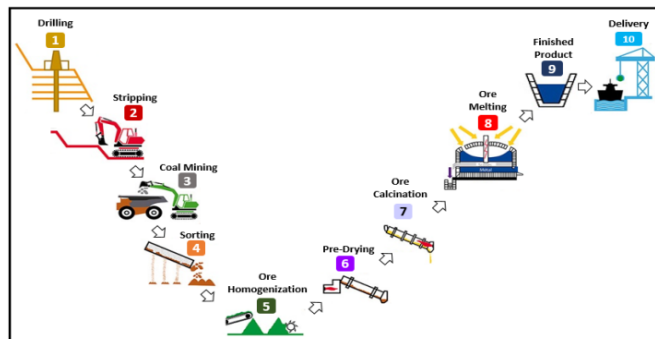


Fig. 3. Industrial process mining

To extract the mineralized ore, it is necessary to have many competences and various skills (Geologists, Scientifics, engineers, operators...), working in collaboration in order to achieve a common goal and generally which starts by:

- Mining Exploration

To find a deposit, it is necessary to study the rocks, most of time they are hidden under the ground, the plants, or water. [40]. Using the most developed equipment, the prospectors can know what hides under the ground, and they used a various methods to find the mineral ore (See Table1).

TABLE I
DIFFERENT TYPES OF MINERAL EXPLORATION

Type	Specification
Investigation (Satellite)	The satellites can often reveal which kind of rocks is present using sophisticated equipment of picture formation.
Investigation (helicopters)	The helicopters are provided with electronic devices, can see under the ground using computerized geophysical equipment.
Geochemical analyzes	To analyze the small grains of ore, or samples of ground, which can reveal a print being able to give an indication of what is under ground.
Drilling Process	The drilling equipment can with draw fragments of rock or carrots on the surface so that the geologist can examine them and determine their value.
Survey	The underground surveys of prospection make it possible to sample several thousands of tons of rocks, with an aim of better knowing the value of minerals.

The prospectors bring the samples of the ore in the preferment geochemical laboratories to make them analyze more, to confirm the contents.

- Mine construction

The engineers must find the best way of reaching the mineral-bearing body, and of extracting it [2].

If it is close to the surface, it is able to build a mine as an open pit. If the mineral body is in deep, the mining engineers will suggest carrying out a deep mine. In some cases, the two ways are used. Then they make the design of the preferment manufacturing, choosing the best equipment for drilling, ore processing, and storing equipment for the waste. The engineers and the technicians, conceive the mining site, choosing the best position to the buildings, the road, and the runways.

- **Mining Extraction**

Extraction can start form the surface, by the construction of open pit mine, or from the underground mine, which can be reached by tunnels, which present a subject of dynamiting. In both cases, the mining workers bore holes in the rock and fill them of explosives, which they explode. Using hard machinery, they remove the dynamited rock and they transported to the treatment manufacturing. Then the rock is crushed into pieces increasingly small and the ore is separated from the rest using various process in depend of the mineral nature and of the ore [3].

- **Mining function**

A largest variety of the competences is subjected to ensure the mine function. The employees manage the services, contracts, and supplies such a building materials, tools, equipment, and food. In the other hand, other employees manage the safety services, the equipment maintenance, and the health precautions, and transportation [6].

- **Environment Protection**

The mining companies are subjected to take careful about the necessity of environmental safety before starting processing. During the production, the executives are asked helps, to ensure the political strategies, in the order to protect the water, air, fauna, and flora [3].

In the end of each mining activity, the company must leave the site much as possible, as his state before starting the activity, this kind of job, is attributed to specific employees working in biology, and environmental sciences.

D. The Moroccan Mining Production

The Moroccan global mining production is assigned to multi actors, national (MANAGEM, OCP, and others), and international (MAYA GOLD AND SILVER, KASBAH RESOURCES...).

- **MANAGEM Group**

It is an international industrial mining group, specialized in mining production of several kinds of metals, such as Cu, Zn, Pb, F, Co, Au, and Ag. Its present since more than 80 years in Morocco, he is a referential actor in African mining sector.

MANAGEM is focused into three activities: Base metals, precious metals, and cobalt. With a strong expertise, and experiences, the group developed from the year 2000 so many projects in sub-Saharan part of Africa. It's present in countries as Gabon, Democratic Republic of Congo, in Soudan, Congo-Brazzaville, Ethiopia, Mali, Mauritania, and even in the Europe especially in Switzerland. The next Fig. 4

presents the implementation of MANAGEM, in the international scale [22].



Fig. 4: MANAGEM activity at national and international level [22]

The MANAGEM Group evolution is characterized by its responsible commitments, which presents the keys of a colossal growth, respecting the safety environment, the risk control, as well as the participation in the regional development of the society [23].

- **Groupe OCP**

The “Cherifian Office of Phosphates”, or OCP, is the world leader in the phosphates and his derivatives products. In 2012 the OCP was classified as the first exporter in the world, which contributes with 33% in the Moroccan gross domestic product [28].

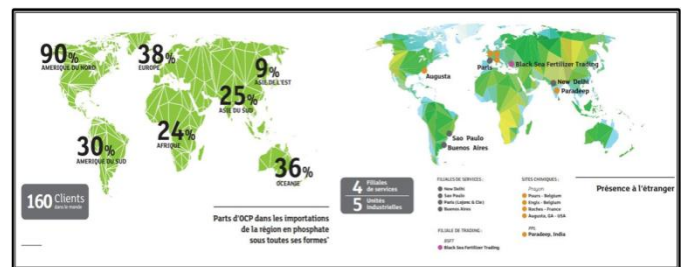


Fig. 5: Repartition of OCP activities in the world. (OCP, 2012)

- **Private Mining Sector**

As regards Mining research, so many effort are well authorized by several National actors, like the National Office Of Hydrocarbons and Mines “ONHYM”, and Cherifian Office of Phosphates “OCP”, as well as the mining companies exerting in the private sector (Managem, Kasbah resources..) [29], this collaboration is for the renewal of the reserves of some deposits, and for the exploration of new potential metallogenic area. What’s raises the evolution the Moroccan mining sector. The following Fig. 6 illustrates the number of production, or exploration projects, carried out by each mining company [35].

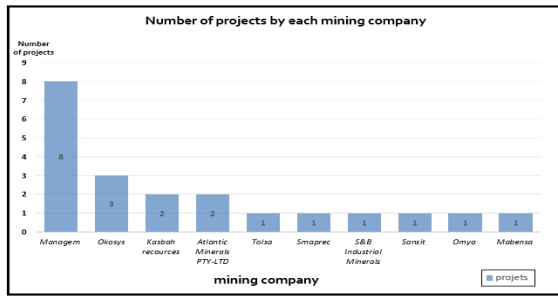


Fig. 6: Moroccan mining activity evolution, expressed by the Number of project by each mining company

The progress of the Moroccan mining sector appears through the increase rate of the investment, which induces a strong competition, explained by the remarkable evolution the total mining production of the kingdom, whereas the sales turnover has increase in 2007 (See Fig. 7).

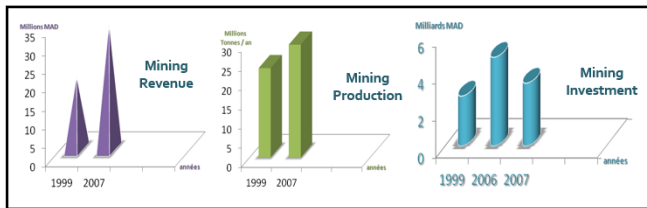


Fig.7: Evolution of the mining sector (revenue, production, investment)

The mining sector evolvement requires a clear view of development, in order to ensure a continuous sustainable improvement.

In the following part, we present our contribution, whereas we will suggest a design of a Global Sustainable Development Management system counseled to the mining companies.

III. TOWARD A MODERN RESTRUCTURING OF THE MINING SECTOR IN MOROCCO

A. Sustainable development issues in the mining sector in Morocco

Leading the strong growth of the mineral substances consumption's (Al, Zn,Mn,...), an ubiquitous straining is trailed, while wondering about the durability of these mineral resources.

The sturdy valorization of mining deposits in butts of a satisfactory production, present a universal contention matter of this century.

In fact, the mining sector, must cope with the need, inasmuch the optimization of the resources, through an exploitation of new deposits (while basing itself on the advanced mining technologies), laying down a new treatment process, thus the recycling of the mining scraps.

The evolution of mining industry generated harmful environmental impacts, and that present the most important puzzle, which need special attention from mining companies [23]. The exploration, construction, extraction, treatment, and

closing, present a several reason, requires setting up the processes to avoid any kind of pollution.

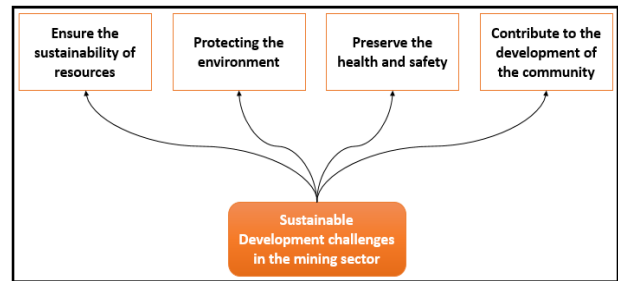


Fig. 8: Sustainable development issues in the Moroccan Mining Sector

Mining activity presents a dangerous employment, what's requires to it, a solid culture of safety processing, based on the OHSAS18001 international standards [13], and on the prevention, by risks policies analysis [9], in contemplation to avoid any kind of accidents.

The mining exertion, depend upon a manpower needs, and out of equipment, which contribute to the direct and indirect, work opportunities, and the evolution of local economic activity around the mine.

The company, which exploits a mining area, must make sure of communication with a various parts, fascinating of account the needs for the bordering communities, by supporting the conception of partnerships with authorities, as well as with the local affiliations or alliances, with an aim of ensuring a regional development.

The heavy position, whatever the mining activity occupies today, can be measured in terms of mining structures sizes at the level of international scale, and also at the organisational level for each structure, while taking a lead in the integration of various systems and standards, supporting any kind of improvement, and contributing to its positioning with stand of the globalization.

The integrated management systems are logical prolongation of the fast development, according management standards [8].

So many terminologies can be employed; it is thus a question of harmonized systems. An integrated system, does not want to say a centralized system [13].

B. The Sustainable development management system (SDMS)

Concerning the transfer of management systems, we notice the divergence of the design of each system, which causes an interoperability problem with improvement.

Our contribution consists in integrating the whole the management systems such as the integrated management systems (IMS), the Energy management system (EMS), the Information management system (InMS), Knowledge and Training management system (KTMS), in only one global system entitled Sustainable Development Management System "SDMS", the following figure presents this concept.

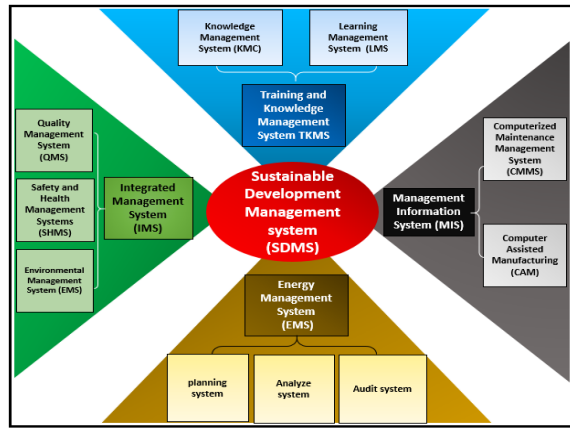


Fig. 9: Sustainable Development Management System Conception

1) *Integrated Management System*

Like any managerial approach, the establishment of an IMS is a voluntary process initiated by the company's management. This system aims at the continuous improvement of the overall performance of the company's quality, safety and the environment.

The IMS includes three management systems: management of Quality, Environment, Health and Safety at Work (Management of Security) [45].

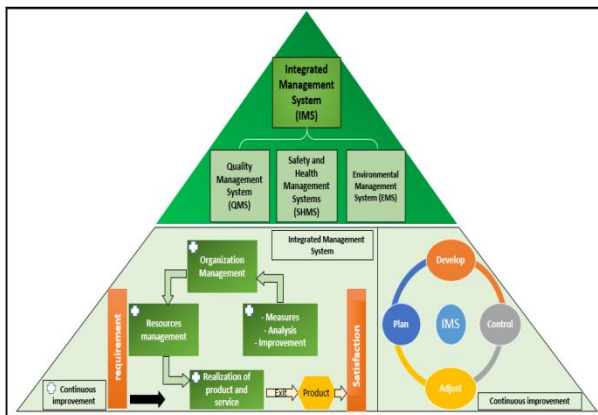


Fig. 10: The concept of Integrated Management System

According to ISO 9001: 2008 The quality management is based on eight basic principles: leadership, involvement of people, process approach, continual improvement, factual approach to decision making, etc...

The inclusion and use of these principles will provide benefits for stakeholders such as the creation of value, stability, and Experience feedback [14], it integration is done by using ISO 9001.

- *Safety and Health Management System (SHMS)*

Safety and Health Management System (SHMS) is a system, which allows taking into account the improvement of working conditions.

This is a workplace safety performance management methodology which is based on prevention techniques, standard procedures [13] and action plans (good practices) [9] by applying any level of mining responsibility.

The Deployment of the SHMS is elaborated from a change project [10] in the business that requires training, participation and contribution of all actors and animators.

In addition, its development is done from an OHSAS18001 standard reference [13] or of good practice guides such as guide ILO / OSH 2001.

- *Environmental Management System (EMS)*

The Environmental Management System (EMS), is defined as being a “component system of Global management, which includes the organisational structure, the planning activities, the responsibilities, the practices, the procedures , the process and the resources to establish, implement, and maintain the environmental policy [41].

It is a system, which includes the management methods of an entity (undertaken, service...), aiming to locate, analyze, evaluate, and reduce the environmental impacts of its activities [12].

The EMS falls under a sustainable developmental perspective, thanks to its actions allowing the reduction of the natural resources consumption, the waste minimization’s, the prevention of pollution, and environmental education...its development is related to the certification ISO14001 [4].

The EMS can plunge into a widened approach in the mining companies by the establishment of integrated management system. It’s integrated, within a classical approach of management, the entire specificized of safety and hygiene, management quality and corporate social responsibility cleanliness system.

These management systems have common operation ranges (example: appendix B of the standard ISO 14001:1996), which can be integrated in collective management system (SMI).

It is great to know that this is not the company to adapt to management repositories, but it's repositories to adapt to the company [45].

This fact is ensured by a closed cycle, which starts with measurements and analyses, assigning an organizational management, whichever include all material, and immaterial resources, in order to guarantee an acceptable performance of the integrated system, and that for a goal to carry out a high quality product, in order to satisfy the customer. (See Fig. 2).

The integrated management system present advantages that result in:

- The consistency of the company strategy, as regards quality, safety, communal responsibility, and environment.
- The limitation of redundancies at the level of operating modes by improving the efficiency of practices whether in the strategic aspect, tactical, or operational.
- The deployment simplicity thanks to similarities between ISO 9001, ISO 14001 and OHSAS 18001.
- Minimization of costs of the enterprise through, for example, a single audit of a single integrated system

instead of three.

- The recognition and preservation of the environment.
- The explanation of the system, as regards organization, use, and documentation.

2) Training and Knowledge Management System (TKMS)

The “TKMS” present a mixture of the knowledge management, and the training management. The following figure presents the conception of the Training and Knowledge management system.

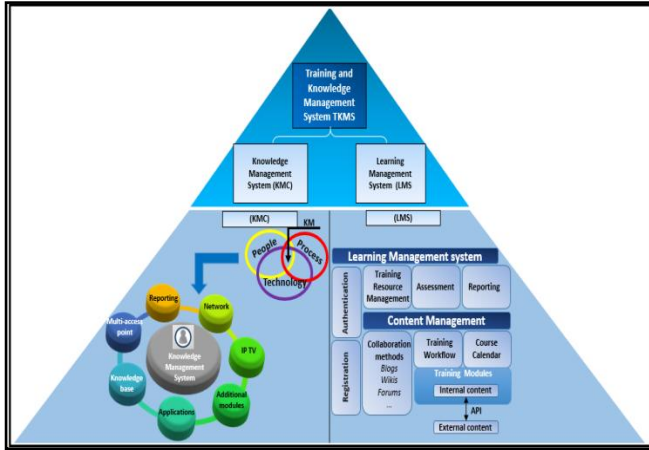


Fig. 11: The concept of Training and knowledge Management System

- Knowledge Management System (KMS)

The KMS is a system gathers the whole of the initiatives, the approach, and the techniques, ensuring the possibility to perceive, to identify, analyze, organize, memorize, and shear knowledge between the members of a company [1].

This system characterizes a significant act as regards approving, reusing, to develop like diffusing the produced knowledge by the mining company [31].

In addition, this management system can improve an organization's performance through motivation of staff whose knowledge is valued, and encouragement of experts to develop a culture of sharing [20], which facilitates innovation capacity within the organization that facilitates the decision support [42].

- Training Management System (TMS)

The TMS consist to the software web application system, developed the accompaniment of employees implied in a process of training [21] that is to say teaching or professional course, using the virtual platforms of e-learning (FOAD) [44], through proving the New Information and Communication Technologies (NICT) system, as example the web “semantic” [19].

3) Energy Management System (EMS)

Energy Management System is a total approach allowing the measurements, the coaching, and ensuring a sustainable

consumption energy control of the companies [5].

It’s setting up to make it able to mining companies to save energy, while contributing to structure a strategy for the energy management, and to characterize in particular again objective, also to evaluate the real performance as well as initializing the behavioral changes (competences).

This is done thanks to the Certification ISO 50001 [27]. The following Fig. 12 illustrates the EMS conception.

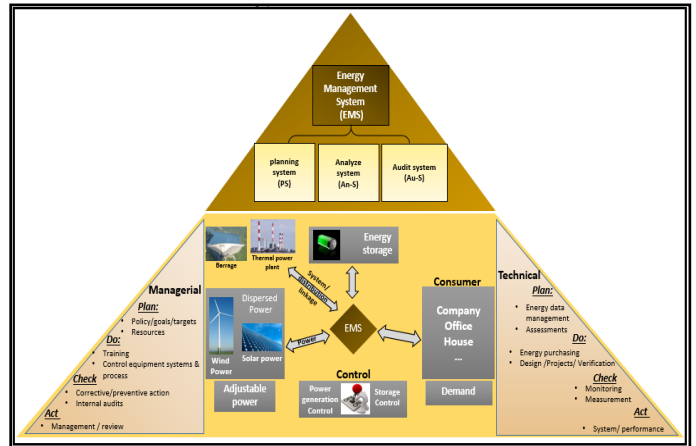


Fig. 12: The concept of Energy Management System

4) Information Management System

Its presents the whole of the Material equipment (computer, Smartphone, GPS...) and immaterial equipment (Staff, procedures, chemical composition, formulates, contents, coordinate of deposits...) allowing collecting, storing, processing, and diffusing the data in positive environment [39].

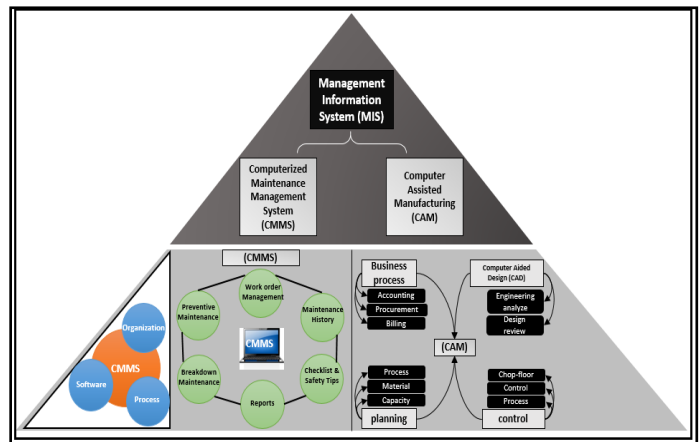


Fig. 13: The concept of Information Management System

It is at the base of the NICT concept, that the Information Management System appeared, their contributions allowing the accompaniment, the automation, and the dematerialization of all operations included in the process or the activity of the company, that thanks to the groupware remote platforms [17].

- The Computerized Maintenance Management System (CMMS)

The information used in the various applications of mining activity, especially in the plant maintenance service, is changed according to the information technologies evolution, and according to the increasing complexity of the industrial environment. In the past this information was seized manually on paper (plans, diagrams, handbooks), and was exchanged verbally from the operator to the other. However today, information is very different. It become structured and formalized in order to be handled by the computer systems [37].

The call for the CMMS (static or dynamic) will meet the needs for the companies, as regard to the exchanges of information, and procedures, than analyzes it maintenance activities and archived [18].

Four standard features, such as the maintenance management, the management of the purchases, as well as the store management [24], characterize the CMMS.

- The Computer Aided Manufacturing (CAM)

The CAM is a modular system (Package Software) of production control, making it possible to manage the whole of the production activities [15] such as the purchase and inventory control, the management of the products [38], the management of the articles entering in the manufacturing processing (nomenclature, range...), the material and immaterial store management, as well as the planning management and the invoicing [30].

C. The uses of SDMS in the mining sector

The use of the SDMS in the mining sector can cause a failure of the integration process, which is generally relative to the resistance according the change, the lack of time, the lack of knowledge.

The integration of the SDMS must be accompanied by a change process [16]-[25], which males it able to guarantee the transition for all the system, by setting the objectives to reached in the future, these objectives must be segmented in three aspects, such as the strategic aspect, tactical and operational aspect [43] removing any obstacle in front of the continuity of the integration influences.

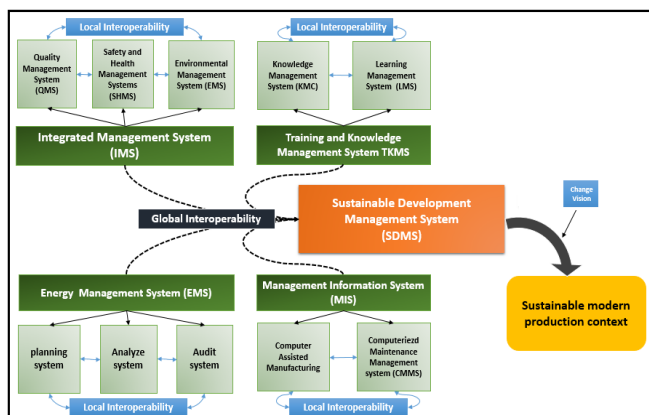


Fig. 14: Location change in a process of integration of the SDMS

IV. CONCLUSION

The implementation of the SDMS in the Moroccan mining sector will bring a return of colossal investment, as regards the optimization of the resources and the energy, of the productivity improvement, environmental protection, as well as the safety work improvement.

The SDMS makes it possible to capitalize knowledge for all the employees of mining sector (Scientifics, engineers, technicians, workers...) what result an increase from efficiency and productivity.

In spite of the development in the matter which characterizes the Moroccan mining sector, it always remains far from the uses of the new technologies (NICT), in the terms of managerial management, and the adopted techniques, which can cause failure during the integration of the SDMS, which requires a vision of multidimensional change, taking into account the technologies, the structure, the process, finally the behavior of staff, and the qualification of the work hand carrying this changes to the mining sector.

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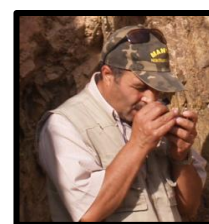


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