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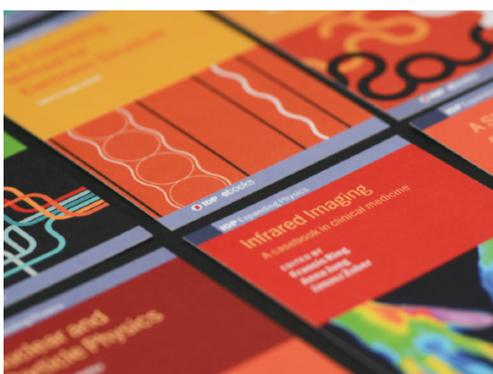
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ICT exploitation in the mining and energy industry in Norte de Santander

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Abstract. This article describes the results of the research paper "Characterization of ICT management of the Coal production sector in Norte de Santander against the guidelines of the current Strategic Plan for ICT in the Mining and Energy sector". The objective of the study details the characteristics of ICT management and its use in the unified environment of mining and energy sector companies in Norte de Santander. As a result, the basic architecture aligned with the ICT strategic plan of the mining and energy sector was identified, which includes: document and archive management, process management, geographic information management, and security. In the same way, the limitations, capacities and state of maturity of the ICT management of the mission processes of the coal supply chain are specified, taking into account the level of integration with systems external to the sector such as the mining cadastre and the Ministry of Mines and Energy, among several and finally the information systems and tools used in decision making.

1. Introduction

The mining sector has been one of the attractions for years in Colombia, listed in the National Development Plan 2014-2018 as one of the "development locomotives" [1] and also in Norte de Santander's Development Plan 2016-2019 "*A Productive North for All*". This attraction is due to the fact that the income of the sector is crucial to encourage the growth of other sectors of the economy in general.

The crisis presented in 2015 due to the closure of the border, prevented mining companies in the region from maintaining their operations which led to their closure, as well as their yards and storage areas.

By the end of 2017, there were 293 mining licenses for coal exploitation, from which 239 thousand tons of coal were produced, corresponding to the municipalities of Sardinata (28%) and Cúcuta (22.5%) and Zulia (27.7%) as stated by the National Mining Agency. This situation was not easy for those who have been making a living from these mining operations for years. (According to ASOCARBON, this industry generates 22 thousand direct and indirect jobs).

At the beginning of 2016, the Ministry of Mines and Energy within the framework of the guidelines of the Ministry of ICTs, published the Strategic Plan for Information and Communication Technologies (PETIC), with the aim of: contributing to optimizing the orientation of the resources assigned to the technological area and motivating the allocation of



new resources and solutions for hardware, software, services and connectivity that the mining institutions require in the short and medium term from their mission context, in order to support management for the period from 2016 to 2019 [2].

For these reasons, there is an interest in knowing the characteristics of ICT management in the productive sector of the coal companies in Norte de Santander and a study was formulated with a descriptive methodological design.

2. Methodology

According to Hernandez, Fernandez and Baptista 2014: descriptive research aims to describe and analyze what exists in reality with respect to the variations or conditions of a situation and thus obtains information about the characteristics and current behavior of phenomena, facts, groups of subjects or areas of interest [3].

On the other hand, the reference framework of Enterprise Architecture (EA): "a model that helps organizations to generate successful planning", was also considered, in the case of this research, the business and technology domains of SMEs have been analyzed.

In 2015, the source of information for companies in the mining exploitation sector [4] was the Chamber of Commerce of Cúcuta. For the study, the statistical calculation of a finite population was applied, where a random sample was obtained. In order to extrapolate the results of the population, the sample must be representative, which leads to a simple random problem because the sample is subjected to a stratified sampling technique [5]. Therefore, SMEs of Coal were selected with the segmented distribution resulting from a proportion of twelve (12) companies with an office in the city of Cúcuta, taking into account that although several companies were not liquidated, they did not reflect activity in their operations. 2015. According to statistics from DANE from that year, the economic crisis in the neighboring country generated negative consequences in the departmental Gross Domestic Product and mining exploitation was the second sector that recorded a greater drop with -1.1%.

To collect the information, a survey was designed as a tool, which considered the four stages of the PETIC's evolutionary model: preparation, integration, knowledge, and participation. This instrument was submitted to the review of two leaders of entities from the local level mining sector: Asociación Productores de Carbon de Norte de Santander (APROCANOR) and the National Mining Agency (ANM) Regional One service point in Cucuta, who responded favorably as it would contribute to the purpose of the investigation.

The survey was done on companies that met the fundamental requirement under Law 905 of 2004 [6] of the size of the company based on the number of employees and the number of financial assets. In addition, the number of mining rights that grant the company the exclusive privilege to explore and exploit the soil and subsoil within the legal framework of the mining industry was considered in the profile of the selected companies.

3. Characterization of SMEs and sample profile

In the study as shown in Figure 1, 58% of the companies dedicated to mining sector work are located in the city of Cúcuta and the remaining distribution corresponds to the location where most of its mining licenses are concentrated in Zulia and Sardinata. The unit of analysis formed by these companies after the segmented distribution for the sample, was reduced to the companies that survived the crisis presented in 2015 by the closure of the border, which did not allow mining companies in the region to maintain their operations and this led to the closure of a large number of microenterprises engaged in mining.

The survey was completed by the leaders of the core processes and the management personnel appointed to formulate the guidelines and strategic directions of the SMEs, the latter represented by the managers and partners correspond to 40% of the respondents, which gave the study a high degree of reliability and the remaining respondents corresponded to process leaders such as mining engineers, personnel chiefs, and a commercial director.

Other characteristics of the SMEs in the study are the following:

- All within the framework of legality with mining licenses between 1 and 8.
- 50% of the companies have a range of 51 to 200 employees, which classifies them as medium-sized companies, according to Law 905 of 2004.
- 87.5% of the companies exploit thermal coal, this type of coal represents 70% of the total production of Norte de Santander.

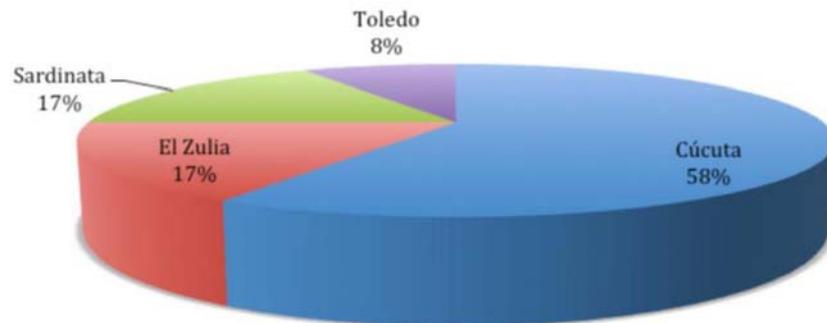


Figure 1. Location of the companies. Source: Survey Question 2.

3.1. The basic architecture of the mining sector in SMEs

The Strategic Plan for Information and Communication Technologies (PETIC): "formulates a Sectorial ICT Architecture that enables the creation of a structure of governable technology in the short, medium and long-term".

For the purposes of the study, the structure of technology in SMEs was articulated with the unified ICT sector plan and its basic architecture is established mainly in:

- Implementation of geographic information services: tools that allow georeferencing, geology, and monitoring of mining areas.
- Implementation of mining planning services: must enable mining planning in monitoring, exploitation, and cotation.
- Implementation of process management services: focus on the needs of purchasing processes, logistics processes, and others required by specific areas of the company.
- Implementation of document management services: you must enable centralized document control.
- Implementation of security services: it is suggested to enable security controls on active directories and central levels of security in databases.

The results of the study show that the SMEs in the mining and energy sector of the department identify the support in the information systems of different areas of the company which even become redundant or conflict due to interests that point to different efforts.

According to the survey analysis, 30% of SMEs have a document management and archiving system to manage document storage and archiving system rules that meet the standards of the nation's general archive. Likewise, the capacity of access to the historical archives is limited because it is manual, as well as the levels of security or privileges over the documents.

With respect to the results of the study, all the technical areas of the mining companies use AutoCAD as a software for the drawing up of their technical plans in the mining projects in execution. Only one company uses GIS-geographic information systems for the centralization of a data set and its subsequent analysis. The main difficulty has been the collection and classification of useful mining information for future characterization and large volumes of information, as well as the conversion of CAD formats that actually support mining operations.

The goal is to complete the information of these vectorial plans, to carry out the conversion process of these CAD formats to be read in the GIS and to optimize their use in a geographic information system.

In terms of technology security architecture, 70% of SMEs lack policies to control access to shared resources and systems, and 75% of companies back up their data on a daily basis. However, their local area networks apply light security controls to systems and implement devices such as firewalls that monitor traffic and protect themselves from viruses and malware with antivirus software. The Strategic ICT Plan for the Energy Mining Sector should define the safety and quality standards to be used in the development of the sector's systems.

The health and safety risks associated with the mining activity require that SMEs use video editing tools to develop content for the training of operational personnel in the prevention and management of industrial safety and mine salvage.

In 2010, the PETIC of the Ministry of Mines and Energy contemplated integration with systems external to the sector and according to the results of the study, 70% of SMEs use computer tools to obtain information through web pages of public entities of the Ministry of Mines and Energy and integrates them into their mission processes in most cases manually, some of them such as electronic publications (mining GDP, foreign investment, production behavior, exports, among others) for greater efficiency and transparency in sectoral procedures and the mining cadastre which streamlines online property registration [7].

3.2. Characterization of the core processes of the coal supply chain in SMEs

The following stages of the Norte de Santander coal chain are based on the approaches of the Energy Mining Planning Unit: exploration, exploitation – development, and assembly of infrastructure, access roads, and services to the mine, profit, transformation, transport, and marketing. According to Nuñez K, 2015 in an exploratory, documentary and descriptive study [8]: “it was able to identify and characterize the specialized software available for mining engineering and concluded that the mining sector has a good number of software tools, which can enable several of these processes in the coal chain”. However, the SMEs surveyed during this research did not show their knowledge and the contribution they can make to the mining chain since most of the software tools are conditioned by the cost of the license and the level of investment of the entrepreneurs is very low due to the sector's situation.

3.2.1. Technological preparation in the organization. On the opportunities represented by the use of ICT to support their business model, the survey shows that it allows them to speed up processes, helps them to improve information processing, is more effective for the company, helps them to increase production by lowering costs and makes the whole company integrate and projects itself better in a more competitive and globalized environment. However, as shown in Figure 2, less than half of the companies have an area in charge of managing ICT and monitoring technological trends, nor do they have clearly defined and prioritized ICT initiatives in the same proportion. Only 17% of companies formulate ICT governance policies.

According to AE's reference framework, the IT strategy and governance components are investigated and it is found that 40% of the SMEs in the sector have the support to manage ICT and monitor technological trends, but in most of these companies the technological services are contracted to third parties for specific tasks and support, which does not allow them to establish strategic ICT projects that are aligned with the business needs.

3.2.2. Commitment to ICT mainstreaming. Less than 20% of SMEs have an IT strategic plan and less than half of companies have not yet formulated a business strategic plan. This suggests that there is a commitment to incorporate ICT but it is not clear what its use and application could be to achieve the strategic goals. Surely if the mining company articulates its strategic IT plan with the business plan, it would link more technology and could obtain greater productivity and

maximize opportunities in the sector, as Fedesarrollo states: At the level of business competitiveness, there is ample evidence in developed countries that the incorporation of ICT represents a source of productivity growth for practically all economic activities, by improving business communications, enhancing decentralized business management, remote monitoring, improved logistics management and web production [9].

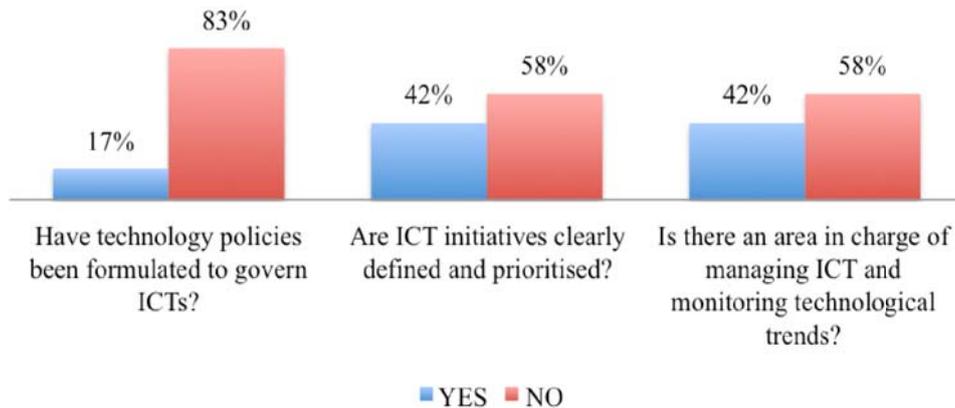


Figure 2. ICT management in SMEs. Source: Survey Question 10b.

3.2.3. Technological resources. Following the definitions of the business architecture framework, the information and technological services component was evaluated and, in this sense, the technological resources in SMEs are dedicated to providing basic computer services, among them: computer equipment, laptops, Internet connection in a high percentage with broadband, e-mail, fixed telephony and intelligent mobile telephony. These hardware devices are mostly interconnected with their own network infrastructure, less than 10% take advantage of other emerging models such as cloud computing schemes. Other features in addition to those described above in the ICT architecture are described below:

- Lack of planning in the computing capabilities required in technological resources.
- All SMEs have digital databases in different technologies and business email. 66% of these companies have a web presence.
- There is a 73% average degree of satisfaction with the quality of the databases.

The information systems that enable their administrative processes are TNS and AUTOCAD for the most part, these tools are acquired through the commercial licensing model. There are no tools to leverage the mission processes, the few implementations are owned developments.

The SMEs that formed the unit of analysis of this study show inexperience and little knowledge regarding ICT as a concept, however, they admit the use of information technology in their processes, since it is generally evident from the already described obtained results, that some tools are used in these organizations for the management, processing and dissemination of information, accounting, and administrative procedures through the use of computer equipment and basic technology services.

3.2.4. Integration. Some 30% of SMEs show integration with other stakeholders such as suppliers in their supply chain. The external systems used by SMEs in various activities of consultation, control and other associated procedures in their mission processes, do not have a direct or automated integration with the company's information systems, otherwise everything is done manually or in some cases the information is downloaded, and technical reports and management tools created such as spreadsheets and word processors.

In addition, during the study, an interview-type instrument was designed for executives responsible for the strategic direction of SMEs and their appraisals, highlighting the urgent need for each link in the supply chain to be able to meet the demand for different goods and services in a timely manner, ensuring product availability and reduce logistics costs in general, thus facilitating the use of technology as the main enabler of the entire mining supply chain. They also expressed that the ICT initiatives in the sector are basic and reduced in the department, they have only exploited the benefits offered by the public entities through the Online Government services-GEL such as ANM, SIMCO, among others and finally their appraisals pointed out that the degree of maturity is medium and they attribute it to the lack of technology in the mines and in the links of the whole chain and the scarcity of equipment and technology supply in Colombia.

3.2.5. Human talent. The distribution of the personnel in its greater proportion corresponds to the missionary and operative processes. The personnel of the administrative area correspond to between 10 to 15% of the total personnel. 64% of SMEs have a human talent development and training plan with greater emphasis on operational personnel in the following areas among the most relevant: mine support, ventilation in underground mines, labor skills, explosive handling and use, work at heights, postural hygiene, environment, first aid and decree 1886/2015 on mining safety. The personnel with functions in technology is usually a single person and more than half of these companies hire and outsource technology personnel according to the demand for ICT work who are not relevant figures in the structure of the organization to make strategic decisions and definitions but a more operational role and support.

3.3. Systems according to maturity level and capabilities

The capability maturity model (CMM) [10] describes a set of characteristics, based on how well an organization adheres to common and repeatable processes to perform the work. MWC maturity models are used to establish and improve processes in an organization by measuring its capacity on a five-level scale: initial, managed, defined, administrated, and optimized. In reality, the application of this model is not only limited to software development companies, but also to companies in various sectors, such as manufacturing and services. This model was used as a reference in the study to determine the degree of maturity of the information systems and processes of small and medium-sized enterprises that are finally categorized at the "DEFINED" maturity level, taking into account that the following characteristics are met:

- Business processes are adequately described and understood in terms of standards, procedures, and manual or automated tools. Each process is characterized, i.e. it has objectives, inputs, activities, and outputs and in the ICT area only general policies are implemented and the documentation is basic.
- The companies that were part of the analysis unit have a quality management system - the international standard ISO 9001 [11].
- The business processes allow the analyzed companies to comply with the product requirements, the processes are standardized and executed according to the documentation, which is the basis of their improvement.

3.3.1. Systems for decision making, knowledge management, and planning. Within the framework of the enterprise architecture, the results of the information systems component showed that the following options generate a competitive advantage for companies in the mining sector and the leaders of these organizations suggest high priority implementation which in the short term will result in:

- The appropriation and use of online government platforms (GELs) [12] in the mining sector and available electronic publications.

- Business management information systems, planning and knowledge management. It is recommended to implement management tools to the outbound logistics, which allow to monitor and improve methods and times in the physical distribution to the ports of export [13].
- Integrated information systems for the management of the mission processes of the coal chain, which can be defined as "the planning and control of flows of materials, products and information that takes place in activities within and between companies, from a source to customers" [14]. Information systems for tracking and controlling of input inventories (wood, fuel, explosives, etc.), and control of the mining payroll, among others.
- The integration of mission-critical processes with its public and private suppliers.

Other useful tools are spreadsheets for SMEs since they have pre-designed formats for recording, tracking and controlling information that is part of the core processes that are later integrated into accounting and administrative software or in some cases consolidation of reports for decision making and planning.

4. Conclusions

It is evident that the business segment of the mining and energy sector is dominated by insufficient management in the areas focused on the development of computer systems; areas that are linked by contracts and external consultancy services. The use of computer tools, according to the characterization of the strategic software consulted in the sample, is limited to specific functions in an isolated manner and are not framed in an integrated information system, which helps the organization to improve its processes and manage its resources.

One of the main problems is the low allocation of resources for the implementation and maintenance of the ICT architecture, due to the fact that 17% of companies have defined technology policies and strategic IT plans that lead them to prioritize their needs in terms of changes in the organization to adapt to the technological environment.

The Associativity is a strategy of transversal improvement in the chain in Norte de Santander, with the adoption of good business practices and productive and economic synergies. Therefore, the entities that best represent the actors in the chain, such as ASOCARBÓN or APROCANOR, should lead the supply chain, align their objectives with a high technological component and increase R&D within the companies so that SMEs can obtain greater added value in the commercial supply of their products and generate an impact on the development of the region.

This joint work should involve academia, through regional bodies such as the University-Business Committee (CUEE), so that projects can be planned in the sector's innovation and research areas.

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