

# **The Relationship and Role of Information & Communication Technology (ICT) in the Mining Industry: An Analysis of Supply Chain Management (SCM) – A Case Study**

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## **ABSTRACT**

An increasing number of researches have been made around Supply Chain Management (SCM) and the Relationship and Role Information and Communication Technology (ICT) plays towards its improvement and sustainability. SCM initiatives driven by ICT brings along synchronized workflow which tends to simplify the complexity of procurement, order processing and financial flow, which help deals with volatile demand resulting from frequent changes in competition, technology and regulations. However, practical insight to addressing the relationship and role ICT plays in the SCM based on real world contemporary case studies, are limited. Through qualitative and quantitative research methodologies as well as review of relevant literature, our paper targets the Mining Industry, specifically, Adamus Resources Limited - Nzema Gold Mine, a Subsidiary of Endeavour Mining Corporation, located in Ghana to close this gap.

**Keywords:** Supply Chain Management (SCM), Information and Communication Technology (ICT), Improving and Sustaining Standards of SCM, Mining Industry, Mine, Ghana

## **1. INTRODUCTION**

Today's Supply Chain Management (SCM) is being viewed by many businesses as an approach that serves as a key source for competitive gains [1]. Information plays a crucial and dominant role in contemporary organization. It serves as the glue between the supply chains and customers as well as facilitating other processes, departments and organizations to work together to build an integrated, and coordinated function [2]. Over the last decade, ICT tools and techniques have evolved from just being a support function to an essential tool of decision-making process.

However, as a result of this, the use of ICT in businesses is deemed a prerequisite for the effective management of current complex supply chains [3]. Indeed ICT implementation drives SCM initiatives by bringing multiple process changes in both suppliers and customers, which leads to information integration, and coordinated workflow as well as synchronized planning [2]. However,

Lucas Jr. and Spittler [4] argued that, the investment of ICT in the supply chain process systems does not warrant an increase in the business performance. This is because having the right ICT system is just one side of the solution whereas training for the use of the ICT system to function properly forms the other side of the solution. In our previous work [5], we reviewed and justified the significant roles ICT plays in SCM and also outlined the importance of ICT in SCM. With reference to our previous work and the relevant literature, there is no doubt that ICT is very important in SCM for sustainable output and Return of Investments of companies and organisations. Through qualitative and quantitative research methodologies as well as review of relevant literature, this paper targets the Mining Industry in Ghana, specifically, Adamus Resources Limited - Nzema Operations, located in Ghana to close this gap and realize the importance of ICT in SCM in the Mining Industry of Ghana.

Our paper is structured as follows. In the subsections of Introduction, we discuss the History of Mining in Ghana; give a Brief Background of our case study Gold Mine (Adamus Resources Limited - Nzema Gold Mine). Furthermore, in the subsections of Introduction, we elaborate on SCM Procedures of the Mine through ICT and discuss our Research Objectives. In Section II, we elaborate on our literature review of the paper by discussing the review of relevant literatures on the relationship and role of ICT in the SCM of the Mining Industry, presenting the definition and theory underlying what role ICT plays in SCM in the Mining Industry, discussing how ICT has helped to improve SCM in the Mining Industry, and what can be done to improve and sustain standards of SCM through ICT in the Mining Industry. Section III presents our Research Methodology and outlines the selected approaches and tools we used for the collection and analyses of the data pertaining to the subject under investigations. Section IV presents the summary of our research results findings from both questionnaire responses and management interviews. Section V finally concludes the paper by presenting discussions on our research findings and linking our findings back to the relevant literature. In Section V, we further discuss the limitations of

the paper, and puts forth recommendations, future work and conclusion remarks.

### **A. History of Gold Mining in Ghana**

Ghana has a long history of mining, especially for gold. Gold from Ghana (gold coast) was traded to Europe at least as early as the tenth century. In the early colonial times, it is thought that, annually more than a quarter of a million ounces of gold reached Europe from African sources. The Precambrian auriferous Tarkwa conglomerates of Ghana were developed in a modern way during the period 1876-1882 by Pierre Bonnat, the father of modern gold mining in the Gold Coast [6]. In 1895, Ashanti Goldfields Corporation began work in the Obuasi district of Ghana, developing the Ashanti and other Mines, which have produced the largest proportion of gold since 1900 in the countries of the Gold Coast. All of these deposits are of Precambrian age [6].

At the Obuasi Mine, over the years, 25 million ounces of gold were mined. At Bogoso, since mining operations commenced in 1873, more than nine million ounces of gold were produced, largely from extensive underground operations [6].

### **B. Brief Background of the Mine (Adamus Resources Limited - Nzema Gold Mine)**

Adamus Resources Limited (a Subsidiary of Endeavour Mining) is located in south-western part of the Republic of Ghana, about 280km west of Ghana's capital city, Accra [7]. The Mine announced its interest in developing the Nzema Gold Mine in 2009 with a designed mill throughput of 2.1 million tonnes per annum ("mtpa") for a projected production target of 100,000 ounces of gold per annum with a ten (10) year estimated life of the Mine [7]. Soon after this announcement of expression of interest, the construction works for the processing plant and the related infrastructure were initiated and completed in January 2011. However, a full swing of production was in April 2011 with an end of year 2011 production of 90,026 ounces achieved [7].

Its mining operations consist of a chain of shallow oxide pits along the Salman trend plus the Anwia deposit 8km west of the plant. However, depending on the type of ore, processing start from 1.6 mtpa to 2.1 mtpa plant with the extraction of the gold through a standard gravity-CIL process. The processing plant is located west of the Salman Central pits and is connected to the national power grid via a substation [7].

To improve and sustain the Mine's operations by increasing Mine life and/or throughput, exploration works is ongoing to discover additional oxide resources both along the Salman trend and the immediate area. In addition, an evaluation is currently underway to identify the

potential of the underlying sulphide mineralization along the Salman trend [7].

### **C. SCM Procedures of the Mine Through ICT**

The supply chain management processes of the Mine starts from customer needs /demands and ends at the point where the customer's needs /demands are fully and satisfactory met. In the past however, each department had its own computer system that focused on sub-optimization. In this modern era, ICT have made it possible for the introduction of Enterprise Resources Planning (ERP) systems such as pronto to manage many supply chains. With the introduction of ERP systems, all departments and functions along the supply chain are integrated into a single computer system that serves all these different departments' particular needs. This ERP system act as an integrated software program that operate on a single database to enable smooth and easy sharing of information and communicate with each other. The Mine SCM processes make provision for the following:

#### **1. Demand Management**

The demand management processes of the Mine's SCM are the processes taken to balance the customers' demands with the capabilities of the supply chain. In the Mine's SCM, the pronto system is used to create reorder reports which determine the reorder quantity of stock items (*which serves as the demand*) or facilitates the calculation of the quantities of stock items to be purchased (*which is also referred to as the need*). This report is maintained in the reorder database to enable the automatic generation of purchase order. However in the case of non-stock or "direct" items purchases, the end users/internal customers are required to place their request by filling out the required information in the online requisition in pronto allowing the purchasing officers or buyers to be able convert the requisition into Quotation Requested (QR)/Request for Quotation (RFQ) and further be able to convert them into purchase order.

#### **2. Acquisition Management**

The Mine SCM acquisition management processes starts with the purchasing officers or buyers receiving the internal customer needs or demands in the form of reorder reports or placement of online requisitions by the end users/internal customers through the ERP/Pronto system, and sending these needs in the form of tenders to selected number of vendors in the form of Request for Quote (RFQ). Once the RFQ's have been sent out to these selected vendors, and quotations received from them, the quotations are carefully evaluated/ analyzed based on some set purchasing criteria such as lead-time, price, quality etc. At the end of the analysis, purchase order (s) is/are created



online through the ERP/Pronto system for the best vendor (s). The purchase order (s) is/are approved by the Supply Chain Manager or a more superior person such as Commercial Manager & General Manager depending on the face value of the purchase order, or by an end user department if the purchase is non-stock/ direct purchase. Once the purchase order (s) has been approved, it is sent electronically to the successful vendor (s) to either supply the items or render the service.

### **3. Logistics Management**

The logistics operations major goal is to move goods and its associated information from vendors to customers through the supply chain network. However, this process is required to keep moving until and unless the goods get to the final destination (i.e. at the right place and at the right time). In the Mine SCM however, this process is wholly the duty of the officer-in-charge of logistics and event management/expediting supported by some other supply chain staffs. To enable a smooth flow of information between the partners within the supply chain network, the Mine has signed several long-term contracts with different number of freight forwarders such as ocean-freight, airfreight, DHL, at high volume purchased countries, with in-country clearing agents and transporters. The logistics and event management/expediting officer monitors all purchase orders/ shipments by tracking to find out the status or progress of all purchase orders/ shipments by login onto the freight forwarders network system (*but the freight forwarders do not have access to the Mine's ERP network*) and quickly informing the Supply Chain Manager of any change in event that may have happened. These events generally relates to late arrival or dispatch of purchase orders/consignments at pre-specified locations. These changes in events are quickly sent across to the appropriate departments by either Supply Chain Manager or directly by the logistics and event management/expediting officer to enable them put in place an appropriate plan to rescue/sustain operations while a continuous monitoring of the progress is done until the delay is fixed or the consignment finally arrives. This process ends when the goods are received, inspected and stored in the warehouse or delivered to internal customers satisfactorily.

### **4.Regular Assessment of Supply Chain Performance**

Regular assessments of the Mine SCM performance is done using the information that are captured in the ERP/Pronto system on the various processes for the purpose of reporting and identifying shortfalls in the processes to look at ways to improve. The ERP/Pronto system enables the possibility of tracking the various process transactions that takes place within each functional

area and between the business partners. This critical activity is undertaken to ensure the internal customer's satisfactions are always met and even exceeded. Metrics and measures such as information on how often vendors keep to their promises on deliveries, information on the percent of orders filled on time from the warehouse to the internal customers, information on how often deliveries made by vendors are made full truckload and full pallets of individual products, and information on how often products delivered by vendors meet the quality standard as quoted, etc. are collected from Pronto and critically analyzed and where there is a shortfall or where applicable, an improvement strategy is adapted to fill the gaps.

## **II. RESEARCH OBJECTIVES**

The paper's aims and objectives are to investigate the role ICT has played towards the improvement of the mining business performance through an effective SCM in the Mining Industry with emphasis on a specific Mine as a case study. More purposely, the paper looks into what role ICT has played to help improve SCM specifically, and mining business performance as a whole and how it will help sustain the standards that have been achieved in the SCM in the Mining Industry.

Because the chosen case study organization operates in a *non-customer competitive and resources and financial acquisition competitive arena*, the direction of the study is channeled towards the reduction of the Mine operational cost performance and the improvement of the SCM operations through the use of ICT towards the achievement of the Mine's growth and sustainability.

## **III. LITERATURE REVIEW**

### **A. Introduction**

This section of the paper reviews the relevant literature on SCM and ICT in relation to the general context within which they are applied. It also reviews literature on the relationship between SCM and ICT. It further looks at reviewing literature on how ICT has helped improved and sustain SCM standards in the Mining Industry. This will clearly establish the current state of the knowledge in the subject, its limitations and how this research fit into the general industrial context. Analyzing the literature is aimed at making available a great deal of information to clearly point out to the fact that, there is the strong need for ICT adaption and implementation within the SCM network for continuous improvement and sustainable SCM standards on a more generic front.

### **B. General Concepts**

The conventional approach to managing supply chains (SC) has evolved considerably over the last decade. Shavazi et al. [8] argued that, "face-

*to-face management, manual tracking systems, paper-dominated order processing systems, and wired communication links were the primary management tools available to logistics managers*". With the current new face of SC, all these management tools have turned out to become obsolete [9]. This has come into play as a result of the massive increasingly growth and the complex nature of the SC network. This complex massive growth has surfaced according to Shavazi et al. [8] because of the high global difference in cost of labor pushing businesses to source for raw materials and services from cheaper labor nations to help control cost of production and stay competitive in the market. Furthermore, they argued that, current customer taste has become increasingly complex with a high demands rate for customized products that better suit their needs. This high resultant increase in product variation has made forecasting of demand a very intricate task for businesses to manage and predict both volumes and option mix as against a distinct demand pattern.

This has brought about the increase in the supply base and cost of coordination. Organizations are therefore required to increase their competitive strength to help them standardize and improve their internal processes to enable them produce goods and services with superior quality, shorter lead time, increasing service level and at reduced minimum possible cost [10][11]. However, Gek et al. [12] added that, though there is the need for businesses to optimize their internal processes, there is also the strong need for them to coordinate with each other's businesses within the supply chain network. With this complex network of suppliers, factories, warehouses, distribution centers and retailers, the key SCM success of any SCM strongly relies on how sound the entire supply chain network system is being managed [8].

The high rate of geographically located businesses within the SC network has made businesses view information as the most critical tools for SC to flourish. Shaikh et al. [11] strengthens his argument by also mentioning that, the most critical aspect in the management and maintenance of the SCM network is the timely availability of relevant information. Sweeney [1] mentioned that, there is a collaborative sharing of information and processes between the various Supply Chain (SC) partners by using an ICT system such as Enterprise Resources Planning (ERP). Indeed, ICT has become the key enabler in the management of the current geographically located supply chains to achieve stronger supply chain capabilities and sustainable business competitiveness [1].

### **1. Supply Chain Management (SCM) Concept**

Sweeney [1] argued that, many definitions exist for SCM. As a matter of fact, many authors have attempted to define Supply Chain Management (SCM) in their various capacities, yet none have so far been able to offer a more comprehensive definition. Shavazi et al. [8] offered a single and encompassing definition by stating that, SCM is a systematic, strategically synchronized conventional organization function within a single business and across the borders of businesses within the SC, to enhance the continual concert of the individual partners and the entire company. Campbell & Wilson [13] defined SCM "as a set of two or more connected business relationships in which exchange in one relationship is contingent of non-exchange in another". Biniazi et al. [10] argued that, supply chain is formed when two or more organizations are integrated though individual businesses that might be officially separated by current issues such as materials, information and financial flows but related to each other with the main focus on promoting entire SC sustainable growth.

### **2. Information and Communication Technology (ICT) Concepts**

Information and Communication Technology (ICT) as cited by Asabere et al. [5] is an umbrella term that includes any communication device or application, as well as the various services and applications associated with them, which enables businesses to gather, store, access, and analyze information used in taking strategic business decisions and also enables communication within the business functions and between the business partners.

To a greater extent, all sectors see the factors of supply chain as drivers for ICT investment. Indeed, there is the strong need for increased organizational efficiency, improved communications within and among partners and reduced paperwork, and responding to customer and supplier needs. The strongest drivers among them appear to be meeting customer needs and the need for better communications within and among partners [8]. This means that, there is a strong need to integrate information flows across the network partners within the value-chain. This has called for common data and transaction standards within the value-chain. Such initiatives are clearly of great importance to support effective exploitation of business-to-business e-commerce.

In the Mining Industry, since the industry deals with high value stock consignments/capital goods, the effects of insufficient, inadequate or inaccurate flow of data and information (Silos' of information) across the boundaries can be profound. It is necessary to interface within and between the partners of the supply chain to ensure optimal exchange of information across the boundaries.



### **3. The Relationship Between ICT & SCM**

Various researchers have attempted looking into the relationship between ICT and SCM. The relationship between ICT and SCM is indeed of much interest to many scholars lately because of the immense importance put forth in the business arena. The extensive adoption of supply chain concept among many businesses partners located in different geographical locations has lately stressed on the increasingly importance of the use of ICT in SCM operation to help offer greater global service to enhance customer needs [14]. Asabere et al. [5] argued that, ICT has helped strengthen the linkage between SCM partners and offered an effective way of managing time, cost and equality of the services delivery. Shavazi et al. [8] also argued that, ICT has come to support the collaboration and coordination effect of the supply chains activities through information sharing. Information sharing is indeed the greatest key element towards the enhancement of supply chain operations. Asabere et al. [5] pointed out that, the development and the presence of ICT have immensely affected SCM and its processes in many ways over the last decade. Indeed, ICT has become an imperative tool for the achievement of competitive gain and this achievement is increasingly dependent on the capability of businesses to create customer's value through the effective use of ICT.

#### **C. What is the Role of ICT in SCM?**

Sweeney [1] argued that, most business activities can be described in terms of five functions including buy, make, store, move and sell, and this is referred to as "micro" or internal supply chain, yet, these functions have been managed traditionally and over the years in isolation (cross-purpose). "Supply Chain Management means thinking beyond the established boundaries, strengthening the linkages between the functions, and finding ways for them to pull together" [1]. Again, Sweeney [1] mentioned that, maximizing the SCM level of effectiveness and efficiency of the flows of material, money, and information along the full chain should be administered in an integrated and holistic approach, with the key aim of improving the overall service and cost objectives. This is indeed the key role that is being played by ICT in the SCM. ICT when employed into the SCM operations closes the gap or acts as an interface between the various processes within and between the SCM systems and therefore according to Sweeney [1], ICT smoothen the flows of raw materials, money, and information from source through the various phases of operations in the chain to the final user. Biniazi et al. [10] argued that, the management of information and appropriate synchronization between the partners will lead to an ever-increasing influence on the speed, accuracy and quality etc. which will

further result in an overall performance increase of the Supply Chain Operations.

#### **D. How has ICT Helped to Improve SCM?**

The use of ICT has become increasingly prevalent. Indeed the greatest effect of ICT on businesses is the huge increase in access to services and information causing better and often cheaper communications within and between the supply chain partners. The presence of ICT in the SCM operations has given rise to a new face of business operations. The use of ICT in the SCM has indeed brought about greater coordinated efforts in business processes among supply chain partners. This has subsequently brought about an improved buyer-supplier relation as a result of process changes leading to reduced variability and uncertainty in information possessed by both parties. Fasanghari, et al. [3] argued that, the adoption of ICT in SCM has helped "improve supply chain agility, reduce cycle time, achieve higher efficiency and deliver products to customers in a timely manner". ICT in the SCM has really made information flow across the length and breadth of the chain in a time-compression manner (quicker). ICT has also made SCM operations more efficient and reliable and serves as every organizational key operations enabler. Shavazi et al. [8] argued that, the close relationship of the two concepts, SCM and ICT sometimes makes it difficult to assess which one contributes to the benefits of the other.

#### **E. What can be Done to Improve and Sustain Standards of SCM Through ICT?**

Biniazi et al. [10] argued that, "Supply Chain design is based on the strategic factors and customer attention and needs to design the supply chain, so that it covers the range of available products, services, new products or customers section, based on the knowledge of the final product in the supply chain". This clearly depicts the fact that every organizations supply chain is its core operational driver, and its design is made possible by putting together a number of independent systems. Sweeney [30] pointed out that, to improve SCM there is the strong need to integrate supply chain activities and information across the length and breadth of the chain as several supply chain non-value added activities arise as a result of the presence of fragmented supply chain configurations. There is this saying that, 'the whole is greater than the sum of the various parts'. This is an unarguable fact beyond all reasonable doubts. An integrated system generates significant improvements as it adapts to the 'total systems' thinking approach and tends to become a more robust system. Sweeney [30] argued that, system deficiencies are mostly caused by poorly designed interfacing among subsystems rather than any inbuilt subsystem weaknesses. It is obvious that, improving and

sustaining SCM standards strongly requires the need for the improvement of the interfacing between the various SCM systems to enable the free flow of information across and along the chain which serves as the key enabler to SCM. Realizing this dream requires the need to make present ICT in the SCM. Indeed, ICT has all it takes to help close this gap by offering closely interface subsystems to deliver updated data and information across and long the supply chain, making the process more efficient and more effective to operate [10]. Sweeney [31] argued that, “effective ICT is a key success factor”. To improve and sustain SCM standards using ICT, ICT implementation in the SCM ought not to be done in isolation, instead be part of an integrated approach to total supply chain design and management [31]. It should also be noted that, users and training are also essential part of the successful improvement and sustainability of the SCM operations through ICT.

### **III. RESEARCH METHODOLOGY**

The approach adopted by researchers to collect and analyze data with regards to the subject matter is termed the research methodology. White [15] argued that, research methodology (research ‘onion’ as put by Saunders et al., [16]) is the rational upon which the research is founded, whereas the approach/technique utilized to collect data and information is identified as the method.

This main aim of this section of the paper is for the authors to present their approach adopted in the investigation of the research subject.

The process of investigation in this paper includes; the methodology adopted, the research design, the data collection methods, the reasons for the adoption of a hybrid of questionnaire and semi-structured interviews as against other methods, and data analysis for the study. The research design section of the paper comprises of quantitative research, qualitative research, validity & reliability of the research and ethics and confidentiality.

#### **A. Research Methodology Adopted**

The authors followed the case study methodology in an attempt to answer the research questions [17]. According to White [15], a case study is an in-depth study of a distinct circumstance such as an organization. In fact, it is a detailed investigation from all sides of a situation. The researchers chose this methodology as a result of their perceived in-depth research on the topic in the chosen organization which is best suited. The application of the investigative study has three main intents, namely: to seek comprehensive information about the role of ICT plays in the SCM in the Mining Industry, to investigate how ICT has helped to improve SCM in the Mining Industry and to seek what can be done to improve and sustain standards of SCM through ICT in the Mining Industry.

#### **B. Research Design**

Trochim [18] argued that, “research design provides the glue that holds the research project together”. It is therefore obvious that, without an appropriate research design in a research, that research will be disintegrated creating lack of correlation among the individual sections.

The authors have made this paper come into reality through the use of case study. To enable them arrive at ‘method triangulation’ [15], they employed a variety of methods and tools in the research design which includes both quantitative and qualitative techniques. As pointed out by White [15], “a characteristic feature of case studies is that they employ varieties of different techniques”. Saunders et al. [16] also argued that, a case study is a research strategy which involves an empirical study of a specific situation trend within its real life perspective via several sources of data. Indeed, it could be argued that, researching a single topic via a variety of diverse methods is highly complementary, as the outcome of the research turns to offer a more comprehensive understanding of the problem under study. The quantitative research was administered through the e-mail addresses of the individual senior staffs of the Mine who were mainly the targeted group for the questionnaire. The management team members of the Mine, basically the heads of departments were interviewed to carry out the qualitative research. Some of the dynamics that were considered in the design to appreciate the relationship and role of ICT in the Mining Industry were included in the survey-based questionnaire for the Mine senior staffs and the in-depth questionnaire for the management interviewees. The following were considered and discussed in detail in the interviews and survey questionnaire design.

#### **1. Quantitative Research**

Quantitative research techniques as argued by White [15] are sometime referred to as ‘scientific methods’ mainly based on the collection of facts and observable facts, and used to describe, explain, infer laws and ascertain a correlation. The quantitative research was administered through the e-mail addresses of the individual senior staffs of the Mine who are mainly the targeted group for the questionnaire in the form of survey using a self-administered structured questionnaire.

The selection of the sample population with the most information regarding the research area is a common slant often used in business research [19]. This is known as purposive sampling approach. Simply put, this technique aims at the most knowledgeable group of people – the senior officers. The two main reasons for focusing on these groups of people are: firstly, because the group will understand strongly the relationship and role that ICT plays in the Mining Industry, hence can make



more reasonable contributions to validate the data collected, secondly, it is imperative for the authors to capture their views to better understand the research topic.

### **1.1 Survey Questionnaire Design**

The paper's survey questionnaire is structured into four (4) sections. The first section has questions that are related to the respondents' general information. The remaining three (3) sections are assigned each to the three research questions. Averagely, each section contains ten (8) questions with a combined multiple-choice, close-ended, open-ended and a rating question with sub-section for further comments.

Under section one (1) of the questionnaire, thus, the general respondents information section, the questionnaire has questions such as, the employment status of the respondents, as there was a high possibility of the various respondents having different employment status. The full job titles and departments they work for were asked to enable an analysis to be made as to whether the type of the departments the respondents work for has some amount of influence on their response to the questionnaire. How long they have worked with their current Mine and how much experience they do have working with other Mines, rating the duration of the respondent such as less than 1 year, 1-5 years, 5-10 years, 10-15 years and above 15 years.

Under the second section of the questionnaire, this section had questions that attempt to gather information to help answer the question what role does ICT plays in SCM in the Mining Industry.

Section three (3) of the questionnaire had all questions related to the research question in an attempt to gather information on how ICT has helped to improve SCM in the Mining Industry?

The last section, section four (4) of the questionnaire also had all its questions moving in the direction of attempting to answer the last research question, what can be done to improve and maintain standards of SCM through ICT in the Mining Industry?

*A copy of the survey questionnaire can be found in Appendix F.*

### **1.2 Primary Quantitative Data Collection**

The survey monkey's website was used right from the scratch which made it easy to carry out, administer and explore the research for smooth understanding and the design of the questionnaire. The target population for the quantitative data collection was the fifty (50) junior and middle senior officers of the Mine. The quantitative data collected from the respondents were done through the individual respondents e-mail addresses and completed questionnaires returned to the authors through an email address provided on the questionnaire.

The questionnaire was designed to provide both categories (yes/no) answers and Likert scale (5 point) questions for the purposes of the analysis. Despite the persistent e-mails and follow-up phone calls, a total of thirty-six (36) valid responses were collected and used for further analysis. This produced a return response rate of 72 per cent which is considered adequate for this research.

Descriptive statistics according to White [15] was used to evaluate and analyze the data and information collected from the quantitative research, making the data more visible and most suitable for onward interpretations.

According to Trochim [18], descriptive statistics is used to describe 'what is or what data shows'. Given the small sample size, it was not most suitable to proceed with inferential statistics. Inferential statistics is however a way of getting to a conclusion of a study by going beyond the direct data in an attempt to infer from the test data about what the population might assume [18].

### **1.3 Pilot Study**

Six (6) respondents were used to conduct a pilot test on the questionnaire before getting to the targeted population. This provided an insight to whether or not the questionnaire will be easy to follow by the respondents. As argued by White [15], the quality of any questionnaire is dependent on the quality of the questions provided in the questionnaire. The pilot study helped ascertain any potential future problematic areas and deficiencies in the questionnaire, making it possible to make the necessary further adjustments to the questionnaire prior to the actual implementation of the questionnaire during the full study [20]. White [15] argued that good and easy going questions will keep the respondents focused and will promote accurate responses.

## **2. Qualitative Research**

This is a "staple form of research" [15] and originated from the interpretative tradition in the social sciences [21]. This method uses descriptive, non-numerical form of collecting and analyzing data [15] and offers potentially great means of investigating the subjectivity and complexity of the subject matter [21][22]. A qualitative research attempts to investigate a central research question instead of proving or disproving a predetermined thought [21]. Wainwright [23] argued that, the qualitative research method attempts to create an in-depth perception of the experiences of the participants and the significances among their explanations of a specific activity, process or occurrence. Rubin and Rubin [24] argued that, qualitative research is all about making out what outcomes mean, how people adjust to situations and how they see what has occurred to them and around them. Over the last decade or so, there has been that

evolution of a greater number of qualitative methods with some of the excellent ones including “interviews, observation and the use of diaries [15]. This paper used interviews as the qualitative research approach with the Mine’s management team to find out what is at stake regarding the relationship and role of ICT in the Mining Industry.

### **2.1 Interview Questionnaire Design**

The interview questionnaire was designed with only open-ended questions with more than one question on the same topic to check and correlate the validity of the response. To enable the authors to easily and properly compare and contrast the opinions of both the non-management and management staffs, similar questions to that of the survey questionnaire were asked but in different approaches. There were certain questions that were pulled out from the survey questionnaire and added to the management interview questionnaire but unfortunately these questions were not put under sections as in the case of the survey questionnaire. The question as to what are the interviewee’s current roles with the ‘Mine’ and the length of stay on the same role with the ‘Mine’ were the first questions on the interview questionnaire. This was followed by a question on how the interviewees will describe the presence of ICT in their Mine’s SCM. Next was the question, what role the interviewees think ICT plays in their Mine SCM. The question, has the infusion of ICT into the Mine SCM brought about some form of improvement to the SCM was asked followed by several series of questions such as, is ICT really an imperative tool to the Mine SCM operations and why, how has ICT helped to improve the Mine SCM and many, many more.

*All responses received from the interviews conducted can be found in Appendix A-E.*

### **2.2 Primary Qualitative Data Collection**

White [15] argued that, interviews are considered more suitable methods to use when a case study research strategy is employed. The interview focused on the management team members, i.e. heads of department of the Mine who are strongly believed to be able to furnish the authors with further insights regarding the “what, how and why” questions [16]. Furthermore, White [15] suggested that, open-ended interviews questions should be employed to allow for qualitative analysis as part of the case study strategy. The paper interview examined the views of the targeted population on their perceived thoughts on the relationship and role of ICT in the Mine SCM system in practice. A detailed literature review was conducted prior to the design of the content of the questionnaire to enhance the reliability and validity of the data. As argued by Sturges & Hanrahan [25], the face-to-face interview is considered most

appropriate and popular by many researchers conducting semi-structured or in-depth interviews and hence, the authors deemed it fit to adopt this technique to solicit the views of their targeted groups during their interview. The authors adapted a sample size of 6 for the interview to enable them have some reassurance as to a reliable sense of “thematic exhaustion” within the data set [26].

### **2.3 Pilot Study**

Two (2) interviewees were interviewed to pilot test the semi-structured interview questions to determine the typical time required for each interviewee and was incorporated back into the study to devise the questions. At the end of the pilot test, it was observed that certain questions were too narrow whereas others were ambiguous making the administering of the interview very lengthy. Those narrow questions were expanded a little and the ambiguous questions rephrased and re-piloted on another interviewee. The final questions were clear enough and the time taken to administer thereafter noted. White [15] argued that, a pilot study makes sure the questions are clear to understand and aids the removal of any vagueness, as well as aids in timing the interview. In a nutshell, this assisted the design and redesign of the questionnaire for the interviews.

### **C. Validity and Reliability of the Research**

Validity is all about whether the result of a research are “*really about what they appear to be about*”, whereas, reliability is basically the degree to which the technique for collecting the data or analysis of the data will offer reliable results [27]. However, White [15] argued that, “*validity is concerned with the idea that the research design fully addresses the research questions and objectives*” that the authors look at answering and achieving, whereas “*reliability is about consistency of the research, and whether other authors could employ the same research design to arrive at similar results, though the explanation and conclusion might absolutely be different from the previous author’s point of view.*”

The authors have attempted to ensure validity of the research with a detailed literature review and several pilots testing of the questionnaire and the interview questions guaranteeing the targeted groups comprehend and appropriately understand the questions [28][29]. Additionally, the authors on various occasions have had series of discussions with the targeted groups (senior managers, managers and supervisors of the Mine), all in the name of communicating deeply with them on the essence of the research. The continuous, devise approach and persistent education of the purpose of the research to the targeted group resulted in the expression of their willingness to offer the authors with the needed data for both the



questionnaire and the interview. Yet, for internal improvement of both the questionnaire and the interview to be achieved, the authors requested the participants of the pilot test to give considerable feedback. Indeed, the feedback received was extremely helpful as it assisted in identifying vague and complex questions, identifying the durations used in answering the questionnaire and interview questions to make out whether the durations are reasonable or whatever, eliminate or revamp vague questions that were not answered or not answered properly [29]. For the fact that one of the author's work in one of the mining companies in Ghana and that he is in close relationship with the majority of the survey respondents and interviewees, and that the respondents have already expressed their greatest desire to respond to both the questionnaire and the interview, makes it obvious that the research result can be considered authentic and hence can be generalized to operating businesses in the same industry. This brings us to the conclusion that, the study can be replicated under a similar methodology with no difficulties, therefore it is considered reliable.

#### **D. Ethics and Confidentiality of the Research**

The respondents of the survey were the main users of the company's senior staff's intranet section; therefore the responses posted cannot be viewed by any other groups of people outside this group. There was also a brief pre-notification message to the targeted respondents to inform them of the purpose of the study and assured respondents that their responses or information provided will be treated strictly confidential and shall only be used for the intended purpose. Additionally, a participant information sheet was sent to respondents to be read and understand, and a model consent form to be read, understood, signed and returned by the participant to the author/ researcher before the commencement of the survey or interview. Following that was an introductory message clearing stating that, the response is only and only for the purpose intended. It is important to "only involve people with their consent or knowledge" [15] and also inform the targeted respondents properly about the research so as to make a more-informed decision as to whether to participate or otherwise. Also during the research, the respondents should be given the right to redraw and remove their consent if they so wish.

The management team of the Mine interviewees were also assured of the fact that, their ideas and opinions shared will be exclusively use for the intended purpose. For that matter, their personalities were not completely disclosed in the paper but only their roles within the Mine were used. The respondent were made to know that, they were not in any way representing their Mine in

sharing their views but they were on their own in relation to the Mining Industry in general, based on their experiences on the ICT and Supply Chain operations of the Mine.

#### **E. Description of the Empirical Research Study**

The authors used approximately two (2) weeks to complete research tasks involved and receive responses of staff for the empirical part (the survey and the interview) of the paper. Though the survey questionnaire could have taken 20-30 minutes to get completed by each respondent, the questionnaire was still made available to the respondents for a period of two (2) weeks for the reason of convenience and accurate answering of the survey questions. After this length of time, 36 usable and fully completed responses were collected from the respondents. The management interview participation was excellent right from the beginning to the end, recording a hundred percent turn-out from the interviewees within two (2) days.

### **IV. ANALYSIS AND RESULTS OF THE RESEARCH FINDINGS**

#### **A. Questionnaire Response**

The responses to the questionnaires we received after distribution are depicted below. We used Microsoft Excel to create charts and tables to correspond to the received questionnaire responses. This can be verified from figures 1 to 19 and table 1-10. We also adopted the Likert Scale Formula:

$$Mean = \frac{\sum N}{\sum n}$$

in the 1-5 scale/opinion questions, in order to achieve accurate result of the responses. In our table results for the scale/opinion questions, we also used SA to denote Strongly Agree, A to denote Agree, NL to denote Neutral, D to denote Disagree and SD to denote Strongly Disagree.

#### **1. General Respondent Information**

- Responses to Question 1.1 depicted below in figure 1, showed that all of the respondents (100%) were contract staff of the Mine.

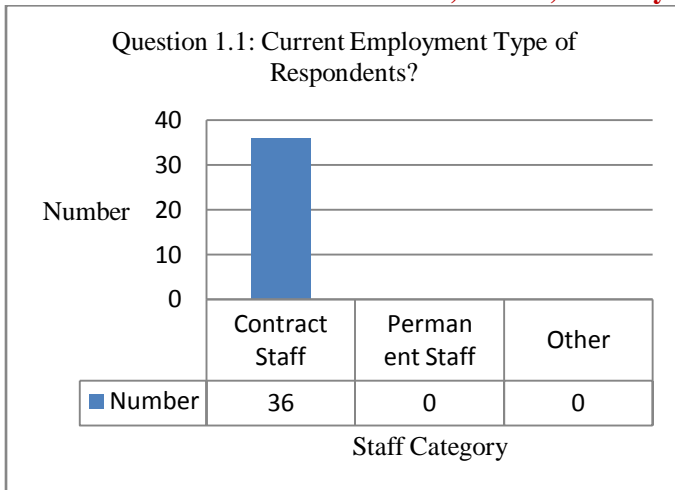


Fig-1: Responses to Question 1.1

- Responses to Question 1.2 depicted below in figure 2, showed that 28 (78%) of the respondents were mostly males and the remaining 8 respondents (22%) were females.

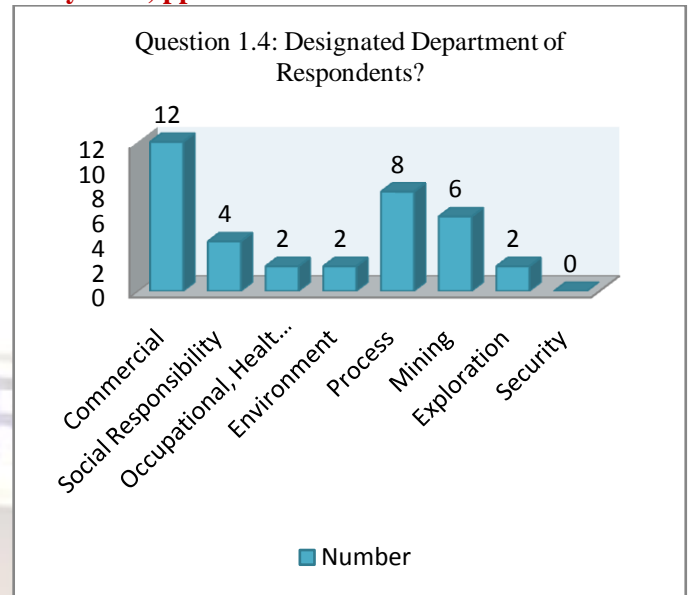


Fig-3: Responses to Question 1.4

- Responses to Question 1.5 depicted below in figure 4, showed that 32 (89%) of the respondents had worked in the Mine for a duration of 1-5 years and the remaining 4 respondents (11%) had worked in the Mine for a duration of 5-10 years.

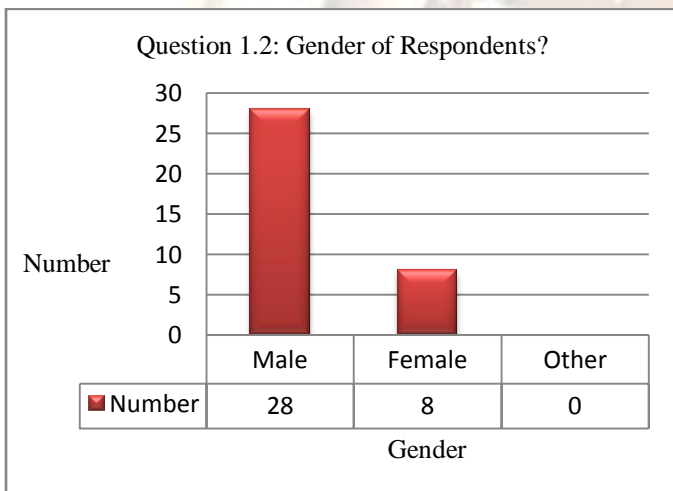


Fig-2: Responses to Question 1.2

- Responses to Question 1.4 depicted below in figure 3, showed that 12 (33%) of the respondents work in the Commercial Department, 4 respondents (11%) work in the Social Responsibility Department, 2 respondents of three different sets (6%) work in the Occupational Health, Environment and Exploration Departments. 8 (22%) & 6 (16%) respondents work in Process and Mining Departments respectively. We didn't receive any responses (0%) from the Security Department.

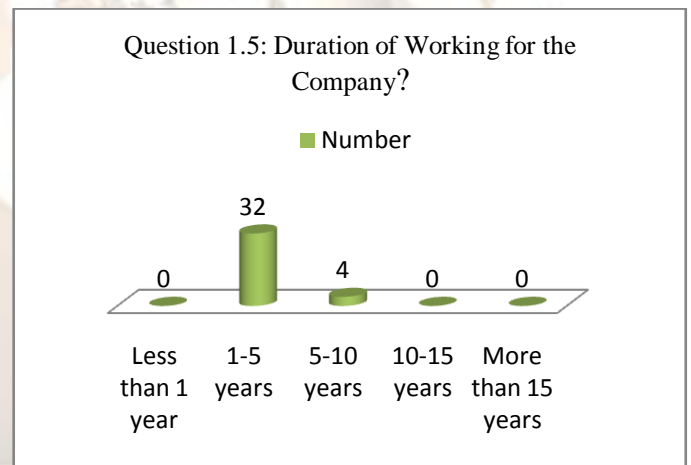


Fig-4: Responses to Question 1.5

- Responses to Question 1.6 depicted in figure 5, showed that 24 (67%) of the respondents had worked in the Mining Industry for a duration of 1-5 years and the remaining 12 respondents (33%) had worked in the Mine industry for a duration of 5-10 years.



Question 1.6: Duration of Working for the Mining Industry?

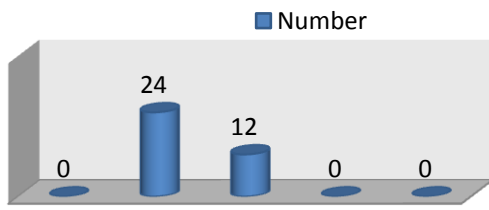


Fig-5: Responses to Question 1.6

## 2. What is the Role of ICT in SCM in the Mining Industry?

- Responses to Question 2.1 (*The Presence of ICT in Your Mine SCM Will Provide Information and Material Availability and Visibility?*) depicted below in Table 1, showed that 32 (89%) of the respondents “Strongly Agree” and the remaining 4 (11%) respondents “Agree” to Question 2.1. From table 1, further applying the Likert Scale Mean Formula to the responses of Question 2.1, depicted the result shown below:

$$Mean = \frac{\sum N}{\sum n} = \frac{40}{36} = 1.11$$

This result depicts that most of the responses to Question 2.1 are aligned to scale 1 (“Strongly Agree”).

Table-1: Responses to Question 2.1

	SA	A	NL	D	SD	Σ
Scale (s)	1	2	3	4	5	
Frequency (n)	32	4	0	0	0	36
N = (n*s)	32	8	0	0	0	40
						Mean 1.111111

- Responses to Question 2.2 (*The Presence of ICT in Your Mine SCM Will Enable a Single Point of Contact for Data?*) depicted below in table 2, showed that 24 (67%) of the respondents “Strongly Agree” and the remaining 12 respondents (33%) “Agree” to Question 2.2. From table 2, further applying the Likert Scale Mean Formula to the responses of Question 2.2, depicted the result shown below:

$$Mean = \frac{\sum N}{\sum n} = \frac{48}{36} = 1.33$$

This result depicts that most of the responses to Question 2.2 are aligned to scale 1 (“Strongly Agree”).

Table-2: Responses to Question 2.2

	SA	A	NL	D	SD	Σ
Scale (s)	1	2	3	4	5	
Frequency (n)	24	12	0	0	0	36
N = (n*s)	24	24	0	0	0	48
						Mean 1.333333

- Responses to Question 2.3 (*The Presence of ICT in Your Mine SCM Will Allow Decisions Based on Total Supply Chain Information?*) depicted below in table 3, showed that 28 (78%) of the respondents “Strongly Agree” and the remaining 4 respondents (11%) “Agree” to Question 2.3. From table 3, further applying the Likert Scale Mean Formula to the responses of Question 2.3, depicted the result shown below:

$$Mean = \frac{\sum N}{\sum n} = \frac{44}{36} = 1.22$$

This result depicts that most of the responses to Question 2.3 are aligned to scale 1 (“Strongly Agree”).

Table-3: Responses to Question 2.3

	SA	A	NL	D	SD	Σ
Scale (s)	1	2	3	4	5	
Frequency (n)	28	8	0	0	0	36
N = (n*s)	28	16	0	0	0	44
						Mean 1.222222

- Responses to Question 2.4 (*The Presence of ICT in Your Mine SCM Will Enable, Strengthen and Smoothen Collaboration with Supply Chain Partners?*) depicted below in table 4, showed that 28 (78%) of the respondents “Strongly Agree” the remaining 4 respondents (11%) “Agree” to Question 2.4. From table 4, further applying the Likert Scale Mean Formula to the responses of Question 2.4, depicted the result shown below:

$$Mean = \frac{\sum N}{\sum n} = \frac{44}{36} = 1.22$$

This result depicts that most of the responses to Question 2.3 are aligned to scale 1 (“Strongly Agree”).

Table-4: Responses to Question 2.4

	SA	A	NL	D	SD	$\Sigma$
Scale (s)	1	2	3	4	5	
Frequency (n)	28	8	0	0	0	<b>36</b>
N = (n*s)	28	16	0	0	0	<b>44</b>
					<b>Mean</b>	<b>1.222222</b>

- Responses to Question 2.5 depicted below in figure 6, showed that all 36 respondents (100%) affirmed to the fact that ICT in the Mine has helped to improved demand response time.

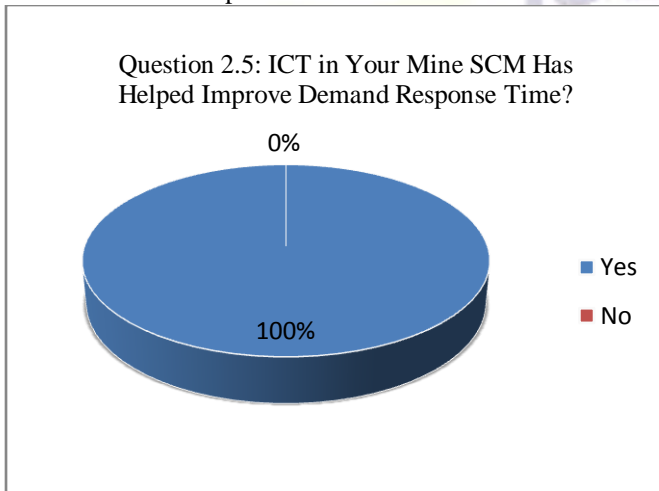


Fig-6: Responses to Question 2.5

- Responses to Question 2.6 depicted below in figure 7, showed that all 36 respondents (100%) affirmed to the fact that the presence of ICT in the Mine has helped streamline logistic activities across the supply chain leading to cost reduction and improved efficiency.

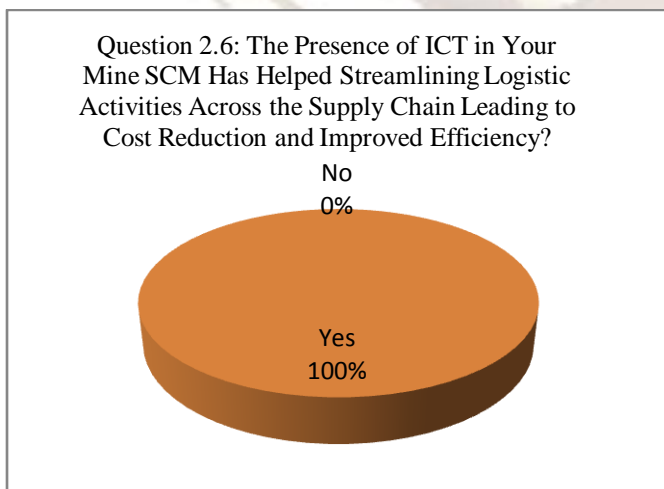


Fig-7: Responses to Question 2.6

- Responses to Question 2.7 depicted below in figure 8, showed that all 36 respondents (100%) affirmed to the fact that the presence of ICT in the Mine has helped in developing high valued chain relationships/partnerships.

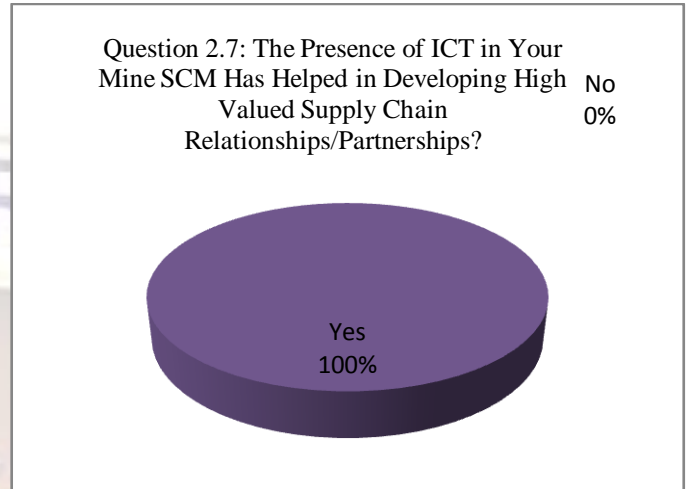


Fig-8: Responses to Question 2.7

- Responses to Question 2.8 depicted below in figure 9, showed that all 36 respondents (100%) affirmed to the fact that the presence of ICT in the Mine has helped to attain global standards and access to the world market.

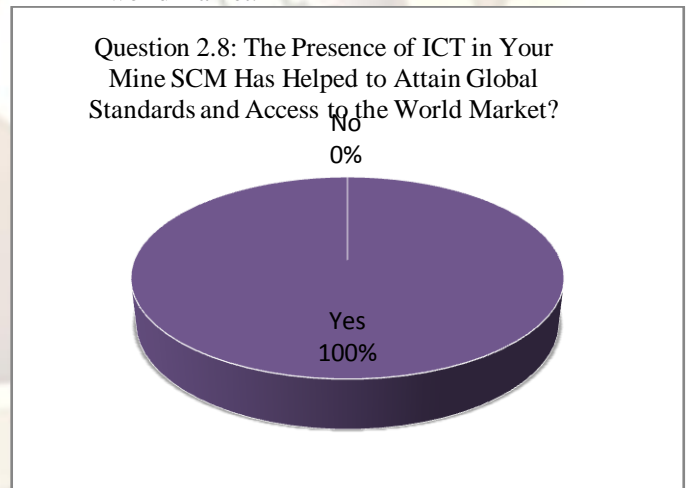


Fig-9: Responses to Question 2.7

### 3. How Has ICT Helped To Improve SCM In The Mining Industry?

- Responses to Question 3.1(*The Presence of ICT in Your Mine SCM has Enabled Greater Material Availability and Visibility Which has Immensely Improved Materials and Maintenance Planning Processes With Many Significant Cost Reduction and Service Improvements?*) depicted below in table 5, showed that 28 (78%) of the respondents “Strongly Agree”, 4 (11%)



“Agree” and the remaining 4 (11%) were “Neutral” to Question 3.1. From table 5, further applying the Likert Scale Mean Formula to the responses of Question 3.1, depicted the result shown below:

$$Mean = \frac{\sum N}{\sum n} = \frac{48}{36} = 1.33$$

This result depicts that most of the responses to Question 3.1 are aligned to scale 1 (“Strongly Agree”).

Table-5: Responses to Question 3.1

	SA	A	NL	D	SD	∑
Scale (s)	1	2	3	4	5	
Frequency (n)	28	4	4	0	0	36
N = (n*s)	28	8	12	0	0	48
					<b>Mean</b>	<b>1.333333</b>

- Responses to Question 3.2 depicted below in figure 10, showed that all 36 respondents (100%) affirmed to the fact that the presence of ICT in the Mine has helped improve the Mine Supply Chain Operations by enabling a quick approach to contacting vendors on issues pertaining to customer service problems such as late deliveries and changes in schedule.

Question 3.2: The Presence of ICT in Your Mine SCM has Helped Improve Your Mine Supply Chain Operations by Enabling a Quick Approach to Contacting Vendors on Issues Pertaining to Customer Service Problems Such as Late Deliveries and Changes in Scheduled?

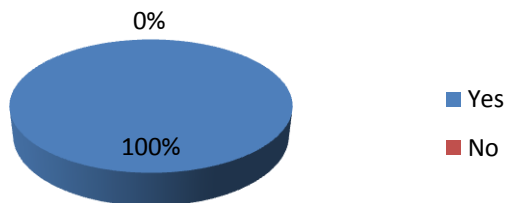


Fig-10: Responses to Question 3.2

- Responses to Question 3.3 depicted below in figure 11, showed that all 36 respondents (100%) affirmed to the fact that ICT in the Mine has improved the Mine Supply Chain Management (SCM) by helping gain instant updates on orders placed with vendors which helps in production and maintenance planning.

Question 3.3: Has ICT Helped to Improve Your Mine SCM by Helping Gain Instant Updates on Orders Placed With Vendors Which Helps in Production and Maintenance Planning?

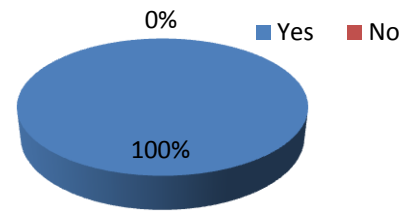


Fig-11: Responses to Question 3.3

- Responses to Question 3.4 (The Ability to Notify Vendors of Changes in Configurations in Products That are Produced to Order has Been Made Possible With the Presence of ICT in Your Mine SCM Leading to an Improved SCM?) depicted below in table 6, showed that 20 (56%) of the respondents “Strongly Agree”, and the remaining 16 (34%) “Agree” to Question 3.4. From table 6, further applying the Likert Scale Mean Formula to the responses of Question 3.4, depicted the result shown below:

$$Mean = \frac{\sum N}{\sum n} = \frac{52}{36} = 1.44$$

This result depicts that most of the responses to Question 3.4 are aligned to scale 1 (“Strongly Agree”).

Table-6: Responses to Question 3.4

	SA	A	NL	D	SD	∑
Scale (s)	1	2	3	4	5	
Frequency (n)	20	16	0	0	0	36
N = (n*s)	20	32	0	0	0	52
					<b>Mean</b>	<b>1.444444</b>

- Responses to Question 3.5 depicted below in figure 12, showed that all 36 respondents (100%) affirmed to the fact that with the presence of ICT in the Mine SCM, the ability to track ordered spares and raw materials on a continuous basis by the Mine’s Supply Chain has been made possible.

Question 3.5: The Ability to Track Ordered Spares and Raw Materials on a Continuous Basis by the Mine's Supply Chain has Been Made Possible With the Presence of ICT in the Mine SCM?

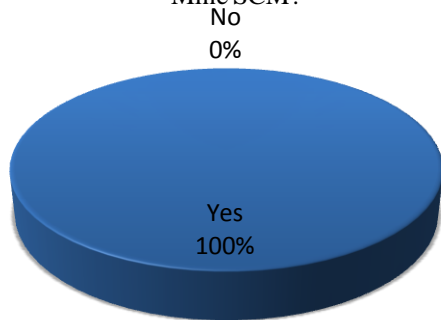


Fig-12: Responses to Question 3.5

- Responses to Question 3.6 depicted below in figure 13, showed that all 36 respondents (100%) affirmed to the fact that the presence of ICT in the Mine SCM has created the ability to directly communicate with vendors and internal customers regarding supply issues on a 7-day/24 hour basis without being physically present.

Question 3.6: The Presence of ICT in Your Mine SCM Has Created the Ability to Directly Communicate With Vendors and Internal Customers Regarding Supply Issues on a 7-Day/24-Hour Basis Without Being Physically Present?

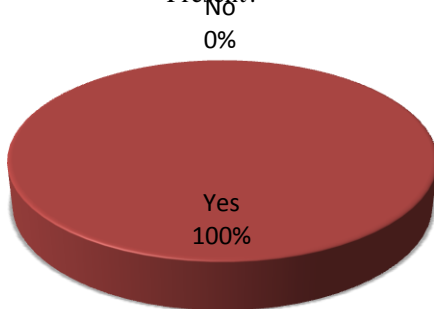


Fig-13: Responses to Question 3.6

- Responses to Question 3.7 depicted below in figure 14, showed that all 36 respondents (100%) affirmed to the fact that the ability to schedule pickups and deliveries has been made possible and even improved with infusion of ICT into the Mine SCM.

Question 3.7: The Ability to Schedule Pickups and Deliveries has Been Made Possible and Even Improved With the Infusion of ICT Into Your Mine SCM?

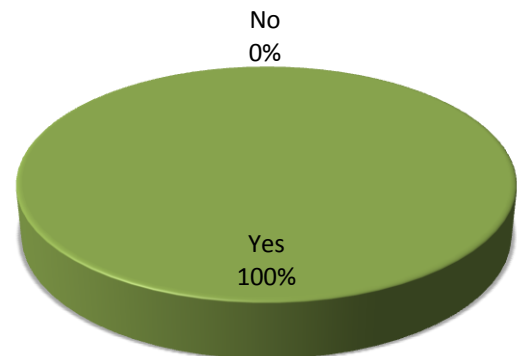


Fig-14: Responses to Question 3.7

- Responses to Question 3.8 depicted below in figure 15, showed that 32 respondents (89%) affirmed to the fact that the presence of ICT in the Mine SCM has enabled the SCM employees to become more responsive to internal customer service problems and reduce service costs whereas 4 respondents (11%) said otherwise.

Question 3.8: The Presence of ICT in Your Mine SCM Has Enabled the SCM Employees to Become More Responsive (Reduce Response Time) to Internal Customer Service Problems and Reduce Service Costs?

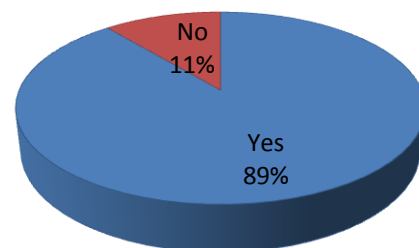


Fig-15: Responses to Question 3.8

#### 4. What can be Done to Improve and Sustain Standards of SCM Through ICT in the Mining Industry?

- Responses to Question 4.1 (*The Presence of ICT in Your Mine SCM Will Help to Achieve the Concept of JIT and Also Help Improve and Sustain Standards in Your Mine SCM?*) depicted below in table 7, showed that 16 (34%) of the respondents



“Strongly Agree”, another 16 (34%) “Agree” to and the remaining 4 respondents (11%) are “Neutral”. From table 7, further applying the Likert Scale Mean Formula to the responses of Question 4.1, depicted the result shown below:

$$Mean = \frac{\sum N}{\sum n} = \frac{60}{36} = 1.7$$

This result depicts that most of the responses to Question 4.1 are aligned to scale 2 (“Agree”).

Table-7: Responses to Question 4.1

	SA	A	NL	D	SD	Σ
Scale (s)	1	2	3	4	5	
Frequency (n)	16	16	4	0	0	36
N = (n*s)	16	32	12	0	0	60
					Mean	1.666667

- Responses to Question 4.2 depicted below in figure 16, showed that all 36 respondents (100%) affirmed to the fact that continuous information sharing, transparency and visibility on inventory and purchase orders statuses are ways that can lead to improved and sustainable standards of SCM through ICT in the Mining Industry.

Question 4.2: Continuous Information Sharing, Transparency & Visibility on Inventory and Purchase Orders Statuses are Ways That can Lead to Improved and Sustainable Standards of SCM Through ICT in the Mining Industry?

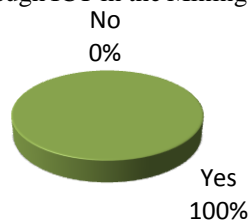


Fig-16: Responses to Question 4.2

- Responses to Question 4.3 depicted below in figure 17, showed that 32 respondents (89%) affirmed to the fact that reduction of overall production costs by streamlining the products flow within the production process and improving information flow between business partners will lead to improved and sustainable standards of SCM through ICT in the Mining Industry whereas 4 (11%) said otherwise.

Question 4.3: Reduction of Overall Production Costs by Streamlining the Products Flow Within the Production Process and Improving Information Flow Between Business Partners Will Lead to Improved and Sustainable Standards of SCM Through ICT in the Mining I

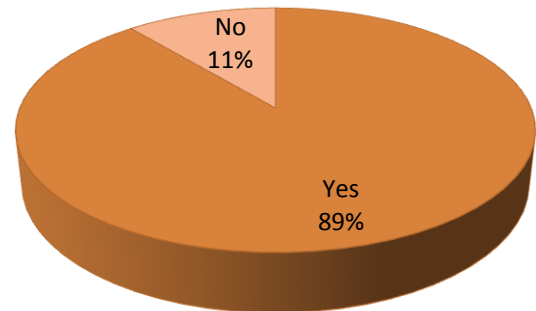


Fig-17: Responses to Question 4.3

- Responses to Question 4.4 (*The Presence of ICT in Your Mine SCM Would Improve and Sustain Standards of Your SCM by Enabling Delivery Speed, Inventory Visibility, and Flexibility in Operations Through the Seamless Cooperation With Both the Internal Customers and Key Suppliers/Vendors is Considered an Approach That Will lead to Improved and Sustainable Standards of SCM Through ICT in the Mining Industry?*) depicted below in table 8, showed that 24 (67%) of the respondents “Strongly Agree” and 12 (33%) “Agree” to Question 4.4. From table 8, further applying the Likert Scale Mean Formula to the responses of Question 4.4, depicted the result shown below:

$$Mean = \frac{\sum N}{\sum n} = \frac{48}{36} = 1.33$$

This result depicts that most of the responses to Question 4.4 are aligned to scale 1 (“Strongly Agree”).

Table-8: Responses to Question 4.4

	SA	A	NL	D	SD	Σ
Scale (s)	1	2	3	4	5	
Frequency (n)	24	12	0	0	0	36
N = (n*s)	24	24	0	0	0	48
					Mean	1.333333

- Responses to Question 4.5 depicted below in figure 18, showed that all 36 respondents (100%) affirmed to the fact that developing

high valued supply chain relationships and enhancing customer services level will lead to the achievement of high level competitive advantage in the resources and finances competitive business environments.

Question 4.5: Developing High Valued Supply Chain Relationships and Enhancing Internal Customer Services Level Will Lead to the Achievement of High Level Competitive Advantage in the Resources and Finances Competitive Business Environment?

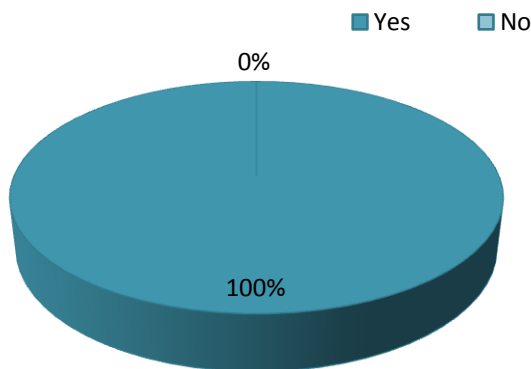


Fig-18: Responses to Question 4.5

- Responses to Question 4.6 (*What is Your Take on the View That Real-Time Posting of Requisitions for Items Which are Taken-off the Shelves Will Help to Improve and Sustain Standards of SCM Through ICT in the Mining Industry?*) depicted below in table 9, showed that 24 (67%) of the respondents “Strongly Agree”, 8 (22%) “Agree” and the remaining 4 (11%) “Strongly Disagree” to Question 4.6. From table 9, further applying the Likert Scale Mean Formula to the responses of Question 4.6, depicted the result shown below:

$$Mean = \frac{\sum N}{\sum n} = \frac{60}{36} = 1.7$$

This result depicts that most of the responses to Question 4.6 are aligned to scale 2 (“Agree”).

Table-9: Responses to Question 4.6

	SA	A	NL	D	SD	Σ
Scale (s)	1	2	3	4	5	
Frequency (n)	24	8	0	0	4	36
N = (n*s)	24	16	0	0	20	60
					<b>Mean</b>	<b>1.666667</b>

- Responses to Question 4.7 depicted below in figure 19, showed that all 36 respondents (100%) affirmed to the fact and believe that consistent stock-takes and stock analysis can help eliminate stock-out of critical raw materials and parts at the warehouse.

Question 4.7: Consistent Stock-Takes and Stock Analysis can Help Eliminate Stock-Out of Critical Raw Materials and Parts at the Warehouse. Do you Believe This Underlying Process Would be Improved and Sustained by Adapting ICT in Your Mine SCM?

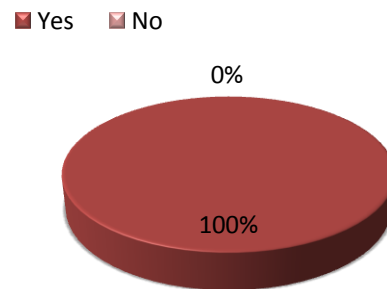


Fig-19: Responses to Question 4.7

- Responses to Question 4.8 (*An increase in the SCM Operational Performance Through a Prompt Action in Handling Requisitions at the Issuing Point will Lead to Improved and sustainable Standards of SCM through ICT in the Mining Industry?*) depicted below in table 10, showed that 32 (89%) of the respondents “Strongly Agree” and the remaining 4 (11%) “Agree” to Question 4.8. From table 10, further applying the Likert Scale Mean Formula to the responses of Question 4.8, depicted the result shown below:

$$Mean = \frac{\sum N}{\sum n} = \frac{40}{36} = 1.11$$

This result depicts that most of the responses to Question 4.8 are aligned to scale 1 (“Strongly Agree”).

Table-10: Responses to Question 4.8

	SA	A	NL	D	SD	Σ
Scale (s)	1	2	3	4	5	
Frequency (n)	32	4	0	0	0	36
N = (n*s)	32	8	0	0	0	40
					<b>Mean</b>	<b>1.111111</b>

## V. RESEARCH DISCUSSIONS

This section of the paper presents and discusses the synthesis of the research findings from both the operational (senior officers) team members and the management members on the subject matter.

The subject of this research finds three main sets of conclusions. These include: the role ICT plays in the Mining Industry, how ICT has helped to improve SCM in the Mining Industry, and what can be done to improve and sustain standards of SCM through the use of ICT in the Mining Industry.

#### **A. What is the Role of ICT in the SCM in the Mining Industry?**

This section attempts to discuss the role ICT plays in the SCM in the Mining Industry towards achieving sustainable business growth from the management interviews and the survey respondents' perspective. From the empirical research, the following research findings were achieved.

##### **1. ICT is Responsible for: Information and Material Availability and Visibility, Single Point of Contact for Data and Total Supply Chain Decision & Collaboration**

Two similar groups of questions were asked in both the management interview and the survey questionnaire under the above subject areas. From the management perspective, the following general views were collated.

The Finance Manager mentioned that, the presence of ICT has enabled SCM to be more efficient and proactive to meet the demands of its internal clients. ICT ensures that information and feedbacks from third party agents are delivered on time and internally enables free work flow and reduces cost. He further mentioned that yes; the infusion of ICT has really brought about great improvement to the supply chain. The Health, Safety and Environment (HSE) Manager also commented that, the presence of ICT in the Mine SCM has helped shorten the processes, created transparency and visibility of information and increased the speed of the processes. ICT plays a major role in the Mines operations including broadening the scope of operations (i.e. sourcing for raw materials) and helping in the integration of information between and within the various actors. He (HSE Manager) further affirmed that, ICT has really brought about lots of improvements to the SCM. ICT has increased the pace of data processing, data collection and transactions within and between various parties involved in the SC. The Maintenance Manager also responded that, the presence of ICT in the mine has massively improved the entire SCM operations and smoothed the processes. ICT helps in coordinating the activities within and between all parties of the SCM of the Mine and beyond. ICT has facilitated maintenance planning activities through the creation of visibility of materials in stock. ICT has also helped in good records keeping; it simplifies tasks, brings about effective communication, and reduces cost. The Process Manager also mentioned that, the presence

of ICT has really improved the Mine's operational processes, reduced the transport cost and time used to pick up reports – as reports are sent electronically, easy reporting has surfaced, and simplified processes. He (Process Manager) further stated that, ICT acts as a catalyst to our operations. In fact, it plays a major part/role in the Mine SCM operations by improving communication between and within all operational partners. Major improvements has shown up in the SCM - from the manual way of conducting business and its associated transactions, to electronic approach which makes everything extremely easier and faster. The Supply Manager finally mentioned that, ICT has enhanced the ability to obtain goods and services from a wider range of suppliers, helps track and trace order status and helps in inventory visibility. For sure! ICT has helped in identification and measurement of service providers.

From the survey respondent's perspective, the following were arrived upon receipt and analysis of the 36 responses.

The 36 responses received on the question, "*The Presence of ICT in Your Mine SCM Will Provide Information and Material Availability and Visibility?*", on a scale of 1 to 5 (1 being 'Strongly agree' and 5 being 'Strongly disagree'), referring to table-1, showed that, 32 (89%) of the respondents "Strongly Agree" and the remaining 4 (11%) respondents "Agree". Further applying the Likert Scale Mean Formula to the responses received depicted **1.11**. This result clearly depicts that most of the responses to the question are aligned to scale 1 ("Strongly Agree"). In another scenario, the 36 responses received on the question, "*The Presence of ICT in Your Mine SCM Will Enable a Single Point of Contact for Data?*", on a scale of 1 to 5 (1 being 'Strongly agree' and 5 being 'Strongly disagree'), referring to table- 2, showed that, 24 (67%) of the respondents "Strongly Agree" and the remaining 12 respondents (33%) "Agree". Further applying the Likert Scale Mean Formula to the responses received depicted **1.33**. This result clearly depicts that most of the responses to the question are aligned to scale 1 ("Strongly Agree"). Furthermore, the 36 responses received on the question, "*The Presence of ICT in Your Mine SCM Will Allow Decisions Based on Total Supply Chain Information?*" on a scale of 1 to 5 (1 being 'Strongly agree' and 5 being 'Strongly disagree'), referring to table- 3, showed that, 28 (78%) of the respondents "Strongly Agree" and the remaining 4 respondents (11%) "Agree". Further applying the Likert Scale Mean Formula to the responses received depicted **1.22**. This result clearly depicts that most of the responses to the question are aligned to scale 1 ("Strongly Agree"). In another scenario, the 36 responses received on the question, "*The Presence of ICT in Your Mine SCM Will Enable, Strengthen and Smoothen Collaboration with Supply Chain*



Partners?" on a scale of 1 to 5 (1 being 'Strongly agree' and 5 being 'Strongly disagree'), referring to table- 4, showed that, 28 (78%) of the respondents "Strongly Agree" the remaining 4 respondents (11%) "Agree". Further applying the Likert Scale Mean Formula to the responses received depicted 1.22. This result clearly depicts that most of the responses to the question are mostly aligned to scale 1 ("Strongly Agree").

From the above scenario, it can be realized that both the management interviewees and the survey respondent views are in a convergence/ on the same page. Indeed this general consensus therefore emphasizes the fact that, the presence of ICT in the Mine SCM has really brought about information & materials availability and visibility and has enabled a single point of contact for data. ICT has really allowed decisions to be made based on total supply chain information and has really enabled, strengthened, and smoothed collaboration with supply chain partners, which will obviously lead to improvement and sustainability of the total supply chain of the Mine.

## **2. ICT: Improves Demand Response Time, Streamlines Logistic Activities Along the Supply Chain, Develops High Valued Supply Chain Relationships/Partnerships & Attains Global Standards and Access to World Market**

Similar sets of questions were asked under both the management interview and the survey questionnaire in different approaches under the above subject areas.

The following general views were collated from the management responses.

The Finance Manager mentioned that, ICT is really an imperative tool to the Mine SCM operations because without ICT a lot of time and energy will be wasted leading to higher cost and lower efficiency of operations. He further affirmed that ICT has helped to improve their Mine SCM in the sense that, it has virtually cut a lot of paperwork, improve understanding of the SCM activities and helped in reducing turnaround time. The Health, Safety Environment Manager also mentioned that, ICT is an extremely imperative tool to their Mine SCM operations. He added that it is in fact, a necessity, a business tool that is needed to be integrated into all businesses. He further added that, ICT has helped improve the Mines operations – created effective communication, transparency, reduced the volume of works done within the shortest possible time. The Maintenance Manager also affirmed that, ICT is an extremely imperative tool. This is because it comes with lots of benefits when adapted. Such benefits include production cost reduction through tightly controlled inventory and controlled processes coupled with excellent maintenance planning system which leads to the balance of demand and supply. Less downtimes or more plant uptime/availability!

He also further mentioned that, ICT has helped the Mine SCM achieve business improvements through a variety of ways. ICT has improved the way we used to operate our business, changed our thinking style on inventory holdings and improved our way of sharing information which used to hinder the progress of our operations. The Process Manager mentioned that, indeed ICT is an extremely imperative to our SCM operations! ICT reduces our workload, improves efficiency, helps monitor the processes, reduces labour and associated costs, enhances labour utilization, improves safety by reducing accident and incidents occurrences. Furthermore, he mentioned that, ICT has helped the Mine achieved massive improvements! He commented that, cost control, transparency and visibility have all improved over years with the use of ICT. He further commented that indeed, cost is something that is dragging our operations into the ditch, and hence drastic cost reduction through transportation cost elimination in case of sample collection and proper inventory control has led to sustaining our Mine SCM operations. The Supply Manager commented that, yes indeed ICT is really an imperative tool to the Mine SCM operations and this is because without ICT in our SCM, tracing and tracking of purchase orders would have been very difficult. He further mentioned that, ICT has helped the Mine to improve on orders delivery turnaround times.

The following were put together from the 36 responses received from the survey on the above subject areas.

The 36 responses received on the question, "The Presence of ICT in Your Mine SCM Helps Improve Demand Response?" on a "Yes" or "No" option showed that, all 36 respondents (100%) said yes, affirming to the fact that, ICT in the Mine has helped to improve demand response time. In another scenario, the 36 responses received on the question, "The Presence of ICT in Your Mine SCM has Helped Streamlining Logistic Activities Across the Supply Chain Leading to Cost Reduction and Improved Efficiency?" on a "Yes" or "No" option showed that, all 36 respondents (100%) responded yes, affirming to the fact that, the presence of ICT in the Mine has helped streamline logistic activities across the supply chain leading to cost reduction and improved efficiency. Furthermore, the 36 responses received on the question, "The Presence of ICT in Your Mine SCM Helps in Developing High Valued Supply Chain Relationships/Partnerships?", on a "Yes" or "No" option showed that, all 36 respondents (100%) responded yes, affirming to the fact that, the presence of ICT in the Mine has helped in developing high valued supply chain relationships/partnerships. In another scenario, the 36 responses received on the question, "The Presence of ICT in Your Mine SCM has Helped to Attain Global Standard and Access to World

Market?", on a "Yes" or "No" option showed that, all 36 respondents (100%) responded yes affirming to the fact that, the presence of ICT in the Mine has helped to attain global standards and access to the world market.

From the above scenario, the responses put forth by both management interviewees and the survey respondents, shows that the two views are moving in the same direction. The kind of consensus achieved from the two set of responses received from both sides points out to the fact that, the presence of ICT in the Mine SCM has: helped improve demand response time, streamlined logistic activities along the supply chain, developed high valued supply chain relationships/partnerships and helped attained global standards and access to the world market.

## **B. How Has ICT Helped To Improve SCM in the Mining Industry?**

This section attempts to discuss how ICT as an enabler has helped to improve the SCM in the Mining Industry towards achieving sustainable business growth from both the management interviewees and the survey respondents' views. From the empirical research, the following research findings were put together.

### **1. ICT: Has Enabled Material Availability and Visibility, Improved the Mine Supply Chain Operations and Helped Gain Instant Updates on Orders and Changes in Configurations in Products**

The two groups (management and the operational staffs) of the research had similar questions posed to them under the above subject areas but in different ways. It was necessary to collate various views on the subject in order to make the comparison quite interesting and easier to achieve.

From the management perspective, the following general views were collated.

The Finance Manager commented that the presence of ICT in their Mine SCM has helped provide information availability, created material visibility, and enabled a single point/location of contact for data. He further explained that, expediting report, for instance, has made it possible for all end user departments to know the progress of their orders. The Finance Manager further commented that, ICT has helped reduced the processing time/time to handle transactions. He further mentioned that, the presence of ICT in the Mine SCM has helped improve demand response time because retrieval of information is not far-fetched and easily accessible response time has been tremendous. ICT has also enabled other user departments to understand and appreciate SCM better. The Health, Safety & Environmental (HSE) Manager also commented that the presence of ICT in their Mine SCM is a perfect

one. He further commented that, with ICT in our Mine SCM, every department including that of HSE department can access and find whatever they need for the departments operations from the warehouse and request the materials without even being physically present at the warehouse. He further commented that, the presence of ICT in the Mine SCM is highly sustainable, and can improve Mine operations so far as we kept updating the ICT systems that we meet the ever changing needs. The HSE Manager mentioned that, the presence of ICT in the Mine SCM has help improve demand response time and that of the development of high valued supply chain relationships to a large extent! Just to mention a few, with the introduction of a comprehensive ERP system which comes with electronic requisition powered by ICT, once materials/spares requisitions are initiated by end users and accepted by issuing staffs, an automatic issuing of the item from the system is made. The errors are created through manual posting. The Maintenance Manager commented that the presence of ICT in their Mine SCM has helped provide information availability, created material visibility, and enabled a single point/location of contact for data. In fact, it has made our work extremely easy. Information is everywhere and easily accessible making work very easy and smooth. In fact, ICT has helped to improved and sustained the Mine SCM performance. It has facilitated our operations by simplifying our operational transaction. The presence of ICT in the Mine SCM helps improve demand response time and that of the development of high valued supply chain relationships by breaking most of the communication barriers between our department and the other departments as well as other clients. The Process Manager mentioned that yes; with the use of ICT, every department and section of the Mine are synchronized making information about every aspect of the operations known to everybody that works not only with the department or section but any other department. Materials/spares in stock in the warehouse, in transit, and cleared at the port on and its way to the Mine site are all made known/availability to all of us at any point in time. Information is just available everywhere! ICT has brought about green supply chain. All transactions that take place within the various departments of the Mine are conducted electronically. All end user departments as well as the supplies department manage invoices received from contractors and suppliers by keying in those invoices into the ERP system for payment by the finance department. This has really brought about speed towards the processing of invoices as they monitor the process and comments about the process as well. This has made the contractors and suppliers to continuously support our business. The process Manager further commented that, yes, the presence of ICT in your



Mine SCM helps improve demand response time and that of the development of high valued supply chain relationships and even beyond that! Automatic update of materials or spares issued from the warehouse are done as soon as the electronic requisitions initiated by the user departments are accepted by the warehouse and picking slips printed for the issue staffs at the warehouse to pick the materials or spares for staging and collection by the users. The Supply Manager commented that, the presence of ICT in the Mine SCM has really made their end users sit in the comfort of their offices to access our stock inventory to process stock issues and dispatch to warehouse issuing counter for action. He further commented that, ICT helped to improve and sustain their Mine SCM performance through the use of information as the basis of Supply Chain controls. The presence of ICT in the Mine SCM has helped improve demand response time and that of the development of high valued supply chain relationships by enabling the implementation of the electronic requisition (purchase and material requisitions) system and through the building of close contact and sharing of real-time information between and within partners. The following were put together from the 36 responses received from the survey on the above subject areas.

The 36 responses received on the question, *“The Presence of ICT in Your Mine SCM has Enabled Greater Material Availability and Visibility Which has Immensely Improved Materials and Maintenance Planning Processes With Many Significant Cost Reduction and Service Improvements?”*, on a scale of 1 to 5 (1 being ‘Strongly agree’ and 5 being ‘Strongly disagree’), referring to table-5 showed that, 28 (78%) of the respondents “Strongly Agree”, 4 (11%) “Agree” and the remaining 4 (11%) were “Neutral”. Further applying the Likert Scale Mean Formula to the responses received depicted **1.33**. This result clearly depicts that most of the responses to the question are mostly aligned to scale 1 (“Strongly Agree”). In another scenario, the 36 responses received on the “Yes” or “No” option question showed that, all 36 respondents (100%) responded yes affirming to the fact that, the presence of ICT in the Mine has helped improve the Mine Supply Chain Operations by enabling a quick approach to contacting vendors on issues pertaining to customer service problems such as late deliveries and changes in schedule. Furthermore, the 36 responses received on the question, *“Has ICT Helped to Improve Your Mine SCM by Helping Gain Instant Updates on Orders Placed with Vendors Which Helps in Production and Maintenance Planning?”* on a “Yes” or “No” option showed that, all 36 respondents (100%) responded yes, affirming to the fact that, ICT in the Mine has improved the Mine SCM by helping gain instant updates on orders placed with vendors which

help in the production and maintenance planning. In another scenario, the 36 responses received on the question, *“The Ability to Notify Vendors of Changes in Configurations in Products That are Produced to Order has Been Made Possible With the Presence of ICT in Your Mine SCM Leading to an Improved SCM?”*, on a scale of 1 to 5 (1 being ‘Strongly agree’ and 5 being ‘Strongly disagree’), referring to table-6 showed that, 20 (56%) of the respondents “Strongly Agree”, and the remaining 16 (34%) “Agree”. Further applying the Likert Scale Mean Formula to the responses received depicted **1.44**. This result clearly depicts that, most of the responses to the question are mostly aligned to scale 1 (“Strongly Agree”).

From the comments and views expressed by both management interviewees (qualitative) and the survey respondents (quantitative) on the above subject area, it can be realized that the responses are driving towards the same point. The achievement of the consensus in the responses received from the two sides are clear and strongly pointing out to the fact that, the presence of ICT in their Mine SCM has enabled material availability and visibility, improved the Mine supply chain operations and helped gain instant updates on orders and changes in configurations in products.

## **2. ICT: Helps Easy Tracking of Ordered Spares and Raw Materials, Helps Direct Communication With Vendors and Internal Customers, Enables Schedule Pickups and Deliveries and Enhances SCM Employee’s Responsive Rate**

The same sets of questions were put forth to both the management interviewees and the operational staffs but tackled in two different directions under the above subject areas. The following general views were collated from the management responses.

The Finance Manager commented that, the presence of ICT in the Mine SCM has really created a quick approach to contacting vendors on issues regarding late deliveries and changes in scheduled shipment dates to improve speed (fast delivery) & on-time delivery, and is really positive in reaching out to clients just by the press of a button, making transactions a lot more easier and enjoyable. He further mentioned that, improvement and maintenance of standards of the Mine SCM through ICT can be achieved by encouraging all to use and continue its usage whilst embracing new ICT methods or technology as and when they emerge. The Health, Safety & Environmental (HSE) Manager commented that he strongly agrees that, the presence of ICT and its tools such as mobile phone (i.e. BlackBerry) which has the facilities to send and receive e-mails makes it extremely easy to contact vendors from anywhere and at anytime. He further mentioned that, improvement and



maintenance of standards of the Mine SCM through ICT is achievable by keeping abreast with technology through adapting developing trends, (i.e. using mobile phone to send and receive e-mails while out of site), acquire new technology, offer training to keep up with the use of the new technology. The Maintenance Manager commented that ICT has come to change the way they operate their Mine. He elaborated further by citing a good example that, his office phone line is linked to his mobile phone line so in case somebody wants to reach him through any of the lines and is not successful, the call is automatically diverted to the other line. He added that, he can now work from anywhere using just his mobile phone to respond to urgent or critical e-mails. The Maintenance Manager stated that improvement and maintenance of standards of the Mine SCM through ICT can be achieved by upgrading the system from time-to-time, ensuring full utilization of the system, training staffs on how to effectively use the system, ensuring compliance of system procedures, there should be system administrators to manage the entire ICT system on the company. The system administrators should link up the system within and between various Mines to create visibility and make necessary changes to the system to ensure friendliness to all users. The Process Manager commented that he strongly agrees with the notion! He added that, the presence of ICT in their Mine SCM has really improved their response speed to their vendors, contractors and even within the various departments. He stated that improvement and maintenance of standards of the Mine SCM through ICT requires an intensive education and training of all staffs. The Supply Manager commented that, ICT has absolutely brought about lots of improvement to their operations! With the presence of ICT in the Mine SCM, difficulties involved in communicating with vendors are the things of the past. In fact, access to all forms of communicating tools and the ability to communicate to vendors about any change whatsoever can be made at anytime and anywhere as far as there is network available in the area. The Supply Manager stated that improvement and maintenance of standards of the Mine SCM through ICT requires just two key things! Training and consistent system upgrades.

The following were put together from the 36 responses received from the survey on the above subject areas.

The 36 responses received on the question, *“The Ability to Track Ordered Spares and Raw Materials on a Continuous Basis by the Mine’s Supply Chain has Been Made Possible With the Presence of ICT in the Mine SCM?”* on a “Yes” or “No” option showed that, all 36 respondents (100%) responded yes, affirming to the fact that, indeed with the presence of ICT in the Mine SCM, the

ability to track ordered spares and raw materials on a continuous basis by the Mine’s Supply Chain has been made possible. In another case, 36 responses received from the question, *“The Presence of ICT in the Mine SCM has Created the Ability to Directly Communicate With Vendors and Internal Customers Regarding Supply Issues on a 7-Day/24 Hour Basis Without Being Physically Present?”* on a “Yes” or “No” option resulted in all 36 respondents (100%) responding to yes, affirming to the fact that, the presence of ICT in the Mine SCM has created the ability to directly communicate with vendors and internal customers regarding supply issues on a 7-day/24 hour basis without being physically present. Furthermore, the 36 responses received on the question, *“The Ability to Schedule Pickups and Deliveries has Been Made Possible and Even Improved With the Infusion of ICT Into Your Mine SCM?”* on a “Yes” or “No” options showed that, all 36 respondents (100%) affirmed to the fact that, the ability to schedule pickups and deliveries has been made possible and even improved with infusion of ICT into the Mine SCM. In another case, 36 responses received from the question, *“The Presence of ICT in Your Mine SCM has Enabled the SCM Employees to Become More Responsive to Internal Customer Service Problems and Reduce Service Costs?”* on a “Yes” or “No” option showed that, 32 respondents (89%) affirmed to the fact, that the presence of ICT in the Mine SCM has enabled the SCM employees to become more responsive to internal customer service problems and reduced service costs whereas 4 respondents (11%) said otherwise. Looking at the number of respondents (or in terms of percentages) who responded to Yes, and those who responded to No, it can be realized that a greater portion of the respondents really affirmed that yes, the question had positive responses. We therefore can confidently say, the respondents agree that, the presence of ICT in the Mine SCM has enabled the SCM employees to become more responsive to internal customer service problems and reduced service costs.

The above comments and views from both the qualitative responses (management interviews) and the quantitative responses (questionnaire responses) make it clear that a consensus has been achieved. The two side views argued strongly in support of each other and in the direction pointing out to the fact that, the presence of ICT in the Mine SCM has helped easy tracking of ordered spares and raw materials, helped direct communication with vendors and internal customers, enabled schedule pickups and deliveries and has enhanced SCM employee’s responsive rate.

### **C. What can be Done to Improve and Sustain Standards of SCM Through ICT in the Mining Industry?**

This section attempts to put forth a discussion on what can be done to improve and sustain standards of SCM through ICT in the Mining Industry towards achieving sustainable business growth from the management interviews and the survey respondents' perspective. The following research findings were achieved from the empirical research.

#### **1. ICT Implementation: Will Help to Achieve the Concept of Just in Time (JIT) by Creating Continuous Information Sharing, Transparency, Visibility and Flexibility in Operations and Reduces Overall Production Costs**

The sets of questions put forth to the management interviewees were similar to that of the operational staffs but asked in quite a different direction under the above subject areas. The following general views were collated from the management responses.

The Finance Manager commented that continuous information sharing, transparency & visibility on their inventory and purchase orders is a healthy sign and should be continued as it will help improve and sustain standards of SCM in the Mine through ICT. The Finance manager further commented that the use of ICT in the Mine has made SCM customer friendly both internally and externally which is a very positive sign towards growth and achieving high level competitive advantage in the *resources and finances* competitive environment. The Health, Safety & Environment (HSE) Manager mentioned that, yes, information sharing on a continuous basis, transparency & purchase order and inventory visibility are the key to process improvement. These are most of key improvement areas that businesses are dying to achieve with the help of ICT. As a matter of fact, ICT cannot be underestimated. The essence of the whole SCM operations is the customer and since the Mine does not have any external competitive market, its focus is on how the internal customer service level can be improved. The Maintenance Manager commented that, information availability helps eliminates greater amount of inventory. Once information is continuously shared among all parties, not only will inventory be made visible to everybody but will be reduced drastically. Information will indeed replace inventory. He further mentioned that, the internal customer's satisfaction is the reason for the whole process. Enhancing these internal customer service levels is the key to achieving sustainable growth leading to the immense gains in the arena they happen to find their business. The Process Manager mentioned that yes to a large extent, information sharing on a continuous basis, transparency & purchase order and

inventory visibility will lead to business improvement. For example, the purchase orders created by the procurement department are made known to each end user for verification through electronic media before approval is given. Internal customer service level enhancement is the key to production success. Therefore the use of ICT will really help to improve our operations to achieve higher competitive stand in our business environment. The Supply Manager also commented that, information is one of the SCM key enablers and creates lots of transparency and visibility within the SCM. Transparency and visibility between and within the SC partners help improve and sustain standards of the Mine SCM. Once the internal customer services are fully satisfied or higher services level are achieved, then there is that high possibility that, the Mine will be competitive in the *resources and finances arena* and hence can attract lots of investors.

The following were put together from the 36 responses received from the survey on the above subject areas.

The 36 responses received on the question, *"The Presence of ICT in Your Mine SCM Will Help to Achieve the Concept of JIT and Also Help Improve and Sustain Standards in Your Mine SCM?"* on a scale of 1 to 5 (1 being 'Strongly agree' and 5 being 'Strongly disagree'), referring to table-7 showed that, 16 (34%) of the respondents "Strongly Agree", another 16 (34%) "Agree" and the remaining 4 respondents (11%) are "Neutral". Further applying the Likert Scale Mean Formula to the responses received depicted **1.7**. This result depicts that, most of the responses to the question are mostly aligned to scale 2 ("Agree"). In another scenario, the 36 responses received on the question, *"Continuous Information Sharing, Transparency & Visibility on Inventory and Purchase Orders Status are ways That can Lead to Improved and Sustainable Standards of SCM Through ICT in the Mining Industry"*, on a "Yes" or "No" option showed that, all 36 respondents (100%) affirmed to the fact that continuous information sharing, transparency and visibility on inventory and purchase orders statuses are ways that can lead to improved and sustainable standards of SCM through ICT in the Mining Industry. Furthermore, the 36 responses received on the question, *"Reduction of Overall Production Costs by Streamlining the Products Flow Within the Production Process and Improving Information Flow Between Business Partners Will Lead to Improved and Sustainable Standards of SCM Through ICT in the Mining Industry"*, on a "Yes" or "No" option showed that, 32 respondents (89%) affirmed to the fact that, reduction of overall production costs by streamlining the products flow within the production process and improving information flow between business partners will lead to improved and



sustainable standards of SCM through ICT in the Mining Industry whereas 4 (11%) said otherwise. Additionally, looking at the number of respondents (or in terms of percentages) who responded to Yes, and those who responded to No, it can be realized that a greater portion of the respondents really affirmed that yes, the question had positive responses. We therefore can confidently say, the respondents agree that, the reduction of overall production costs by streamlining the products flow within the production process and improving information flow between business partners will lead to improved and sustainable standards of SCM through ICT in the Mining Industry. In another case, the 36 responses received on the question, *“The Presence of ICT in Your Mine SCM Would Improve and Sustain Standards of Your SCM by Enabling Delivery Speed, Inventory Visibility, and Flexibility in Operations Through the Seamless Co-operation With Both the Internal Customers and Key Suppliers/Vendors is Considered an Approach That Will lead to Improved and Sustainable Standards of SCM Through ICT in the Mining Industry?”*, on a scale of 1 to 5 (1 being ‘Strongly agree’ and 5 being ‘Strongly disagree’), referring to table-8 showed that, 24 (67%) of the respondents “Strongly Agree” and 12 (33%) of the respondents “Agree”. Further applying the Likert Scale Mean Formula to the responses received depicted **1.33**. This result depicts that most of the responses to the question are mostly aligned to scale 1 (*“Strongly Agree”*).

The comments and views put forth by the two main target groups show that the responses are moving in the same direction and hence the argument put forth are in support of the subject. The consensus achieved from the two group responses received clearly pointing out to the fact that, the implementation of ICT in the Mine SCM will help to achieve the concept of JIT by creating continuous information sharing, transparency, visibility and flexibility in operations and reduce overall production costs which are all what mining companies are dying to achieve.

## **2. ICT Implementation: Will Improve and Sustain Standards of the SCM Such as High Valued Supply Chain Relationships and Enhancing Internal Customer Services Level, Real-Time Posting of Requisitions, Consistent Stock-Takes and Stock Analysis & Quick Processing of On-Line Requisitions**

In both the management interview and the survey questionnaire, questions asked on both were quite similar but asked in different directions under the above subject areas for easy comparison and interpretation.

The following general views were collated from the management responses.

The Finance Manager strongly commented that, real-time is the order of the day and that real-time posting of requisitions for items which are taken-off the shelves will help to improve and sustain standards of SCM through ICT in the Mining Industry. The Finance Manager added that, decisions need to be taken not on very old transactions as that might be detrimental to the Mines. This can only be achieved if the Mine is capturing data as and when events happen. The Finance Manager further commented that, every Mine wants as much as possible to reduce cash cost per ounce, a positive sign to investors that the Mine is operating efficiently. It is therefore imperative that ICT supports SCM in this direction to make work processes flow freely at no extra costs. Therefore, the Finance Manager strongly agreed that, reduction of overall production costs by streamlining the products flow within the production process and improving information flow between business partners will help improve and sustain standards of SCM in the Mine through ICT. The Health, Safety & Environment (HSE) Manager mentioned that, interestingly, they do not run manual requisitions. Every requisition is issued electronically by end user/requester through the ERP system. Once the requisitions are issued, signals are sent to the warehouse team and once accepted, it automatically issues out from the system quantities and a picking slip is used to collate the items requested. In view of that, I (HSE Manager) strongly do go by the statement that *“real-time posting of requisitions for items which are taken-off the shelves will help to improve and sustain standards of SCM through ICT in the Mining Industry”* Production cost is a headache for most managers. If a seamless production can be realized by using ICT to close these gaps through the provision of consistent and timely information, then our business will never be the same. We will see massive improvements to the Mine SCM and those improvements will be sustainable. The Maintenance Manager agrees perfectly with this notion. However, he continued by saying that, in their case, requisitions are not even manual they are all electronically generated and so posting are done real-time all the time. It indeed helps a lot. Cost is something that is killing our operations slowly. If an attempt is made to streamline the flow of products within the production stream and improved through partnership information flow using ICT system, it is obvious that massive improvement and sustainability will be achieved. The Process Manager mentioned that, with the use of ICT, material requisitions have been made possible electronically and hence postings are done in a real-time manner. This has really brought about great improvement and sustainability to our SCM operational standards – i.e. inventory control systems. He further mentioned that, with the use of



ICT, production cost can be controlled by streamlining products flow within the production system and improving information sharing among the trading partners leading to total SCM improvement and sustainability. The Supply Manager mentioned that, real-time posting of requisitions are what we are currently practicing in our operations. Since its insertion into our SCM operations, it has increasingly brought about great improvement and has helped sustain the SCM. Overall cost of production is what we are all striving to reduce drastically! Any cost effective approach that can be adapted to reduce the over cost of production is most welcome. However, streamlining products flow across the production line and improving information flow among partners, I strongly believe will lead to improved and sustained SCM standards through ICT.

The following were put together from the 36 responses received from the survey on the above subject areas.

The 36 responses received on the question, *“Developing High Valued Supply Chain Relationships and Enhancing Customer Services Level Will Lead to the Achievement of High Level Competitive Advantage in the Resources and Finances Competitive Business Environments?”* on a “Yes” or “No” option showed that, all 36 respondents (100%) affirmed to the fact that developing high valued supply chain relationships and enhancing customer services level will lead to the achievement of high level competitive advantage in the resources and finances competitive business environments. In another case, the 36 responses received on the question, *“An increase in the SCM Operational Performance Through a Prompt Action in Handling Requisitions at the Issuing Point will lead to Improved and sustainable Standards of SCM through ICT in the Mining Industry?”*, on a scale of 1 to 5 (1 being ‘Strongly agree’ and 5 being ‘Strongly disagree’), referring to table-9 showed that, 24 (67%) of the respondents “Strongly Agree”, 8 (22%) “Agree” and the remaining 4 (11%) “Strongly Disagree”. Further applying the Likert Scale Mean Formula to the responses received depicted **1.7**. This result depicts that most of the responses to the question are mostly aligned to scale 2 (“Agree”). Furthermore, the 36 responses received on the question, *“Consistent Stock-Takes and Stock Analysis can Help Eliminate Stock-Out of Critical Raw Materials and Parts at the Warehouse. Do You Believe This Underlying Process Would Be Improved and Sustained by Adapting ICT in Your Mine SCM?”*, on a “Yes or “No” option showed that, all 36 respondents (100%) affirmed to the fact and believe that consistent stock-takes and stock analysis can help eliminate stock-out of critical raw materials and parts at the warehouse. In another scenario, the 36 responses received on the question, *“An Increase in the SCM Operational Performance*

*Through a Prompt Action in Handling Requisitions at the Issuing Point Will Lead to Improved and Sustainable Standards of SCM Through ICT in the Mining Industry?”*, on a scale of 1 to 5 (1 being ‘Strongly agree’ and 5 being ‘Strongly disagree’), referring to table-10 showed that, 32 (89%) of the respondents “Strongly Agree” and the remaining 4 (11%) “Agree”. Further applying the Likert Scale Mean Formula to the responses of question depicted **1.11**. This result depicts that most of the responses to the question are mostly aligned to scale 1 (“Strongly Agree”).

The above mix of comments and views from both management team members and operational staffs clearly depicts the fact that a consensus has been achieved. This consensus therefore depicts the fact that, the implementation of ICT in the Mine SCM will absolutely improve and sustain standards of the SCM such as high valued supply chain relationships and enhancing internal customer services level, real-time posting of requisitions, consistent stock-takes and stock analysis & quick processing of on-line requisitions. These SCM attributes or drivers are indeed highly enhanced with the implementation of ICT in the Mine SCM.

## **VI. CONCLUSIONS, RECOMMENDATIONS AND FUTURE WORK**

### **A. Conclusions and Recommendations**

We have introduced in this paper a more practical insight and approach to addressing the relationship and role ICT plays in the SCM based on real world contemporary case studies. This paper has therefore put forth a new face of addressing the relationship and role ICT plays in the SCM by using the Mining Industry, specifically, Adamus Resources Limited - Nzema Gold Mine, a Subsidiary of Endeavour Mining Corporation, located in Ghana as the case study organization to close this gap. In this way, a clear understanding of the level of importance attached to ICT in the *non-strategic*, and *finance* and *resources* competitive arena will be established. This will help ICT and SCM practitioners to understand the usage trend of ICT in this new environment and become aware of which best practices exist and how they relate to their business domains.

Based on the surveys and the interviews conducted on the operational staffs and the management team members of the Mine respectively, it was realized that, the relationship and role of ICT in the SCM of Mining Industry were numerous. The research clearly depicts that, there is a great deal of interest in the use of ICT by the SCM of the Mining Industry as ICT has helped to improve their SCM and sustain standards of their SCM but lacks the total coverage of its implementation. Yet it is believed and expected that, this will increase immensely in the next few years.

This clearly indicates the level of importance that the Mining Industry sees ICT role towards their operation performance and hence are aiming at expanding its coverage to move away from the silo optimization to a more robust grip on the entire SC. From the other side, it was observed that, though there is a high interest in the use of ICT in the Mine's SCM to support and improve its operations, its use is however still in infancy. It was additionally observed that, there is currently the lack of trust from the part of the mining companies to their external supply chain partners in system coordination; hence there are currently no system coordination/synchronization/harmonization between the mining companies and their upstream supply chain partners. Their concerns are that, once the coordination takes place, internal confidential information will be made public or known by the suppliers and third-party logistics companies. However, in our view, every system has an internal control system that helps control accessible information or offer limitation to users. It's obvious they are yet to explore this kind of service.

This paper recommends that, to make the whole Mining Industry SCM process more robust, there ought to be such seamless coordination. For example, this will help the logistics and event management/expediting officer monitor all purchase orders/shipments by tracking to find out the status or progress of all purchase orders/shipments by login onto just one system while the freight forwarders also will monitor the stock levels and advise the Mine on the possible need to change freight mode for certain items that have already been ordered. In the case of the suppliers, they can also see the stock levels of the Mine store stock and advise the Mine on the need to order or in the case of consignment stock once stock is visible to the supplier, they are made alert to start organizing delivery to the Mine which all stands to drive away late delivery and hence minimize immensely stock-out and over stocking.

### **B. Future Work**

To enable the generalization of the research findings, the study will have to be replicated on a bigger scale involving larger operational staffs and management team members from various mining companies including some of the giant and long existing mining companies in Ghana to arrive at a typical case study. Different views from the various gold mining companies in Ghana will greatly enhance the research as this will help the researchers make a more reasonable and informed comparative decision analysis on the subject matter. Then, it can finally be confidently stated that, indeed the research findings are truly a representative of the family of other circumstances of which the same outcome will be adapted.

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## APPENDICES

### Appendix A - Interview with the Finance Manager

1. **Please give a brief description about your role in the Mine and how long you’ve been working with the Mine as well as the industry.**...I am the Finance Manager of Adamus Resources Limited, generally responsible for monthly, quarterly and yearly financial and management reports. I have been working for Adamus for 2 years 5 months now and have 7.5 years’ experience in the mining industry.
2. **How would you describe the presence of ICT in your Mine’s SCM?** - The presence of ICT has enabled SCM to be more efficient, proactive to meet the demands of its clients.
3. **What role does ICT plays in your Mine SCM?** - It ensures information to and feedback from third party agents are delivered on time. Internally too, it



- enables work to flow freely and reduces cost.
4. **In your view, has the infusion of ICT into your Mine SCM brought about some form of improvement to the SCM?** - Yes
  5. **Is ICT really an imperative tool to your Mine SCM operations and why?** - Yes, because without that a lot of time, energy will be wasted leading to higher cost and lower efficiency.
  6. **How has ICT helped to improve your Mine SCM?** - It has virtually cut a lot of paperwork, improved understanding of the SCM activities and helped in reducing turnaround time.
  7. **Has the presence of ICT in your Mine SCM helped provide information availability, created material visibility and enabled a single point/location of contact for data? Please explain** - Yes, expediting report, for instance, has made it possible for all end user departments to know the progress of their orders.
  8. **How has ICT helped to improve and sustain your Mine SCM performance?** - Reduction of the processing time/time to handle transactions.
  9. **How has the presence of ICT in your Mine SCM help improve demand response time and that of the development of high valued supply chain relationships? Please explain.** - Because retrieval of information is not far-fetched and easily assessable response time has been tremendous. ICT has also enabled other user departments to understand and appreciate SCM better.
  10. **What is your take on the notion that the presence of ICT in your Mine SCM will help in creating quick approach to contacting vendors on issues regarding late deliveries and changes in scheduled shipment dates to improve speed (fast delivery) & on-time delivery?** - Positive as reaching out to clients just by the press of a button is a lot easier and enjoyable.
  11. **What do you think can be done to improve and maintain standards of your Mine SCM through ICT?** - All must be encouraged to continue its usage whilst embracing new ICT methods or technology as and when they emerge.
  12. **What is/are your view(s) on the statement that, continuous information sharing, transparency & visibility on your inventory and purchase orders will help improve and sustain standards of SCM in your Mine through ICT?** - It's a healthy sign and should be continued.
  13. **What is your opinion on the use of ICT by your Mine SCM enhances internal customer services level to the achievement of high level competitive advantage in the resources and finances competitive business environment that the Mine finds itself?** - ICT has made SCM customer friendly internally which is a very positive sign.
  14. **What is your take on the view that real-time posting of requisitions for items which are taken-off the shelves will help to improve and sustain standards of SCM through ICT in the Mining Industry?** - Real time is the order of the day. Decisions need to be taken not on very old transactions that might be detrimental to the Mines. This can only be achieved if we are capturing data as and when events happen.
  15. **What is your take on the view that, reducing overall production costs by streamlining the products flow within the production process and improving information flow between business partners will help improve and sustain standards of SCM in your Mine through ICT?** - Every Mine wants as much as possible to reduce cash cost per ounce, a positive sign to investors that the Mine is operating efficiently. It is therefore imperative that ICT supports SCM in this direction to make workprocesses flow freely at no extra cost.

#### **Appendix B - Interview with the HSE Manager**

1. **Please give a brief description about your role in the Mine and how long you've been working with the Mine as well as the industry?** - My role involves managing and controlling the health and safety aspect of the Mine operations. The health aspect is being handled by the medical doctors; I just facilitate his operations (i.e. helping providing the necessary logistics). The safety aspect is my specialization area. I ensure all operations staffs, contracts and any other group of people are not affected by our operations. All these are done in conjunction with the line manager – they have the responsibility of taking care of the employees and contractors working under them. I have over a decade (1999) experience in the industry.
2. **How would you describe the presence of ICT in your Mine's SCM?** - The presence of ICT in the Mine SCM has helped shorten the processes, created transparency

and visibility of information and increased the fastness of the process.

3. **What role does ICT plays in your Mine SCM?** - ICT plays a major role in the Mines operations including broadening the scope of operations (i.e. sourcing for raw materials) and helps integrate information between and within the various actors.
4. **In your view, has the infusion of ICT into your Mine SCM brought about some form of improvement to the SCM?** - Yes, it has really brought about lots of improvements to the SCM. It has increased the pace of data processing, data collection and transactions within and between various parties involved in the SC
5. **Is ICT really an imperative tool to your Mine SCM operations and why?** - Extremely imperative! In fact, it is a necessity and a business tool which is needed to be integrated into all businesses.
6. **How has ICT helped to improve your Mine SCM?** - It has improved the Mines operations – created effective communication, transparency, reduced the volume of works done within the shortest possible time.
7. **Has the presence of ICT in your Mine SCM helped provide information availability, created material visibility, and enabled a single point/location of contact for data? Please explain** - Perfectly! With ICT in our Mine SCM, every department including my department can access and find whatever they need for their departments operations from the warehouse and request the materials without even being physically present at the warehouse.
8. **How has ICT helped to improve and sustain your Mine SCM performance?** - Highly sustainable, and can improve Mine operations so far as we keep updating the ICT systems that we use to meet the ever changing needs.
9. **How has the presence of ICT in your Mine SCM helped improve demand response time and that of the development of high valued supply chain relationships? Please explain** - To a large extent! Just to mention a few, with the introduction of a comprehensive ERP system which comes with electronic requisition powered by ICT, once materials/spares requisitions are initiated by end users and accepted by issuing staffs, an automatic issuing of the item from the system is made. There are errors created through manual posting.
10. **What is your take on the notion that the presence of ICT in your Mine SCM will help in creating quick approach to contacting vendors on issues regarding late deliveries and changes in scheduled shipment dates to improve speed (fast delivery) & on-time delivery ?** - I strongly agree that, the presence of ICT and it tools such as mobile phone (i.e. BlackBerry) which has the facilitates to send and receive e-mails makes it extremely easy to contact vendors from anywhere and at anytime
11. **What do you think can be done to improve and maintain standards of your Mine SCM through ICT?** - Keep abreast with technology by adapting developing trends, i.e. Mobile phone to receive e-mails and send while out of site...acquire new technology, there should be training to keep up to the use of the new technology.
12. **What is/are your view(s) on the statement that, continuous information sharing, transparency & visibility on your inventory and purchase orders will help improve and sustain standards of SCM in your Mine through ICT?** - Of course yes! Information sharing on a continuous basis, transparency& purchase order & inventory visibility are the key to process improvements. These are most of key improvement areas that businesses are dying to achieve with the help of ICT.
13. **What is your opinion on the use of ICT by your Mine SCM enhances internal customer services level to the achievement of high level competitive advantage in the resources and finances competitive business environment that the Mine finds itself** - As a matter of fact, ICT cannot be underestimated. The essence of the whole SCM operations is the customer and since the Mine does not have any external competitive market, its focus is on how the internal customer service level can be improved.
14. **What is your take on the view that real-time posting of requisitions for items which are taken-off the shelves will help to improve and sustain standards of SCM through ICT in the Mining Industry?** - Interestingly, we do not run manual requisition. Every requisition is issued electronically by end user/requester through the ERP system. Once the requisitions are issued, signals are sent to the warehouse team and once accepted, it automatically issues out from the system quantities and a picking slip is used to collate the items requested.



15. **What is your take on the view that, reducing overall production costs by streamlining the products flow within the production process and improving information flow between business partners will help improve and sustain standards of SCM in your Mine through ICT?** - I go by the statement. Production cost is a headache for most managers. If a seamless production can be realized by using ICT to close these gaps through the provision of consistent and timely information, then our business will never be the same. We will see massive improvements to the Mine SCM and those improvements will be sustainable.

#### **Appendix C - Interview with the Maintenance Manager**

1. **Please give a brief description about your role in the Mine and how long you've been working with the Mine as well as the industry?** - My role involves the coordination of the maintenance activities between operations, supplies, maintenance, financial and external contracts.  
Maintenance - Schedule and plan all maintenance activities.  
Supplies – liaise with suppliers to ensure spare availability and qualities are maintained.  
Operations – collate jobs and deliver to maintenance staffs.  
Financial – processing and management of purchase requisitions and service orders that are channeled through my hands to financial via the supplies department.  
External Contract-liaise with external contractors for maintenance support service. I have worked in this industry for over 9years.

2. **How would you describe the presence of ICT in your Mine's SCM?** - The presence of ICT in the Mine has massively improved the entire SCM operations and smoothened the processes.

3. **What role does ICT plays in your Mine SCM?** - ICT help in coordinating the activities within and between all parties of the SCM of the Mine and beyond.

4. **In your view, has the infusion of ICT into your Mine SCM brought about some form of improvement to the SCM?** - ICT has facilitated maintenance planning activities through the creation of visibility of materials in stock. It has also helped in good records keeping, it simplifies task, brings about effective communication and reduces cost.

5. **Is ICT really an imperative tool to your Mine SCM operations and why?** - Yes, ICT is an extremely imperative tool. It is because it comes with lots of benefits when adapted. Such benefits include production cost reduction through tightly control inventory control process coupled with excellent maintenance planning system which leads to the balance of demand and supply. Less downtimes or more plant uptime/availability!

6. **How has ICT helped to improve your Mine SCM?** - ICT has helped us achieve business improvements through variety of ways. It has sped up the way we used to operate our business, change our thinking style on inventory holdings and improve our way of sharing information which used to hinder the progress of our operations.

7. **Has the presence of ICT in your Mine SCM helped provide information availability, created material visibility, and enabled a single point/location of contact for data? Please explain** - Yes, of course. In fact, it has made our work extremely easy. Information is everywhere and easily accessible, making my work very easy and smooth.

8. **How has ICT helped to improved and sustained your Mine SCM performance?** - Facilitated our operations by simplifying our operational transaction.

9. **How has the presence of ICT in your Mine SCM help improve demand response time and that of the development of high valued supply chain relationships? Please explain** – ICT has broken most of the communication barriers between our department and the other departments as well as other clients.

10. **What is your take on the notion that the presence of ICT in your Mine SCM will help in creating quick approach to contacting vendors on issues regarding late deliveries and changes in scheduled shipment dates to improve speed (fast delivery) & on-time delivery?** - ICT has come to change the way we operate our Mine. As I speak, my office phone line is linked to my mobile phone line so in case somebody wants to reach me through any of the lines and not successful, the call is automatically diverted to the other line. Interestingly, I can now work from anywhere using just my phone to response to urgent or critical e-mails.

11. **What do you think can be done to improve and maintain standards of your Mine SCM through ICT?** - Upgrading the system from time-to-time, ensuring full

utilization of the system, by training staffs on effectively use of the system, by ensuring compliance of system procedures, there should be a system administrators to manage the entire system of the company, link up system within and between various Mines to create visibility with necessary making changes. The system should be friendly to all uses.

12. **What is/are your view(s) on the statement that, continuous information sharing, transparency & visibility on your inventory and purchase orders will help improve and sustain standards of SCM in your Mine through ICT?** - Information availability helps eliminates greater amount of inventory. Once information is continuously shared among all parties, not only will inventory be made visible to everybody but will be reduced drastically... information will indeed replace inventory.
13. **What is your opinion on the use of ICT by your Mine SCM enhances internal customer services level to the achievement of high level competitive advantage in the resources and finances competitive business environment that the Mine find itself** - The internal customer's satisfaction is the reason for the whole process. Enhancing these internal customer service levels is the key to achieving sustainable growth leading to the immense gains in the arena we find our business.
14. **What is your take on the view that real-time posting of requisitions for items which are taken-off the shelves will help to improve and sustain standards of SCM through ICT in the Mining Industry?** - I agree perfectly with the notion. In our case, requisitions are not even manual they are all electronically generated and so posting are done real-time all the time. It indeed helps a lot.
15. **What is your take on the view that, reducing overall production costs by streamlining the products flow within the production process and improving information flow between business partners will help improve and sustain standards of SCM in your Mine through ICT?** - Cost is something that is killing our operations slowly. If an attempt is made to streamline the flow of products within the production stream and improve partnership information flow using ICT system, it is of course obvious that massive improvement and sustainability will be achieved.

#### **Appendix D - Interview with the Process Manager**

1. **Please give a brief description about your role in the Mine and how long you've been working with the Mine as well as the industry?** - I am the Process Manager and my role involves managing the production and engineering operations of the Mine. I have been working in the industry for over 17years
2. **How would you describe the presence of ICT in your Mine's SCM?** - In the past, calculators were used in calculating samples taken from CIL/CIP tanks. We needed to drive down to the contract laboratories just to pick up a lab report. In fact, the presence of ICT has really improved our operations processes, reduced the transport cost and time used to pickup reports – as reports are sent electronically, easy reporting has surfaced, and simplified processes.
3. **What role does ICT plays in your Mine SCM?** - ICT acts as a catalyst to our operations. In fact, it plays a major part/role in the Mine SCM operations by improving communication between and within all operational partners.
4. **In your view, has the infusion of ICT into your Mine SCM brought about some form of improvement to the SCM?** - Major improvements have shown up in the SCM - from the manual way of conducting business and its associated transactions, to electronic approach which makes everything extremely easier and faster.
5. **Is ICT really an imperative tool to your Mine SCM operations and why?** - Extremely imperative to our SCM operations! Reduces the workload, improves efficiency, helps monitor the processes, reduces labour and associated costs, enhances labour utilization, improve safety by reducing accident and incident occurrences.
6. **How has ICT helped to improve your Mine SCM?** - Massive improvements! Cost control, transparency and visibility have all improved over the years with the use of ICT. Indeed, cost is something that is dragging our operations into the ditch, and hence drastic cost reduction through transportation cost elimination in the case of sample collection and proper inventory control have led to sustaining our Mine SCM operations.
7. **Has the presence of ICT in your Mine SCM helped provide information availability, created material visibility,**



- and enabled a single point/location of contact for data? Please explain - Yes, with the use of ICT, every department and section of the Mine are synchronized making information about every aspect of the operations known to everybody that works not only with the department or section but any other department. Materials/spares in stock in the warehouse, in transit, and cleared at the port on and its way to the Mine site are all made known/available to all us at any point in time. Information is just available everywhere!
8. **How has ICT helped to improve and sustain your Mine SCM performance? -** ICT has brought about green supply chain. All transactions that take place within the various departments of the Mine are conducted electronically. All end user departments as well as the supplies department manage invoices received from contractors and suppliers by keying in those invoices into the ERP system for payment by financial. This has really brought about speed towards the processing of invoices as they monitor the process and comments about the process as well. This has made the contractors and suppliers to continuously support our business.
  9. **How has the presence of ICT in your Mine SCM helped improve demand response time and that of the development of high valued supply chain relationships? Please explain -** Yes and even beyond that! Automatic update of materials or spares issued from the warehouse are done as soon as the electronic requisitions initiated by the user departments are accepted by the warehouse and picking slips printed for the issue staffs at the warehouse to pick the materials or spares for staging for collection by the users. ICT has made it possible for major contractors and suppliers to be linked up to our system to enable visibility which makes them also plan our demand, hence improving our demand response time.
  10. **What is your take on the notion that the presence of ICT in your Mine SCM will help in creating quick approach to contacting vendors on issues regarding late deliveries and changes in scheduled shipment dates to improve speed (fast delivery) & on-time delivery? -** I strongly agree with the notion! The presence of ICT in our Mine SCM has really improved our response speed to our vendors, contractors and even within the various departments.
  11. **What do you think can be done to improve and maintain the standards of your Mine SCM through ICT? -** Intensive Education and training to all staffs.
  12. **What is/are your view (s) on the statement that, continuous information sharing, transparency & visibility on your inventory and purchase orders will help improve and sustain standards of SCM in your Mine through ICT? -** Yes to a large extent, i.e. purchase orders created by procurement are made know to each end user for verification through the electronic system before approval is given.
  13. **What is your opinion on the use of ICT by your Mine SCM enhances internal customer services level to the achievement of high level competitive advantage in the resources and finances competitive business environment that the Mine find itself -** Internal customer service level enhancement is the key to production success. Therefore the use of ICT will really help to improve our operations to achieve higher competitive stand in our business environment.
  14. **What is your take on the view that real-time posting of requisitions for items which are taken-off the shelves will help to improve and sustain standards of SCM through ICT in the Mining Industry? -** With the use of ICT, material requisitions have been made possible electronically and hence postings are done in a real-time manner. This has really brought about great improvement and sustainability to our SCM operational standards – i.e. inventory control systems.
  15. **What is your take on the view that, reducing overall production costs by streamlining the products flow within the production process and improving information flow between business partners will help improve and sustain standards of SCM in your Mine through ICT? -** With the use of ICT, of course production cost can be controlled by streamlining products flow within the production system and improving information sharing among the trading partners leading to total SCM improvement and sustainability.

#### **Appendix E - Interview with the Supply and Logistics Manager**

1. **Please give a brief description about your role in the Mine and how long you've been working with the Mine as well as the industry? -** I am the supply and logistics manager and have worked

- with the Mine for 3 years with 18 years in the Mining Industry.
2. **How would you describe the presence of ICT in your Mine's SCM –** ICT Enhances the ability to obtain goods and services from a wider range of suppliers.
  3. **What role does ICT plays in your Mine SCM? –** ICT helps in inventory visibility, track and trace order status.
  4. **In your view, has the infusion of ICT into your Mine SCM brought about some form of improvement to the SCM? –** For sure! ICT has helped in identification and measurement of service providers.
  5. **Is ICT really an imperative tool to your Mine SCM operations and why? –** Yes! Because without ICT into our SCM, tracing and tracking of purchase orders would have been very difficult.
  6. **How has ICT helped to improve your Mine SCM? –** ICT has helped us to improve on our orders delivery turnaround time.
  7. **Has the presence of ICT in your Mine SCM helped provide information availability, created material visibility, and enabled a single point/location of contact for data? Please explain. –** Our end users sit in the comfort of their offices to access our stock inventory to process stock issues and dispatch to warehouse issuing counters for action.
  8. **How has ICT helped to improve and sustain your Mine SCM performance? –** Information as the basis of supply chain controls.
  9. **How has the presence of ICT in your Mine SCM helped improve demand response time and that of the development of high valued supply chain relationships? Please explain –** By enabling the implementation of the electronic requisition (purchase and material requisitions) system and through the building of close contact and sharing of real-time information between and within partners.
  10. **What is your take on the notion that the presence of ICT in your Mine SCM will help in creating quick approach to contacting vendors on issues regarding late deliveries and changes in scheduled shipment dates to improve speed (fast delivery) & on-time delivery? –** Absolutely, ICT has brought about lots of improvement to our operations! With the presence of ICT in the Mine SCM, difficulties involved in communicating with vendors are the things of the past. In fact, access to all forms of communicating tools and the ability to communicate to vendors about any change whatsoever can be made at anytime and anywhere as far as there is network available in the area.
  11. **What do you think can be done to improve and maintain standards of your Mine SCM through ICT? –** Just two key things! Training and consistent system upgrade.
  12. **What is/are your view (s) on the statement that, continuous information sharing, transparency & visibility on your inventory and purchase orders will help improve and sustain standards of SCM in your Mine through ICT? –** Information is one of the SCM key enablers and creates lots of transparency and visibility within the SCM. Transparency and visibility between and within the SC partners helps to improve and sustain standards of the Mine SCM.
  13. **What is your opinion on the use of ICT by your Mine SCM enhances internal customer services level to the achievement of high level competitive advantage in the resources and finances competitive business environment that the Mine find itself –** Once the internal customer services are fully satisfied or higher services level are achieved, then there is that high possibility that, the Mine will be competitive in the *resources and finances arena* and hence can attract lots of investors.
  14. **What is your take on the view that real-time posting of requisitions for items which are taken-off the shelves will help to improve and sustain standards of SCM through ICT in the Mining Industry? –** Real-time posting of requisitions are what we are currently practicing in our operations. Of course, since it insertion into our SCM operations, it has increasingly brought about great improvement and has helped sustain SCM.
  15. **What is your take on the view that, reducing overall production costs by streamlining the products flow within the production process and improving information flow between business partners will help improve and sustain standards of SCM in your Mine through ICT? –** Overall cost of production is what we are all striving to reduce drastically! Any cost effective approach that can be adapted to reduce the over cost of production is most welcome. However, streamlining products flow across the production line and improving information flow among partners, I strongly believe



will lead to improved and sustained SCM standards through ICT.

**APPENDIX F- Research Survey Questionnaire**  
*The Relationship and Role of Information & Communication Technology (ICT) in the Mining Industry: An Analysis of the Supply Chain Management (SCM)*

**SECTION 1. General Respondent Information**

This section of the survey questionnaire attempts to gather some general information about the respondents. Please read carefully the content of each question to enable you answer the question accurately. **(6-questions)**

**1.1** What is your current employment type?

- (Please check (X) in the appropriate box)
- a. Permanent staff
  - b. Contract Staff
  - c. Other

(specify).....

**1.2** Gender (Optional)

(Please check (X) in the appropriate box)

- a. Male
- a. Female

**1.3** What is your full job title? (Optional)

.....  
.....

**1.4** What is your designated department?

(Please check (X) in the appropriate box)

- a. Finance
- b. Human Resources and Security
- c. Engineering
- d. Processing
- e. Community Relationship
- f. Health, Safety & Environment
- g. Mining (Open Pit & Underground)
- h. Other

(specify)

.....  
.....

**1.5** How long have you been working for the company?

(Please check (X) in the appropriate box)

- a. Less than 1 year
- b. 1-5years
- c. 5-10years
- d. 10-15years
- e.

Otherspecify.....

.....

**1.6** How long have you being working in the mining industry?

(Please check (X) in the appropriate box)

- a. Less than 1year
- b. 1-5years
- c. 5-10years
- d. 10-15years
- e. Other

(specify).....

.....

**SECTION 2. What is the Role of ICT in SCM in the Mining Industry?**

This section of the survey questionnaire attempts to gather information on the role ICT plays in the SCM in the Mining Industry. Please read carefully the content of each question to enable you answer the question accurately. **(8-questions)**

**2.1** On a scale of 1 to 5 (1 being 'Strongly agree' and 5 being 'Strongly disagree'), to what extent do you agree or disagree with the concept that, the presence of ICT in SCM in the Mining Industry will provide information availability and visibility?  
.....

**2.2** On a scale of 1 to 5 (1 being 'Strongly agree' and 5 being 'Strongly disagree'), to what extent do you agree or disagree with the notion that, the presence of ICT in SCM in the Mining Industry will enable a single point of contact for data?  
.....

**2.3** On a scale of 1 to 5 (1 being 'Strongly agree' and 5 being 'Strongly disagree'), to what extent do you agree or disagree with the notion that, the presence of ICT in SCM in the Mining Industry will allow decisions based on total supply chain information?  
.....

**2.4** On a scale of 1 to 5 (1 being 'Strongly agree' and 5 being 'Strongly disagree'), to what extent do you agree or disagree with the notion that, the presence of ICT in SCM in the Mining Industry will enable collaboration with supply chain partners?  
.....

**2.5** Does the presence of ICT in SCM of the Mine help improve demand response time?  
a. Yes  b. No  c. Other (specify).....

**2.6** Do you agree that ICT presence in SCM helps in the streamlining logistic activities across the supply chain to reduce cost and improved efficiency?  
a. Yes  b. No  c. Other (specify).....

**2.7** Does ICT presence in SCM help in developing high valued supply chain relationships?  
a. Yes  b. No  c. Other (specify).....

**2.8** The presence of ICT in SCM has helped to attain global standards and access to the world market?  
a. Yes  b. No  c. Other (specify).....

**SECTION 3. How has ICT Helped to Improve SCM in the Mining Industry?**

This section of the survey questionnaire attempts to gather information on how ICT has helped to

improve SCM in the Mining Industry. Please read carefully the content of each question to enable you answer the question accurately. **(8-questions)**

**3.1** On a scale of 1 to 5 (*1 being 'Strongly agree' and 5 being 'Strongly disagree'*), to what extent do you agree or disagree with the notion that, the presence of ICT in the SCM in the Mining Industry has enabled greater material availability and visibility which has immensely improved materials and maintenance planning processes with many significant cost reduction and service improvements .....

**3.2** ICT has helped improve SCM in Mining Industry by enabling a quick approach to contacting vendors on issues pertaining to customer service problems such as late deliveries and changes in scheduled shipment dates which has improved speed (fast delivery) & on-time delivery.  
a. Yes  b. No  c. Other (specify).....

**3.3** ICT has helped to improve SCM in the Mining Industry by helping to receive instant updates on orders placed with vendors which subsequently help in the production and maintenance planning.  
a. Yes  b. No  c. Other (specify).....

**3.4** On a scale of 1 to 5 (*1 being 'Strongly agree' and 5 being 'Strongly disagree'*), to what extent do you agree or disagree with the notion that, the ability to notify vendors of changes in configurations in products that are produced to order has been made possible with the presence of ICT in the SCM which has led to an improved SCM in the Mining Industry.....

**3.5** The ability to track ordered spares and raw materials on a continuous basis by the Mine's supply chain has been made possible with the presence of ICT in the SCM in the Mining Industry.  
a. Yes  b. No  c. Other (specify).....

**3.6** ICT in SCM in the Mining Industry has created the ability to directly communicate with vendors and internal customers regarding supply issues on a 7-day/24-hour basis.  
a. Yes  b. No  c. Other (specify).....

**3.7** The ability to schedule pickups and deliveries has been made possible and even improved with the infusion of ICT into the SCM of the Mining Industry.  
a. Yes  b. No  c. Other (specify).....

**3.8** ICT in SCM of the Mining Industry has enabled the SCM employees of the Mine becoming more responsive (reduce response time) to internal customer service problems and reduce service costs.

a. Yes  b. No  c. Other (specify).....

**SECTION 4. What can be done to improve and sustain standards of SCM through ICT in the Mining Industry?**

This section of the survey questionnaire attempts to gather information on what can be done to improve and sustain standards of SCM through ICT in the Mining Industry. Please read carefully the content of each question to enable you answer the question accurately. **(8-questions)**

**4.1** On a scale of 1 to 5 (*1 being 'Strongly agree' and 5 being 'Strongly disagree'*), to what extent do you agree or disagree with the notion that, continuously decreasing inventory costs by matching production to spares and materials demand in consistent goal with the concept of Just in Time (JIT) will help improve and sustain standards of SCM through ICT in the Mining Industry?.....

**4.2** Continuous information sharing, transparency & visibility on inventory and purchase orders status are ways that can lead to improved and sustainable standards of SCM through ICT in the Mining Industry?  
a. Yes  b. No  c. Other (specify).....

**4.3** Reducing overall production costs by streamlining the products flow within the production process and improving information flow between business partners will lead to improved and sustainable standards of SCM through ICT in the Mining Industry?  
a. Yes  b. No  c. Other (specify).....

**4.4** On a scale of 1 to 5 (*1 being 'Strongly agree' and 5 being 'Strongly disagree'*), to what extent do you agree or disagree with the notion that, improvement of internal customer satisfaction by offering increased spares and materials purchased delivery speed, inventory visibility and flexibility in operations through the seamless cooperation with both the internal customers and key suppliers/vendors is considered an approach that will lead to improved and sustainable standards of SCM through ICT in the Mining Industry?.....

**4.5** Developing high valued supply chain relationships and enhancing internal customer services level will lead to the achievement of high



level competitive advantage in the *resources and finances* competitive business environment.

a. Yes  b. No  c. Other (specify).....

**4.6** On a scale of 1 to 5 (1 being 'Strongly agree' and 5 being 'Strongly disagree'), what is your take on the view that real-time posting of requisitions for items which are taken-off the shelves will help to improved and sustainable standards of SCM through ICT in the Mining Industry?.....

**4.7** Do you agree or disagree with the point that SCM standards can be improve and sustain through the use of ICT in the Mining Industry with a consistent stock analysis to eliminate stock-out of critical raw materials or parts at the warehouse  
a. Yes  b. No  c. Other (specify).....

**4.8** On a scale of 1 to 5 (1 being 'Strongly agree' and 5 being 'Strongly disagree'), what is your take on the view that an increase in the SCM operational performance through a prompt action in handling requisitions at the issuing point will lead to improved and sustainable standards of SCM through ICT in the Mining Industry.....

#### AUTHOR BIOGRAPHIES



**Nana Yaw Asaber** received his BSc in Computer Science from Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana in 2004 and MSc in ICT from Aalborg University, Denmark in 2010. He has eight (8) years of teaching/lecturing experience at tertiary level of education in Ghana and is currently on Lectureship Study Leave granted by Accra Polytechnic, Ghana pursuing his PhD in Computer Science at School of Software, Dalian University of Technology, Dalian, P.R China. He has a number of journal publications in International Journals. His research interests include: Artificial Intelligence (AI), Software Engineering, Expert Systems, Mobile Learning, E-learning, ICT in Education, Information Systems, Multimedia, Recommender Systems, Social Computing, Wireless/Data/Mobile Communication and Computing Technologies.



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