Applications of Radio Frequency Identification (RFID) in Mining Industries

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Abstract. RFID technology has recently become a dream of many companies or organizations because of its strategic potential in transforming mining operations. Now is the perfect time, for RFID technology arise as the next revolution in mining industries. This paper will review regarding the application of RFID in mining industries and access knowledge regarding RFID technology and overseen the opportunity of this technology to become an importance element in mining industries. The application of Radio-Frequency Identification (RFID) in mining industries includes to control of Personal Protective Equipment (PPE), control of personnel to access mining sites and RFID solutions for tracking explosives.

1. Introduction

The mining industry is the oldest industries for worldwide and become a main economic contribution for many countries around the world. For example China, Australia, Indonesia, Malaysia and others. At this time, the mining industries is undergoing an economic boom that is causal to economic regaining and social development in various countries. In order to survive, it must encounter quite a lot of challenges related to initiate of new development in the projects [1].

Mining industries is categorized as high risk job that will reflect to occupational safety and health. The uncertainty event could happen anytime. The proactive action is become a must in control the management of risks associated with occupational safety and health. Relatively, related to systematic approach. Practically, once core decisions are being decided thru the life cycle of the mining business starting at the stage of exploration work concluded mine operations to mine rehabilitation. Consequently, the risk controlling is main impotence part subsequently the chance of opposing significances cannot be removed completely without causing economically non-viable or else mining operations technically [2].
This paper will review regarding the application of RFID in mining industries and access knowledge regarding RFID technology and overseen the opportunity of this technology to become an importance element in mining industries. Judgements regarding the choice of new technologies like RFID involve substantial investment and can have a strategic impact on the organization. We will discusses the practice of this technology from a management perspective, give some theoretical frameworks that are beneficial for the organization to implement the RFID technology in mining industries [3].

RFID technology has recently took the dreams of many company or organization because of its strategic potential and high operational in transforming mining operations. Now is the perfect time for RFID technology arise as the next revolution in mining industries. Truly, RFID technology is predicted to alter many of the mining operations including the actual time data collection and sharing amongst mining investors, the establishing of innovative business models and practices such as the total inventory management, products anti-fabricating strategies, build-to-order supply chain management and reverse logistics. Additionally, RFID technology permits the reshape of inter-organizational and intra-organizational business developments that could lead to the rise smart processes. It is a processes that can initiate business transactions without any human interferences and minimalism the integration of inter- organizational and intra-organizational information systems. The RFID technology principally should permit the tagged entity to turn into an intelligently communicating element of the organization’s overall information internal frame and become a mobile based on the mobility of RFID technology [4].

2. Radio Frequency Identification RFID
Radio Frequency Identification (RFID) is the technology use of electromagnetic fields to transmit data. It also refer to the process of using the technology of wireless broadcast to collect and recovery data, [5]. RFID is an unique Automatic Identification and Data Capture (AIDC) technologies [6]. This technology is considered by many scholars and experts as an “Internet of Thing”. It talk about to the prospect to find out information regarding the tagged object by surfing database entry or Internet address that matches to a particular RFID [4].

3. The Principle RFID
The usual Radio Frequency Identification technology is comprise of the electronic tags, reader, antenna and a computer with software to manage and control the RFID equipment [5].

Principally, an RFID system is comprise of four component:

i. An electronic tag consists of microprocessor chip (is an integrated circuit with memory). RFID tags can be passive (without batteries) or active (with batteries). [7]. This microprocessor chip is implanted in a physical object to be recognized [8]

ii. The reader is a device that can read data from RFID and respond without making any physical contact to the tags [8]. Communication between reader and tag allows the locality information of an items to be recorded and transmitted to a server via a computer network, thus permitting the movement of the items to be tracked and traced. [7].

iii. The antennae are the channels for the interaction of data between the reader and tag. It has a reading range both sideways and in front of the antenna. The location and design is vital in controlling the coverage area, efficiency and accurateness of communication between the tags [7]

iv. A computer with software to manage and control the RFID equipment, screening the data, and cooperates with enterprise applications [8]
4. Application of RFID in Mining sites

The following below is the applications of RFID in mining sites.

4.1. Control of Personal Protective Equipment (PPE)

In mining industries necessitate the employees to wear PPE. The usual PPE consist of safety vests, gloves, steel-toed, safety boot, clothing, ear plugs, hard hats, eyewear, masks, and etc. Different work situation has different PPE requests that essential be uses referring to rules and regulations that must be compliance. In order to solve this problem, the RFID technology can be used, as a one step to create safety environment for the mining worker.

According to Kelm et al. (2013), to control the Personal Protective Equipment (PPE) required each PPE component must have attached with an RFID tags. The mechanism of RFID is when a person wearing PPE that equip with RFID tags passing through the gate, it will be detected by an RFID reader or an antenna system. The RFID tag may encompasses essential information of PPE that had been wearing by the worker. This technique guarantees that essential and compulsory PPE components that must be worn by the personnel before the employee starts to work. There are some important PPE information that can be stored on the chip of a passive RFID includes:

i. Serial number to differentiate from other equipment’s
ii. Operation manual to safely use the equipment’s
iii. Maintenance records (lasting useful time or date of equipment’s)
iv. Info or data log about individuals who use the equipment’s
v. Disposal facility or recycle procedure (to ensure damaged or outdated equipment’s is not reused over).
vii. Expiration date of PPE
vii. Latest use of PPE

4.2. Control of Personnel to Access Mining Sites

Main mission of logistics at mining places is to accomplish access control of personnel. On huge mining area, many labours are mostly employed and on site concurrently. It also involve several vendors, subcontractors and guests. They might enter frequently to the mining area daily. The illegal individuals should be not permit to entry to the mining site for the safety precaution, to prevent theft, and illegal employment in mining sites. In order to prevent it from happen, the mining area are secure usually by a barrier or buffer zone. Reliant on the how big of the mining site, the operated mining firm may employ extra access control, for example security guard that manage entry and exit to the mining site and also guarding the interior and borders of the mining site.

To solve this problem, the implementation of RFID technology become main vital aspect. The use Identification (ID) cards for personnel that use RFID technology to operate may reduce the risk of safety precaution, theft avoidance and illegitimate employment in mining sites. Identity cards are distributed to control personnel from exiting and entering the mining area. The size of the ID cards usually similar to credit card. It will carry name and photo of the worker. The ID cards can be read by a barcode reader by touch the card. With RFID technology, it will ease the process of identifying personnel. Traditionally, before this the process of identifying personnel use a lot of labor and time-consuming. The security guards tend do not carefully check so that this technology will bring the future of new system in security aspect. It will measure when a person enters or leaves the mining site. The statistical data that get from the system, will become an important for business to measuring the workers performance for example attendance and punctuality. The systems currently for ID cards established on (passive) RFID and barcodes. The access control and time recording systems using automated-identification (ID) technologies joint with time and attendance recording competencies are suitable for mining site. Development advance RFID, for face detection system for individual to entering mining area not widely use the camera that function as biometric recognition be able to handle the problem encounter in mining site.
4.3. RFID Solutions for Tracking Explosives

RFID technology is proper for inventory management of boosters and detonators, tracing of detonators and explosives, security and recovery of the assembly from the explosion debris in the case of a misfire. This technology are be able to tracking and monitoring of detonators and boosters, reposition of the explosive materials or detonator in case of misfire, remote reading of detonators' IDs once detonators are in situation to blast are important for dependable inventory control also for safety features in mining work. Reading if possible at the time the detonator is being loaded in a blast hole can offer the trustworthy inventory control. This take account of the record keeping of depletion of detonators and permits bring up to date the inventory [10].

4.3.1. Tracking Of Detonator and Booster through Transit.

To tracking of detonator and booster through transit, there are two possible method. The first is tags was attached with explosives and read by a mobile reader and second is by tags was attached to explosives and read by stationary readers.

For the first method, the tags was attached with explosives and read by a mobile reader. The passive RFID tags may possibly be attached with explosives and so that it can be read by a mobile reader. During loading, the explosives can be traced and read by the mobile reader and data may possibly be linked to the computer inside the driver's compartment via mobile reader for upcoming indications. At the exit or entrance of the supplier or manufacturer, the explosives can over once more be traced and tracked by the reader positioned and contrary to the earlier data obtainable in computer. The driver can trace and track the explosives through the mobile reader in between the transportation for any mistake and ensure with the earlier data during transportation. The explosives can all over again be traced and rechecked with the data got at the time of loading at the entrance of shipment. The transferred power from tags to reader and then reader to tags would be inadequate to avoid from the lethal accidents due to impulsive explosion and to sustain the physical condition of the explosives available in the container [10].

For the second method, the tags was attached to explosives and read by stationary readers. Basically, the tags attached with explosives available in the vessel and readers should be located at considered place inside the truck. The readers will read the tags and eventually transmit the data to the computer that been placed in the truck. The main vital issues must be considered before attaching the tags with explosives and locating the readers at the considered places. For example location of the tags, ii) tag overcrowding, and the ability to handle coordination of readers and RFID tags. In order to avoid the risk of trigger of the explosives, the conveyed power from tags to reader and vice versa must be carefully control [10].

4.3.2. In Case of Misfire to Finding Detonators after Blast.

Misfired might happen, if the external source trigger or initiate the explosive. Example electronic devices, flash, impact by a large piece from rock fragments and other. So Misfired explosives risk must be present in order to keep safety for the worker at mining site. During drilling into explosive also can trigger the blasting. In order to do second blasting, the blasting engineer must know the exact location the explosive that misfired. The existence of misfired explosives in the drilling zone may cause very bad injury and might cause death.

So in order to prevent this, we must tracking, monitoring and retrieval of misfired explosives using RFID technology to prevent this accidents before happen. Misfired explosives can be trace or track using RFID tags that been attach or located on the explosives or detonators submerged inside the drilled bore hole of the surface of rock. When the explosion of explosive will destroyed the RFID tags during the event. Misfired explosives with the RFID tag will be able to sending and transfer signal to the reader. The data is expected by the reader right after the blasting, will give information regarding the explosives that are still not be blast completely and Might be dangerous for second blasting. So the action will be taken to proceed to trace and trace the remaining explosive. The challenges that must be encounter before implementation of RFID technology. The following is main importance aspect that must considered according Mishra et al. 2012:
i. Must be robust to mining environment
ii. Ability to resist vibration
iii. Economically such as low cost. Because the tags will destroyed by explosive

5. Conclusions
Mining industries is currently undergoing an economic boom that is causal to economic recovery and social development in various countries. Now is the perfect time for RFID technology arise as the next revolution in mining industries. Truly, RFID technology is predicted to alter many of the mining operations including the real-time data collection and sharing among mining investors, the establishing of innovative business models and practices such as the total inventory management, products anti-fabricating strategies, build-to-order supply chain management and reverse logistics. The application of Radio-Frequency Identification (RFID) in mining industries includes to control of Personal Protective Equipment (PPE), control of personnel to access mining sites and RFID solutions for tracking explosives. This technology are able give an economic value to the industries and will become a new changes to mining commodity.

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References
[1] A. Badri, S. Nadeau, and A. Gbodossou, “A new practical approach to risk management for underground mining project in Quebec,” J. Loss Prev. Process Ind., vol. 26, no. 6, pp. 1145–1158, 2013.
[2] D. Komljenovic, W. a. Groves, and V. J. Kechojevic, “Injuries in U.S. mining operations - A preliminary risk analysis,” Saf. Sci., vol. 46, no. 5, pp. 792–801, 2008.
[3] G. Ferrer, N. Dew, and U. Apte, “When is RFID right for your service?,” Int. J. Prod. Econ., vol. 124, no. 2, pp. 414–425, 2010.
[4] S. Fosso Wamba, A. Anand, and L. Carter, “A literature review of RFID-enabled healthcare applications and issues,” Int. J. Inf. Manage., vol. 33, no. 5, pp. 875–891, 2013.
[5] Y. Y. Niu, Z. J. Zhu, and M. R. Fan, “The Application of RFID in Coal Mine Safety Management,” Adv. Mater. Res., vol. 710, pp. 720–722, 2013.
[6] M. K. Lim, W. Bahr, and S. C. H. Leung, “RFID in the warehouse: A literature analysis (1995-2010) of its applications, benefits, challenges and future trends,” Int. J. Prod. Econ., vol. 145, no. 1, pp. 409–430, 2013.
[7] E. W. T. Ngai, K. K. L. Moon, F. J. Riggins, and C. Y. Yi, “RFID research: An academic literature review (1995-2005) and future research directions,” Int. J. Prod. Econ., vol. 112, no. 2, pp. 510–520, 2008.
[8] S. Fosso Wamba, L. a. Lefebvre, Y. Bendavid, and É. Lefebvre, “Exploring the impact of RFID technology and the EPC network on mobile B2B eCommerce: A case study in the retail industry,” Int. J. Prod. Econ., vol. 112, no. 2, pp. 614–629, 2008.
[9] A. Kelm, L. Laußat, A. Meins-Becker, D. Platz, M. J. Khazaee, A. M. Costin, M. Helmus, and J. Teizer, “Mobile passive Radio Frequency Identification (RFID) portal for automated and rapid control of Personal Protective Equipment (PPE) on construction sites,” Autom. Constr., vol. 36, pp. 38–52, 2013.
[10] P. K. Mishra, M. Bolic, M. C. E. Yagoub, and R. F. Stewart, “RFID technology for tracking and tracing explosives and detonators in mining services applications,” J. Appl. Geophys., vol. 76, pp. 33–43, 2012.