THE CONSIDERATIONS OF DEVELOPING AND IMPLEMENTING AN IT SYSTEM TO TRACK AND TRACE EXPLOSIVES IN THE SOUTH AFRICAN MARKET

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ABSTRACT

The mining industry accounts for roughly one-third of the market capitalisation of the Johannesburg Stock Exchange, is a magnet for foreign investment, and employment represents a significant percentage of the country’s total economically active population. Currently South African mines have a renewed focus on safety and security. Section 54 of the Mine Health and Safety Act has no doubt saved many lives, but still closures under this section, 6% of which can be attributed to explosives control, are costing the industry up to R4.6 billion per annum.

This article investigates the manner in which the South African explosives industry is actively changing the way explosives are controlled and explosive accessories are managed. The industry is under extreme pressure to gain control over their final products due to on-going theft and loss throughout the supply chain. A project was identified to track and trace explosives and explosive accessories through the supply chain which in turn could highlight risk areas. The increased visibility obtained from implementing a system and automating transactions is the key to the success in identifying these risk areas and enabling authorities to focus their investigations and establish proper control procedures.

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1 INTRODUCTION

The South African explosives industry is under pressure to gain control over their products due to ongoing loss and even theft of explosives and explosive accessories, including detonators, detonating cord and other initiation systems. The industry is busy changing the way they manage explosives, and is also investigating how the use of technology can improve the flow of information, increase visibility along the supply chain, and ultimately lead to better control.

The mining industry is of prime economic and social importance to South Africa. It plays a major role in the South African economy, acts as a magnet for foreign investment, and is an important employer particularly when one considers that each miner supports an average of seven to ten family members. Currently the South African mines face major challenges with a renewed focus on safety and security. They are primarily governed by the Department of Minerals and Energy (DMR) which works under the governing principles set out in the Mining Health and Safety Act (MHS) adopted in 1996. This act was brought into action as the South African mines were seen as very unsafe and needed to be forced to bring safe practises into place. This department has appointed inspectors with the power to close a mine should suspected unsafe practises be noticed.

UASA (United Association of South Africa) has emphasised several times in the recent past that although Section 54 of the Mine Health and Safety Act has no doubt saved many lives, the fact that often all the activities at mines are halted while an incident only affects one specific plant or a workplace, is costing the industry up to R4.6 billion per annum. (UASA, 2011) Currently the mining industry loses a significant portion of their revenue due to section 54 closures, and 6% of these closures can be attributed to explosives control. (Department of Mineral Resources, 2011) Figure 1 below graphically depicts the various causes of mine closures.

Taking the above data into consideration the cost for the mining industry of not having proper explosives control is around R280 million per annum. This is not only significant in terms of costs but the risk in terms of theft of explosives, which can then be used for criminal activities, has made the problem wider than the mining industry and the safety of the public has come into question.

The Department of Labour (DOL) in South Africa has a branch actively looking at explosives manufacturing sites, and has on numerous occasions indicated that the suppliers need to help stop the theft of explosives and explosive accessories. The other regulating body for explosives is the Chief Inspector of Explosives (CIE) who is appointed by the South African Police Service (SAPS) to govern all movement and control of explosives before it reaches the mines. They have also put significant pressure on the industry to adopt new ways of handling and controlling explosives.
Given the above, mining houses thus have a forced focus on improving their systems in terms of safety and security. There is a dire need to obtain control over the handling of explosives and explosive accessories, and the mining industry has turned to its suppliers for an answer on how to address and hopefully solve the issues of control and tracking of explosives. This need is not only required internally, as for instance automated teller machine (ATM) bombings are also on the increase and the SAPS have made this a top priority to solve. Even though the criminal element can never be addressed fully, by knowing where certain hot spots are the SAPS can focus their efforts.

This then poses the following question:

What is a good way to implement a solution for the South African Explosives industry to track and trace explosives and explosive accessories?

By analysing the requirements from the Department of Minerals and Energy, Chief Inspector of Explosives, and industry forums like NIXT (National Institute for Explosive Technology) it becomes clear that the industry is looking for ways to change the manner in which it handles and manages explosives and explosive accessories due to the current problems experienced.

The industry has also shown interest in using standards published in other countries. The Federation of European Explosives Manufacturers (FEEM) has published guidelines for the identification and traceability of explosives. The FEEM recommends that as a first prerequisite, an Application Identifier (AI), e.g. a bar code, be printed on every single cartridge, detonator, detonating-cord and other accessories.

A need for collaboration is also expressed and hence a second prerequisite is the creation of a platform for shared information. In particular, there has to be clear visibility of downstream flow; data on real movements needs to be captured as far down the chain as possible and shared with upstream suppliers and authorities. There needs to be willingness amongst the stakeholders to put aside any previous mistrust and instead create an environment in which information can freely flow in all directions in the chain. (Christopher, 2000)

2 SYSTEM DEVELOPMENT CONSIDERATIONS

2.1 Regulations Pertaining To Explosives Storage And Transport

Movement of dangerous goods is often very difficult because of the restrictive policies and regulations that govern the movement of these types of products. Particularly in the case of movement of dangerous goods across the world, there is no universal standard, and different countries impose additional requirements over and above the regulatory requirements, or impose more restrictive requirements. This places barriers against the movement of dangerous goods and adds on to the cost and complexity for operators, shippers and others in the supply chain. (Brennan, 2010) As an example, all explosives in South Africa are governed principally by the Explosives Act (15 of 2003 as amended) and The Explosives Act 1956 as amended. Military explosives are additionally governed by the Defence Act and National Conventional Arms Control Act. As soon as explosives have to be transported, a number of other Acts come into play, such as the Railway Safety Regulator Act, Occupational Health and Safety Act, Road Traffic regulations, Harbour regulations, and the Merchant Shipping Act to name only a few.

All aspects regarding the security of these products remain a principal concern and are therefore monitored very closely at all stages of the movement. As the CIE does not have the manpower to do excessive inspections they rely on the suppliers to self regulate and adhere to all rules and regulations with the understanding that if something goes wrong they will be held accountable. This is based on a strong trust relationship and potentially might be abused by the
manufacturers. It can also be noted that it is a major risk to lose products or not know where they are in the supply chain. The penalties for companies in this regard have significant consequences.

The introduction of technologies like Bar Coding and Radio Frequency Identification (RFID) has proven that it reduces the chances of theft, reduces staffing needs and allows better control. (Delaney, 2004) There are other explosives tracking systems that are operational (Darnbrough, 2008) in other countries, but the concepts stay the same - the key is how the information is used. Using tags, and with tracking technology having made huge strides in recent years, mining companies can keep their eye firmly locked on the prize, tracking the progress of explosives from ordering through delivery and onto final detonation. By using tracking technology, mining companies can provide safe storage, security, tracking and regularity compliance in the use of explosives.

Tracking systems can provide the magazine keeper with new resources to perform key tasks better and achieve higher work efficiency while meeting all present and hopefully future regulations. For the first time, both stock management and risk reporting can be generated in both paper-based and electronic formats. “Paper-based systems provide a lack of traceability once the explosives leaves the box, restricting personnel from fully understanding what is being loaded into each blast hole,” Cash said. (IPICO Inc., 2006) “Real-time globally visible explosives security is one of the best defences against terrorists who misuse explosives to manufacture bombs”, said Bob Morhard, Managing Partner, ExploTrack, LLC.

2.2 Industry Dynamics

Although all the indication is given that suppliers and manufacturers of explosives will be responsible for finding a solution, it also has to make business sense. Simply improving control by means of physical checks and additional people will only add to the cost of a supply chain - on its own this does not add value.

In order to develop a system, the specific interactions between one of the suppliers and distributors of explosive accessories in South Africa have been analysed, and a system designed for their particular needs. The design, however, is generic and handles all the basic needs that an explosives company would need to control the stock throughout the supply chain. The resulting formalised collaboration has had a major impact on the way they do business and this meant that the supplier truly has “cradle to grave” control of products sent out. Once the project was completed it could be seen that by having more real time data and by automating transactions certain benefits were gained internally. These benefits could be quantified and measured in terms of the benefits versus the cost of implementation.

Although this company was the first and currently the only explosives company in South Africa to successfully implement a solution of this nature, on its own it does not necessarily give it a significant strategic advantage. However, such a system will in all probability become a qualifying requirement, i.e. in future one would not be allowed to enter the market without one.

2.3 Inefficiencies In Current Control

The current state of the South African logistics systems is not as efficient as one might think, with the industry incurring billions in unnecessary costs due to inefficiencies. This has two implications:

- Companies with considerable opportunities in cost and inventory reduction and customer service improvements are prime acquisition targets for overseas multinational retailers or equity players who add value and sell them on.
- First movers who manage to address the supply chain challenge will have great opportunity to reduce costs and improve service, and consequently gain market share and margin ahead of the competition.
In order to reform the SA explosives industry and avoid falling even further behind in the global environment, a large and holistic supply chain effort is required, consisting of an integrated and collaborative approach. Attempts to fix problems such as shrinkage, security, demand forecasting, lead times and other silo-based problems in isolation will yield suboptimal value.

The most basic definition of visibility in the supply chain is the traceability of products in transit from the manufacturer to the final destination. These could be parts or components used to make a final product or the final product itself. In a broader sense, visibility is the increase of available data that can be analysed to make recommendations and determine strategies to improve and strengthen a supply chain. There are certainly different levels of visibility, but as risks in the supply chain continue to exist and customer demand continues to be less understanding of disruptions, more companies are recognizing the importance of creating and managing a visible supply chain. (KLCI Research Group, 2002)

![Figure 2: Steps in Utilizing Information](image)

Significant cost savings and improved efficiencies are achieved through effective supply chain optimisation. This is supported by the implementation and use of appropriate technology. An example of this is through track-and-trace technology whereby real-time information determines whether distribution points have the right inventory and right inventory levels. (Dutton, 2009) Real-time information creates visibility, and details of individual lanes, routes and facilities become apparent. The success of supply chain collaboration is built on information. All parties need to have visibility and sufficient information to make the best decisions. (Barloworld, 2006)

As can be seen in Figure 3, South African logistics companies spend a lot more on administration than most other countries. One major reason for this is the fact that many SA companies rely on manual data entry, and that the way ERP systems were implemented in South Africa is lacking on capturing and automated updating of data in ERP systems - this definitely was the case with the company under consideration.
Efficient supply chain control is dependent on access to real-time information that is critical for controlling the flow of products, services and information between suppliers and customers. Recent developments in technology and standards have enabled more efficient solutions for data capturing, storing and sharing in a supply chain setting. In traditional supply chain inventory management, orders are the only information that firms exchange, but information technology now allows firms to share demand and inventory data quickly and inexpensively. (Ghomi & Azad, 2009) Such a system and the requirements for visibility in a supply chain are illustrated in Figure 4.
By using technology as an enabler to business processes and focussing on the correct systems a solution can be designed to encompass and control most risks relating to control and information of explosives.
3 A WAY TO IMPLEMENT A SOLUTION FOR THE SOUTH AFRICAN EXPLOSIVES INDUSTRY TO TRACK AND TRACE EXPLOSIVES

Transporting explosives is an administrative intensive task in general. In the case, the cost of administration in the logistics and manufacturing side was roughly 1% of the revenue generated for the two companies. The risk however of not doing the administration correctly was a total shut down of operations. The need therefore to get a system working correctly and as soon as possible was of key importance to the business.

There are real benefits in information sharing and having it real time. Integrating and coordinating supply chain operations is widely considered a prerequisite for achieving high efficiency and competitiveness. Focusing on the performance and competitive situation for the entire supply chain rather than a single company is a trend in several industries. The supply chain perspective implies an increased need for orchestrating a broad set of activities, resources and companies, often with decentralised geographical structure and high complexity (Busi & Dreyer, 2004) (Chopra & Meindl, 2007) (Jonsson & Mattsson, 2003) (Rudberg & Olhager, 2002)

For an explosives tracking application to be effective, it needs to be accurate, safe and secure, as well as cost effective while providing clear chain-of-custody and authentication in extremely fast-paced, dynamic environments, with large volumes of explosives moving throughout the global supply chain. The system should also provide real-time explosives security and inventory control by monitoring and tracking explosives and detonators from production through logistics, storage and use throughout the South African explosives supply chain.

The scope of this change was to improve the integrity of the data and information in the supply chain with the means of an ERP system that receives its inputs from automated data inputs. This would help significantly with traceability of outbound products through the supply chain. The system was developed as a solution to integrate and automate transactions between the companies. The key focus was to trace individual boxes and all their movements, track individual product movements, do the financial transactions on the ERP system and create a platform to share this information across the supply chain. Figure 5 is a visual interpretation of this with the most important issues that were addressed.

![Figure 5: The Key Drivers Of The System](image-url)
As can be seen in the high level process overview in Figure 6, all movement points are captured by scanning every box. The data is uploaded to a central server and processed in the workflows. It is imperative to keep a database of transactions as the current ERP system does not have this capability. The transactions are queued to the ERP system and completed when the ERP system is available.

**Process Overview**

![Process Overview Diagram](image)

**Figure 6: Flow Of Materials And Transactions Automated**

The system can be seen as a traceability layer on top of the current ERP system with asynchronous connectivity keeping the ERP system as real time as possible in terms of all the financial transactions. This enables the two companies to have a virtual look at all stock currently in the system and not rely on the paper system that was used previously. It also enables sharing of information on a standard platform, making planning more efficient and effective.

Knowing where your products went also enables the companies to effectively recall boxes with quality defects. It also answers the questions asked by the CIE when boxes are found in non permit holders hands - where did the box come from? Every box that is manufactured has a unique label that can be interrogated in the system in terms of where it is and how it got there. By including the date stamp and batch number it makes it easy to interrogate the system for the specific box’s movements. The production personnel, magazine clerks and freight controllers are also issued with a username and password to make sure accountability of transactions are kept, and this forces ownership of transactions to the correct level of employees i.e. the people actually moving the product and not an administrator sitting in an office. The move away from manual entries decreases the risk of making mistakes.

The reporting on the website is easy to access and reports on batches, individual boxes or people can be drawn to interrogate where the stock is and who moved it. As can be seen in the example in Figure 7, the user who is logged in can interrogate all the boxes in a batch with their current location.
status as well as the supporting documentation for the movements. The user details of the person that handled the boxes are also captured.

![Figure 7: Tracking Of Individual Boxes To Customer](image)

Integrating the manufacturing, storage and deliveries real-time onto one system means that control over the entire supply chain is gained. The current system is estimated to have 98% accuracy on all products delivered. This is a very significant change from the paper system where virtually no box traceability existed. In all the product recalls that were issued in the last two years of the project running there was only one instance where all boxes could not be accounted for. Previously this entailed phoning every customer who receives similar products and asking them to go through their magazine to look for the batch in question. Certainly this leaves an impression of not knowing what is going on in the operations?

The benefits and value of a standardised industry platform and a standard communication process included:

- Improved operational efficiency and simplified processes, reducing paper dependency and duplication;
- Standardisation for both data and format, improving processing time;
- Efficient use of resources, thus increasing productivity;
- Improved communication between trading partners;
- Electronic updates tracking and maintaining a record of processes, with secure business-to-business communication;
- Risks could easily be identified and addressed;
- Economies of scale by two companies using same infrastructure platform;
- One system vs. several integration points meant one port of call for information;
- Reduced investment requirements for hardware, software and expertise (making effective use of the internet for low-tech user access) at all points, which are all centrally managed; and
- Decreased wrong deliveries.
Figure 8 is a graphical depiction of the three biggest contributors to success on this solution.

Figure 8: The Solution Components

The system meets all the potential legislation requirements and also made it easier for the business to track and trace their products through the outbound supply chain. The information that is now available provides the regulating bodies with the potential risk areas in South Africa and they can focus their efforts in these areas rather than spreading resources thin to try and find the source of loss or theft. The system has great potential to solve the security concerns, but it also now places the responsibility on the mining houses to make sure they have proper security systems in place.

Other intangible benefits include reduction in lost sales due to increased visibility into existing inventory (knowing what’s in your backroom so you can eliminate out-of-stocks), improved customer service due to timely delivery of orders, and more confidence in managing the supply chain due to accurate, real-time knowledge of location of products moving in the supply chain.

Apart from tracking of explosives the solution implemented also showed some real monetary benefits. The difficulty is to separate benefits of focussed leadership in this area from real benefits gained from the system.

The following data was retrieved from the ERP system to see how many of the transactions were automated. The number of transactions done by normal administrators and the system are tracked separately. This is broken down into three types of movements: Backflushing, Stock Movements, and Sales. A clear trend can be seen in the reduction in manual administrative functions. This time “saved” resulted in two administrative personnel members being completely freed up as resources and moved to a different department.
The customer experience can also be measured by tracking the Full Order on Time (FOOT) and looking at trends on customer complaints. This should indicate whether your customer is satisfied with the system that is used to support movement of products to the mines. Customer complaints decreased significantly with scanner checking every box for accuracy.

4 Conclusion

Technology enhancements on an Information System like bar coding or RFID help streamline systems and contribute to having accurate and real time data. Ultimately to get control over the supply chain real-time, accurate and accessible information is needed. Once control is achieved, the information needs to be shared and this adds value to the whole supply chain.

In an attempt to thus answer the question asked originally, namely “What is a good way to implement a solution for the South African Explosives industry to track and trace explosives and explosive accessories?” was to create a technology enabler on the ERP system to capture individual box movements throughout the supply chain and share this information with regulatory authorities as well as customers. This then highlights where most theft or losses occur and the focus can be moved to those areas.

The future of the industry is yet to be determined but the recommendation is to establish a group of technical experts through an institution such as the SABS to establish a standard for the industry. With this in mind, a steering committee consisting of suppliers of all tiers of South African industry should be set up to aid the CIE and DMR in determining which direction to follow. The steering committee should meet on a quarterly basis to give feedback on progress made in the programme, and to acquire input for future endeavours.

Significant gains were made in the supply chain from this project and the following were measured:

- Customer complaints related to loading errors were down by 76%;
- FOOT increased by 1.8%;
- Administration costs went down by approximately R50 000 per month;
- Real time visibility decreased the effect of the bullwhip effect, and working capital requirements decreased;
- Control over discrepancies has increased and are noted by a decrease in necessary adjustments.
It is important to note that these were not the initial reasons behind the project but spin-off benefits from enabling the processes by means of technology.

This study is important and worthwhile because it outlines the fact that technology does not always solve the problems, but when used as an enabler on top of proper business processes they become invaluable to the business. The results as described in this paper are evidence of that.

5 REFERENCES


