

PROPOSED IMPLEMENTATION OF RFID TECHNOLOGY IN ZAMBIAN RAIL TRANSPORT

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Abstract

This paper presents the possibility to influence the use of the RFID technology on the Zambian rail infrastructure for improved communication and identification of rail freight and courier assets. It suggests that the current manual systems have had the toil on the industry hence the stunted growth due to information communication challenges to make informed decisions. The RFID technology has over the years improved on agility bring with it better mobility capability and reduced cost of implementation. This presents an opportunity to provide near real-time information to key stakeholders which includes Zambian Government programs which introduced the traffic quota systems, Statutory Instrument (SI) No. 7, regulating 30% specific bulk cargo to move on rail (GRZ, 2018). It extends the possibility for technical data required for operations and maintenance of the rolling stock (Wagons and Locomotives) accessible at any given instance. This systematic approach targets the freight and commercial parcels courier for local traffic as well as cross-border rail interchange.

At a global situation, a number of technologies have been developed and adopted over time, however most of these modern systems as they may be have proved to be costly and generate instead more demerits than the intended purpose. RFID on the other hand, has continued to prove its outstanding consistency in delivering expectations which is a fundamental requirement for an industry such as the railways. This is so considering the sub-Saharan environment for the Zambian situation. The RFID technology, complex as it may appear or sound, has seen continuous enhancements, presenting a host of ingenuity for seamless automated mechanism and application as far as asset tracking is concerned. In this case, asset tracking considers rolling stock; cargo, yard shunting/marshaling, in between small yards or stations; and at the international exchange points for the different rail administrations; and the cargo customer siding to be the overall mesh of areas of needs to be satisfied.

Keywords:

Rail; Freight; RFID; Operators; Tracking; Assets; Technology; Shunting; Environment; Parcels

1. Introduction

The Railways Services of Zambia consists of two railway networks. These are the Zambia Railways Limited and the Tanzania Zambia Railways Authority. On the Zambia Railways network, the rail track covers a total length of 1,248Km from the Vic-falls in Livingstone Southern Province to Chililabombwe in the Copperbelt province (ZRL, 2013). On the subsequent side, the TAZARA which is a joint ownership between Tanzania and Zambia has a total network of 1,860KM (New York Times Edition, 1971). Zambia railways network was established under the Rhodesian Railways of 1906 during British colonial rule as part of the vision of the Cape-to-Cairo railway but the economic spur which followed was to access the mines of Central Africa (Memories of Rhodesia, 2018).

In many cases business heads find it difficult to make decisions on the implementation of RFID systems due to lack of knowledge about RFID technology. As the system is deemed a new phenomenon, this leads to phobia - an erroneous perception about the benefits that an RFID system is capable of producing. With this in mind, managers will have grey perceptions and expectations of RFID technology. This paper also addresses the issue of deciding RFID implementation.

The increase of freight, passenger travel and new trade opportunities and demands e.g. from the Asian markets have resulted in exposing the inefficiencies in the freight sector of the railways. A large part of the transportation drift from rail to road of various commodities – copper included, is due to the reduced client confidence in the rail transport sector. Lack of effective Information Communication Technology investment in the rail industry has today largely contributed to the poor performance in the sector. It is evident that very low levels of ICT systems intervention are in place to provide to establish a reliable information platform for stakeholders to grow the sector. It is of great importance that when huge sums are invested in the sector, necessary technologies should be employed to effectively and efficiently manage the business, else it remains a financial drain to the national economy.

1.2 Radio Frequency Identification Technology

RFID (Radio frequency Identification) is a technology providing automatic, contactless identification of objects using radio waves (Andrea Rosova, n.d.). RFID refers to technologies and systems that use radio waves (wireless) to transmit and uniquely identify objects (Finkenzeller, 2010). A basic RFID system typically consists of components for its function, these are tags, antennas, readers, and middleware/firmware that hosts the application software in conformity to IEEE 802.15 and ISO 18000 category. In the past, the lack of wide acceptance of the industry standards which resulted to fragmentation of markets, RFID was applied to a few application such as RFID-enabled smart tickets, highway toll booths, etc. The situation has now improving, new debates on RFID merits and implications. With new waves of applications for Ticketing, purchasing and inventory management receiving a lot of attention (Bari Nath, 2006). Compared to a barcode technology, it is evident that the RFID technology offers much faster reading capability speeds which of course with seamless applications and system automation.

The tags come in different forms and can be as small as a grain of rice (Attarana, 2007). The tag holds the electronic product code (EPC) used in the product identification exercises. Information stored on the tag is transferred through suitable radio frequencies to the reader. The antenna is predominantly made of a coil of wire. This is used to transmit and receive information that permits the tag to exchange data with a reader (Kim and Garrison, 2010). RFID readers can either be stationary or mobile (hand held units). They have the ability to read wide range of frequencies within a specified range. The reader is one of the key components of the entire RFID solution. The reader is capable of automatically recognizing and distinguishing all the Radio Frequency tags within its reading range. This feature allows the reader to simultaneously process all the data and provide for efficient material handling, sorting of inventory and packaging (Finkenzeller, 2003). As RFID application is likely to generate a high volume of data about objects and other things, some of the existing legacy systems might have to be updated to cope with the demands of the RFID application.

Ranked no, 154 of the top 500 developer Engineering News-Record (ENR) for the railroad, TransCore - an American company, have produced RFID wireless and field rail equipment such as the 'Advanced equipment identifier' (AEI) and the 'Train recording unit' (TRU) both used to monitor rail car assets, have built a reputation that has stood test of time in providing a lasting solution for the rail industry security and location tracking (Harrisburg, 2018).

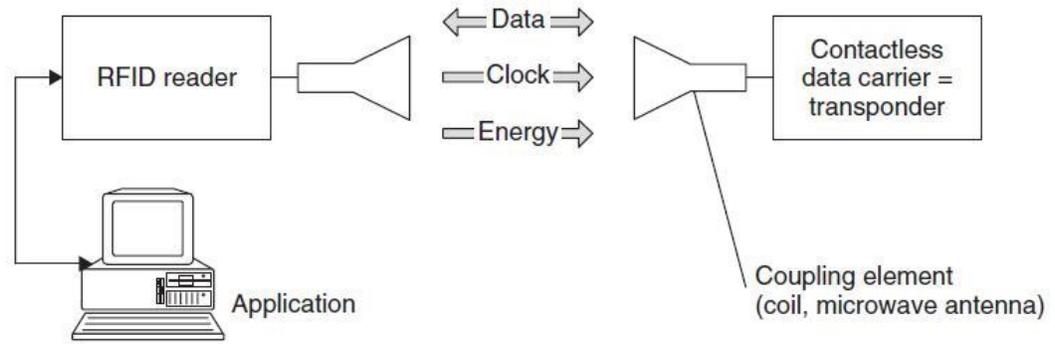


Figure 1. The reader and the transponder are the main components of every RFID system (Finkenzeller, 2010)



Figure 2. Above shows the passive tag on a rail car and the wayside reader



Figure 3. Shows the parcels with a RFID tags

1.3 Problem Statement

It is critical to note that the demand to utilize rail transport remains and still is constant as this is the economic backbone for any developing/developed country. Most businesses requiring transportation of bulk cargo have opted to utilize other services such as the road transport for its flexible conditions and easy tracking systems the service provides. Equally with the courier/parcels services, customers suggest to use road services to send merchandise as it is easier to monitor movements from source to destination. However, in most situations, especially in the southern African region, the rail service remains active on the traditional exports from the mines such as copper, coal and other bulk products used for mines mineral processing because the infrastructure already exists (a sunk cost). However, it is assumed that with the right investment and management, the rail must be competitive with road. Although RFID technology should not be considered a cure for the imperfect business practices, if implemented correctly, it can assist to drastically reduce business overheads (Liu, 2010) To make the industry competitive, relevant and first choice to bulk and parcels carrier transportation, RFID technology should be implemented to enable efficiency and transparency in monitoring consignment movements and operations to remove inadequacies and eventually rebuild the much needed B2B customer confidence achieved through continuous performance reviews.

2.0 RFID in Rail Transport

With the application of RFID technology in the Zambian rail industry, it is envisioned that freight information and communication shall be enhanced thereby restoring customer confidence, increase customer base and investment as the viability level of the rail industry shall improve. To justify the adoption of the RFID technology application, this can be referred to that in Europe union were it amended the Commission Regulation (EU) No 1236/2013 and to incorporate the Technical Services for Interoperability (TSI) subsystems Commission Regulation (EU) 2015/924 'WAG TSI' that relates to rolling stock – freight wagons (Agency, 2015). According to WAG TSI, the entry requirements for a subsystem refers to safety, reliability and ability to perform its function, health and environment

protection, technical compatibility, vehicle capability to transmit information between ground and vehicle.

By applying the regulation, it suggests that the service shall allow transparency in the freight contracts, since the customer shall be able to (Agency, 2015) (G.Sucharitha & A.Godavari, 2015):

- i) track each and every consignment movement, till place of destination;
- ii) be informed in good time on the departure and train arrival times;
- iii) track parcel/packages for courier delivery (courier-of-couriers), in the case of parcels services;
- iv) quick authentication/verification of passenger Tickets, in the case for passenger services;

Whereas the Operator shall be able to:

- v) Track the rail cars / Assets for operations identification and positioning ;
- vi) Rolling-stock Hot-wheel detections;
- vii) Rail Line/Track inspection, maintenance and fault detection;
- viii) Speed indication;
- ix) Train Collision Avoidance system (TCAS) / Automated Train Protection (ATP);

The specification for the RFID tag on the rolling stock would be as follows:

- i) Passive tags at each side of the rail car. See figure 2.
- ii) The available reader situated along the track wayside reader should be able to scan/decode tags from vehicles moving at speeds ≤ 30 km/h and transmit the information to the central control database. See figure 2
- iii) In conformity to regulations, the reader and tag interface, protocols, orders, schemes collision investigation should meet the ISO 18000-6 type A.
- iv) Presentation of the tags on the wagon for the allows for the readers to obtain information at entry and exit locations on the track

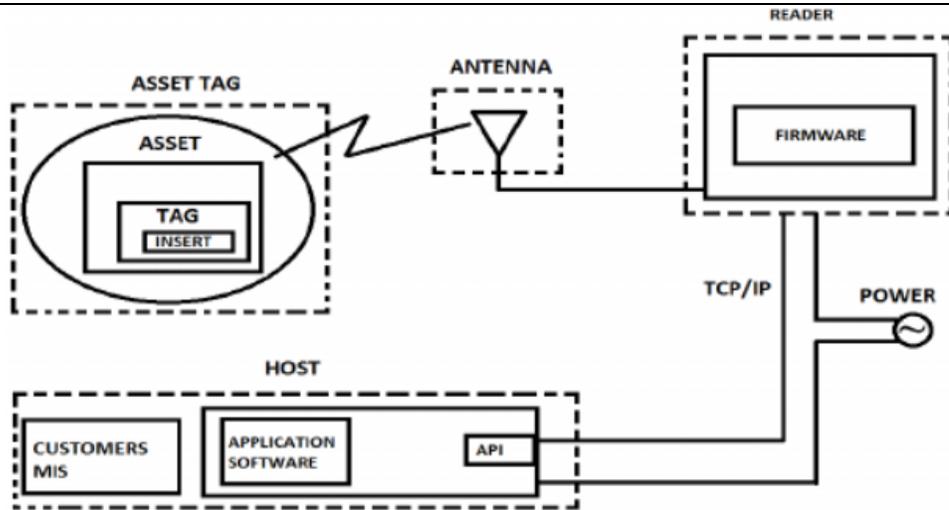


Figure 4. Shows the block diagram of components and data transmission

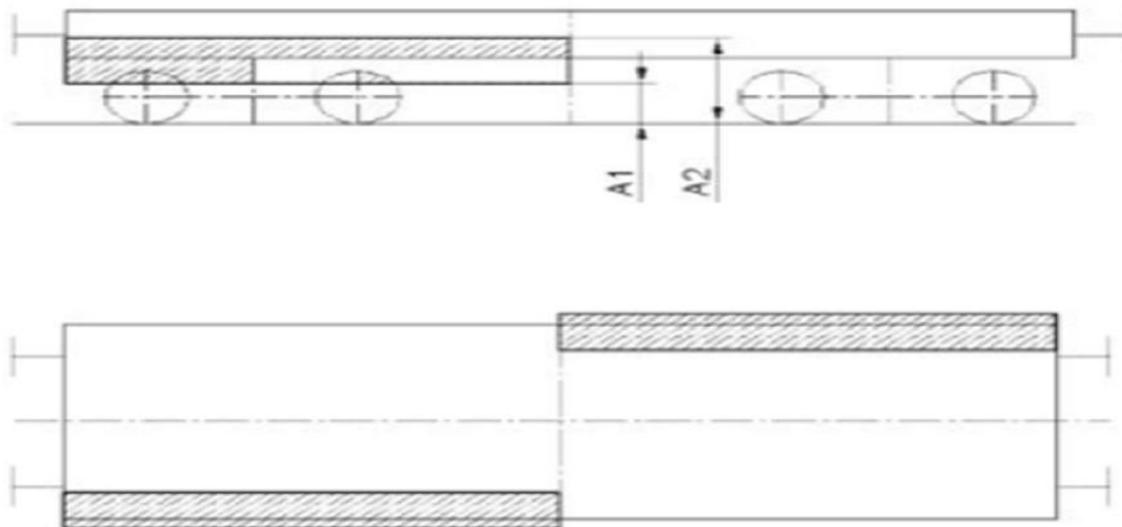


Figure 5. Placement of tags on the wagons (source: EU Commission Regulation (Agency, 2015))

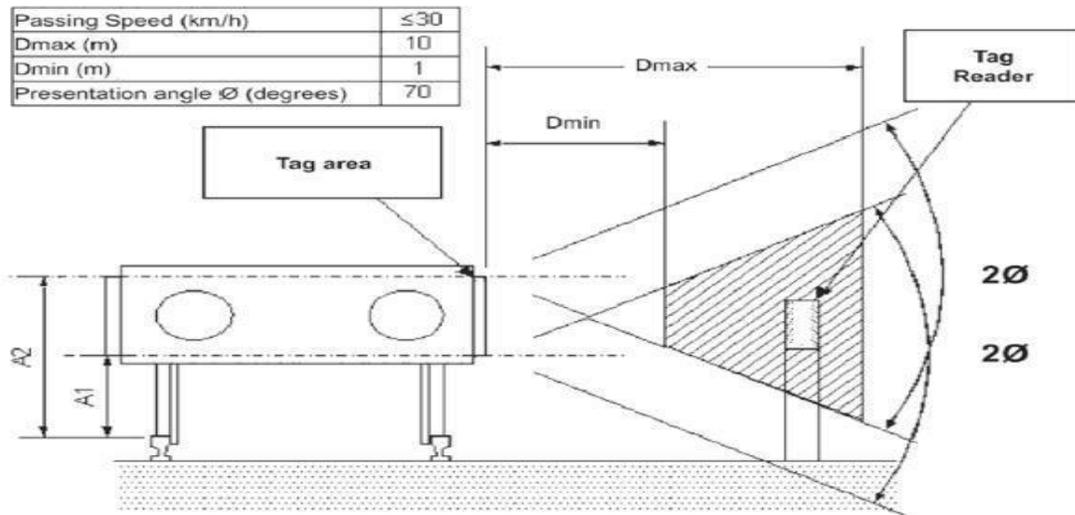
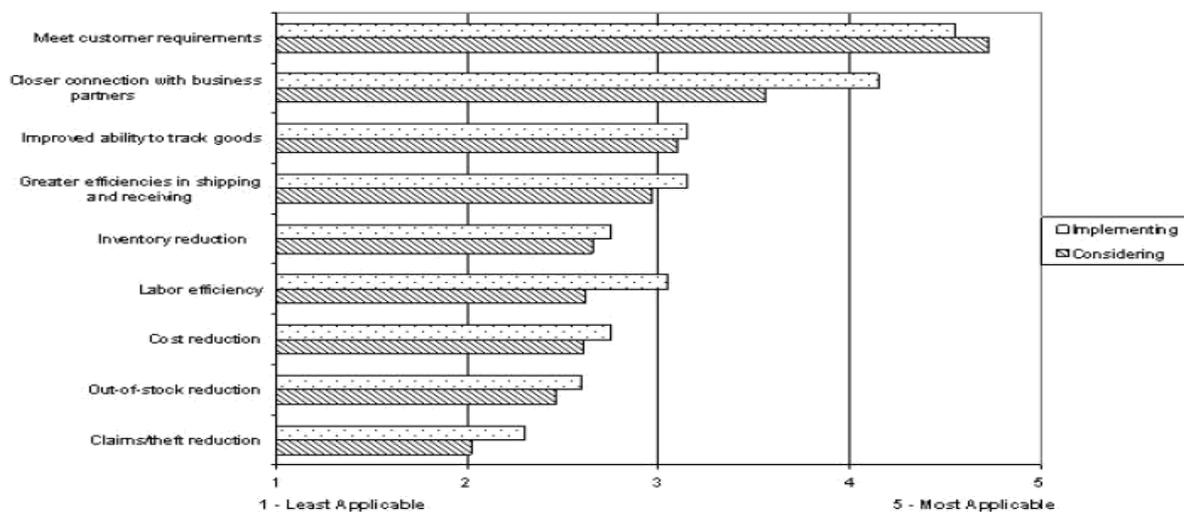


Figure 6. Placement of the wayside reader of passive RFID tags on the wagon (source: EU Commission Regulation (Agency, 2015))

With the successful implementation of the above structures on the Zambia rail systems, rail administrators shall be able to extract real-time data to arrive at data that can generate meaningful information for effective reporting and decision making. The data obtained can also be utilized to derive other objectives such as consignment tracking, logistics planning, train simulations, frequencies, load/weight reports / projections, planned maintenance, bill of lading, traffic, etc. These all target the essential operations of the rail transport business.



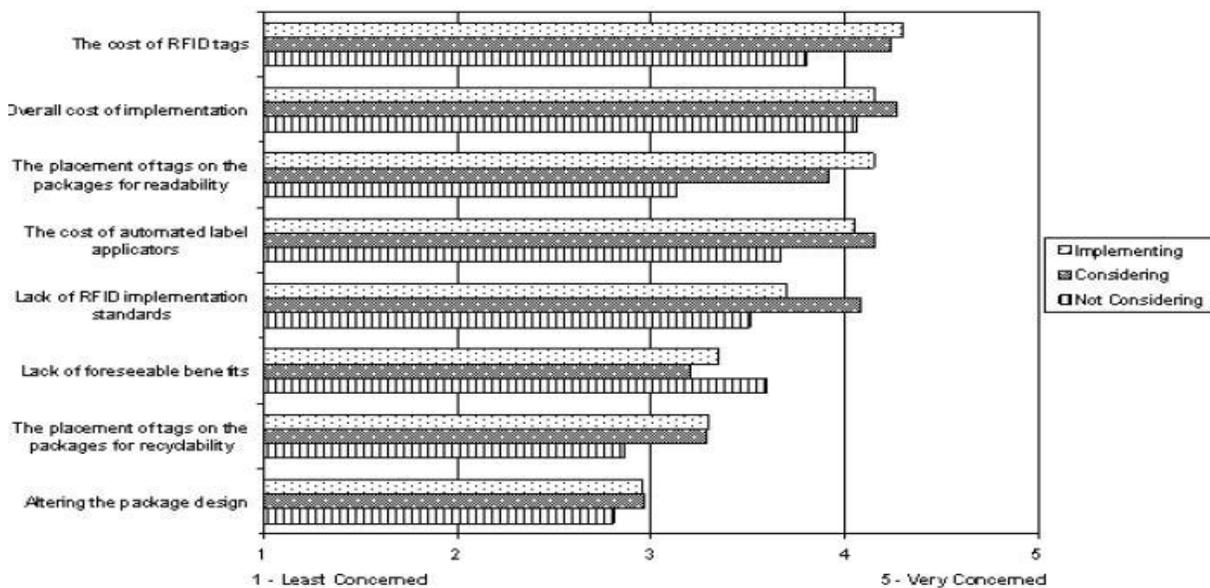
Freight transport creates empirical economic contribution to any society, therefore, by introducing

technologies such as RFID on the operations of freight traffic has a positive effect that promotes the utilization and cohesion of business applications in today's globalization efforts. However, to the contrary, the current drastic growth on the competitive road sector usage and expansion projects is being considered to be rapidly taking away the much-required resources to boost improvements over the rail sector, through the efforts to reduce traffic congestions, road carnage, noise and carbon pollution and road infrastructure damage. Deliberate adoption of effective technologies and policies by the Zambian Government that can reduce the negativity in the transport sector by promoting alternative systems shall bring forth improved delivery of services such as the rail industry, creating a user friendly and green transport business environment.

2.1 International RFID technology Observations

At this point, it is important to note what has been collected through world experts of the technology in terms of preference of RFID application in the rail industry. The tables below reflect current expectations for RFID Implementation:

- i) The figure 7 below shows the study on the major reasons for implementing or considering RFID system deployment (Vijayaraman Bindiganavale, 2008).
- ii) The figure 8 below shows the study of those that are implementing; considering; not considering deployment in an organization (Vijayaraman Bindiganavale, 2008)



2.2 RFID Principles

Two categories of RFID tags exist; a remotely powered Passive tag and a self-powered Active tag (Upfold and Liu, 2010). Passive tags are the most deployed to date and have no battery to power the microchip. The passive tag's chip is stimulated by electromagnetic waves from its reader, thereby, giving the chip power to transmit (Kelly and Erickson, 2005). The passive tags are cheaper to manufacture compared to the active tags. By contrast, an active tag has its own battery which powers the chip and is as a result more expensive. The power supply makes it possible for the chip to have a stronger signal to transmit stored information and broadcast over longer ranges. Evidently, since active tags are self-powered, they are constantly transmitting even in the absence of a reader.

3. Purpose of Rail Freight and Courier Services with RFID Research

RFID technology has advanced in recent years, not only from a research perspective but also from corporate practice. Unlike earlier barcode technology, RFID enables identification from a distance (Finkenzeller, 2010). RFID technology is identified of being key technology for the logistic operations, as well as customer orientation (Müller-Seitz, 2009). RFID tags provides unique identifier identity. RFID enables a tagged object or entity to be easily transformed together with intelligent communicating elements of a particular organization's entire IS framework.

The GPS item tracking technology together with RFID co-exists in very rare situations. The GPS (Global Positioning System), utilizes signal processors to receive low-power satellite signals and calculates positioning of an entity. It can then transmit that information either through a cellular network or a long-range system like Symphony Link. GPS compared to RFID, signal processors are power-hungry, whereas RFID on the other hand, are not quite as power-hungry. Passive RFID system tags don't require power at all (Ray, 2017). The Satellite communication is used only for monitoring and positioning purposes of locomotives and rail cars with high level of costs (Transcore, 2011).

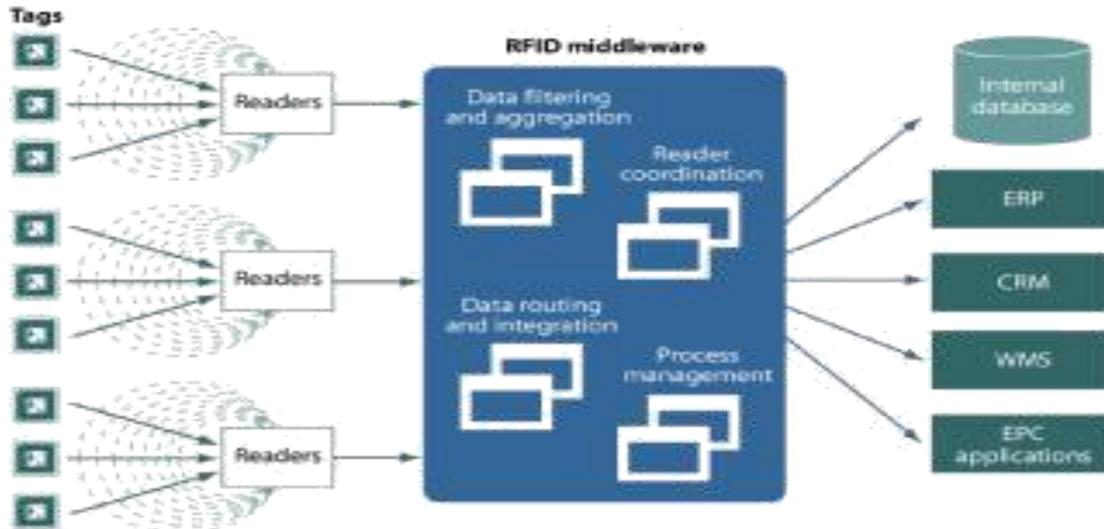


Figure 9 Fundamental functioning of RFID. Source: (Forrester Research, 2004)

The general benefits by the application of the technology by the Zambian railways would include:

- i) The information system practical usage of the RFID application integration is that it would support the Government's SI quota system to the government ministry of transport and commerce trade and industry with the Zambia Revenue Authority to efficiently obtain information for tax revenue purposes from the mineral production mines;
- ii) The information system practical usage that would track the movements of minerals by rail for the MVCMP- Zambia Revenue Authority, Ministry of Transport and Ministry of Finance.
- iii) The tagging of all wagons and locomotives to ensure that all rolling-stock on the Zambian railway meets the regional standard as per SADC (Southern African Development Commission) (SADC, 2012) or by SARA (Southern African Railways Administration) (SARA, 2018) regional railways future declaration to allow information sharing and tracking of wagons in the region by administrators and clients.
- iv) A scenario as to how railways could apply the technology can be presented as when a rolling-stock e.g. wagon enters a station, it is scanned by wayside readers that update the rolling-stock inventory which is stored in a secure computer database (Gasparik, 2011). When the consignment on the wagons are delivered to the client site, the backend/back

office computer at the database central train control unit updates the database and the consignment appears delivered.

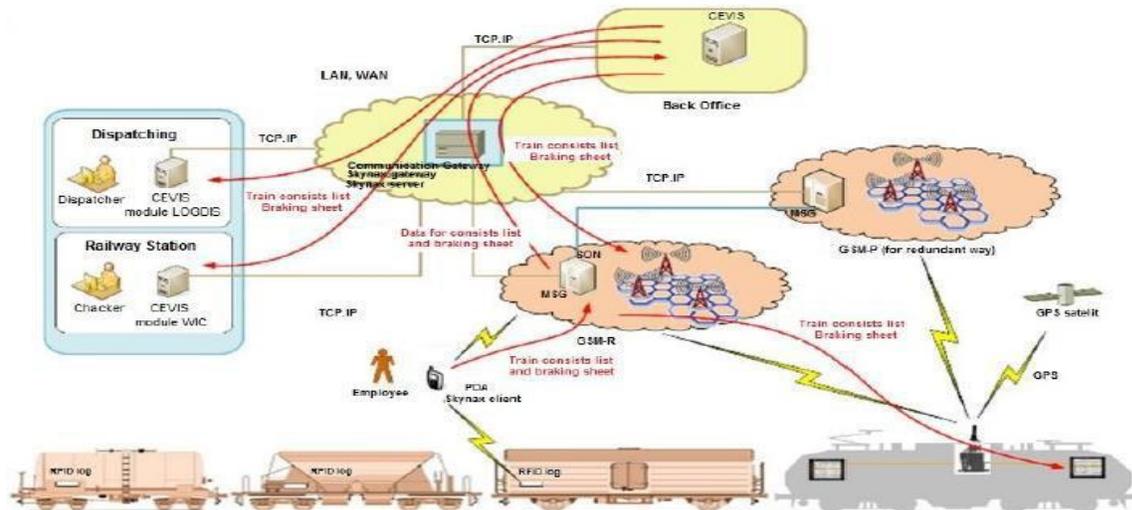


Figure 10. Up-to-date data collection by RFID technology for preparation of train consist list (Project (OE10016, LOGI-GATE))

In South Africa and Botswana railways, automatic identification system on rail cars were introduced. This was coupled with various challenges were faced such as the power source tag, crossing sensing and interference caused by congestion of the railway environment. To rectify the problem, a change of the technology by using passive UHF tags with transmitting frequency range of 915 MHz reached shooting distance 1.5 to 12 meters without unwanted interference and crossed near the capture tag scanning device. However, today one can access a 433MHz Ultra High active skyRFID tags go upto 500 meters, while the 2.4GHz do 100 meters with also real-time location. Provider of South Africa rail freight company Transnet Freight Rail, which represents a network of railways more than 23 000 km, has its fleet equipped with TransCore automatic identification. In 2007 alone, passive RFID tags were capable to identify approximately 80,000 wagons. (Izolova, 2011)

4 Objectives of the Study

4.1 Main Study Objective

- To identify challenges in the introduction and investment of RFID technology in Zambian Rail Freight Operations and Infrastructure

4.1.1 Specific Objectives

- i) To identify the barriers and opportunities that current railway operators face in using RFID technologies in Zambia.
- ii) To find out policy issues impeding the need for having RFID technology that would coordinate the implementation of integrated systems.
- iii) To identify solutions that would eliminate barriers that prevent the introduction of RFID technology in the Zambian rail industry;
- iv) To seek opportunities offered by other technologies that would allow and support seamless introduction of RFID technology in the Zambian rail industry.

5 Study Questions

- i) What are the barriers and opportunities that rail operators face in using RFID technology in Zambia?
- ii) What policy issues impeding the need for having a coordinated action on RFID technology in order to improve on the growth of an integrated Zambian rail transport systems?
- iii) What solutions available to alleviate the challenges of RFID technologies in order to harmonize implementation of the technology?
- iv) What other technologies offered as key support to the opportunity of seamless utilization of RFID technology?

6 Significance of the RFID Study

The study suggests influencing the pursuance of strategies on the Zambian rail operators, which includes the Zambia Railways and TAZARA respectively to become competitive with other transporter such those using road by the implementation of the RFID technology; it may trigger accountability, transparency, safety, quality of service and integrity in support of regional rail transport system standards; it may also suggest possible solutions to eliminate obstacles that prevent efficient

systems performance; and may suggest the possibility of implementing the RFID technology in the rail transport from a national perspective to that of regional rollout.

7. Conclusion

RFID technology has become the most flexible technology that is able to operate in diverse environment conditions to improve rail transit times and that is why its application in most rail projects it has been well received as a critical component that is capable of exhibiting professionalism in terms of rail service quality delivery.

The technology provides the opportunity or platform to integrate with existing systems that bring about efficiency in operations and management.

Many rail operators consider the deployment of RFID technology as a huge cost without checking what is on the market, finances may necessarily not be the main reason of failed implementation, but to build a standard for the nation and as well as the region so as to promote its deployment.

Upon achieving this, other concerns such as financial processes; on-line transactions; and workforce management integration requirements may term to influence a complicated RFID solution and thus the desire to have a more robust rail information system for the industry as a preferred enterprise system to accommodate automated business operations and coordination, for instance B2B, G2B demands which are a new catch words in today's online trading. As for Africa Rail, it begins with RFID and the limits are endless towards achieving Internet of Things generation (IoT)!

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