

# A Tracking System to Enhance Transportation of Examination Materials based on Spatial and Cloud Technologies

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**Abstract** - This article is an extract of the ongoing study which seeks to develop a framework for secure transportation, tracking and storage of examination question papers, answer scripts using spatial data, sensing, and cloud technologies. This part of the study investigated the transportation of examination materials in relation to examination malpractices and leakages. Based on the findings, the study explored the use of GPS, GPRS/GSM and cloud technologies to enhance the distribution process of examination question papers and answer scripts. We proposed a GPS tracking system which would ensure real-time tracking and monitoring of the examination distribution process. The primary benefit of this system is that the transportation vehicles will always be tracked and remain monitored such that if there is any holdup, immediate action can be taken. Also since GPS allows constant updates in real-time, any sort of uneven event happening, the main station will be informed immediately. This helps timely action to be taken and also eliminates human interventions or rather depending on humans to report any uneven event. The baseline study indicated that the challenges faced in the distribution process were mainly lack of reliable transportation vehicles which accounted for 67% of those who did not have any designated vehicles. A remote monitoring system was proposed as a way of improving the distribution process.

**Keywords:** *Tracking, Examination Malpractices, Leakages.*

## I. INTRODUCTION

The increasing demand in the qualification awarded by the Examinations Council of Zambia (ECZ) calls for an efficient and effective management of the examination process. In the amended Zambian Constitution of 2016, a requirement was added where all those vying for political positions should have a minimum of a Grade 12 or School Certificate [1]. This has raised the demand for the Grade 12 Certificate and hence the need to ensure that the examination process is well managed which includes the distribution process of examination papers. Technologies have been developed where remote vehicle tracking is possible using Global Positioning System (GPS) tracker to help know in real-

time or near real-time the location of trucks delivering examination papers. This would help in detecting and reacting quickly to any uneven situations and probably resolve the problems as they occur or at least minimize the damage [2].

## II. BACKGROUND OF THE STUDY

Security is key to all types of organisations be it a profit making, non-profit making or governmental as having a secure environment would increase efficiency and reduce on losses and liabilities. Ensuring that examination papers are securely transported from the source to the various examination centres needs to be addressed. In Zambia, the school examinations question papers and answer scripts are delivered to various district education offices as stipulated in [3]. The main concern is the security of these examination materials during transportation to various destinations throughout the country i.e. in schools or districts as there is no way of remotely tracking and monitoring the distribution process.

The ECZ, established by Act No. 15 of Parliament in 1983 Chapter 137 [4] [5] is responsible for conducting examinations and awarding certificates and diplomas to deserving candidates. The whole examination process includes preparing and distributing the question papers and answer scripts to the district education offices who in turn distribute to schools in their respective districts [3] using their own transport arrangements. The National Policy on Education, Educating Our Future, emphasizes on improving educational quality, access to good quality education, fair assessments of all learners, and upholding the education standards [6]. It is important that all learners should have a fair national examination at the end of their schooling thus making it more important to safeguard the examination materials so that no one has prior access before the examination. In addition, with the education system having been liberalized and decentralized in accordance with the democratic principles of local government, the focal point of educational

administration and management for schools are districts education boards and centres [6]. With the increase in the number of candidates, examination centres, districts and also examination sessions offered, this makes it difficult to physically monitor all examination centres and the manner in which they keep and transport the examination materials. Therefore, in order to improve on delivery of services in government, the National Policy on Information and Communication Technology commits to assist in the decentralisation process' implementation by extensively integrating and utilising ICTs at all levels [7]. This research is riding on this policy statement to implement an automated tracking and monitoring system for managing examination question papers and answer scripts during transportation.

**A. Distribution Process**

The distribution of examination materials to district education offices is done by the examining body under the auspices of the Ministry of General Education. According to [1] which states that “The Examinations Council of Zambia shall deliver question papers directly to the District Education Board Secretary’s (DEBS) Office under police escort”. This process of distribution also ties well with what Malawi National Examinations Board (MANEB) did as indicated in the Malawi National Examinations Board Act (CAP 30:04) that “All national examination papers shall be delivered and kept securely at a distribution centre designated by the District Education Managers prior to delivery to examination administration centres.” [8]. This kind of system that is solely dependent on humans is bound to abuse as the same people entrusted to secure the materials can abuse their authority to gain undue advantage for themselves or others. Just as [9] said “All security products are only as secure as the people who configure and maintain them.” From this statement by [9], it means that these examination materials transported in this manner are only as secure as the people who transport and keep them. Beyond that it becomes very difficult to know what happens as there are no systems in place to remotely monitor the distribution process.

The current distribution process shown in Figure 1 is such that ECZ delivers the examination materials to the DEBS’ office. Ministry of General Education takes charge of the security of the materials once they have been delivered by the ECZ and received by the District Education Board Secretary and of their further distribution to zones and schools, and transportation of scripts to marking centres.

Advancements in technology have enabled its applications in almost all areas of life thereby reducing on manual interventions in the processes. In logistics management, use of GPS tracking and General Packet Radio Service (GPRS) has been there for sometime now. This research attempted to borrow some concepts and technologies used in logistics management to come up with a framework for managing, securing and monitoring examination materials in transit.

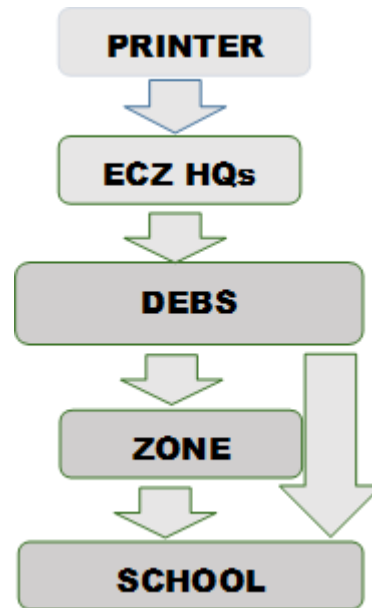


Fig. 1. Current Examinations Materials Distribution Process

Why then are we talking about securing examination materials and not any other items? As already alluded to in [1] the desire to gain the academic qualification at school certificate or Grade 12 level has tremendously increased with the Law passed in the Amended Zambian Constitution of 2016, cap 70. (1) which states that “Subject to clause (2), a person is eligible to be elected as a Member of Parliament, if that person— (d) has obtained, as a minimum academic qualification, a grade twelve certificate or its equivalent” [1]. This condition in the Law also applies to any other person seeking to be elected to political office as stated in cap. 82, 100 and 53 of [1]. This mandatory requirement has put the examination process in Zambia at a higher risk than before as more and more people are trying to gain this qualification as they seek political office. The need to safeguard this qualification and ensure its credibility and international recognition has become even more important than before. As such ensuring the security of examination materials at all stages in the examination process is very critical. This underscores the need to have a system that will help monitor the transportation of these examination materials to respective destinations throughout the country. It is therefore important to put stringent measures to secure the examination materials to prevent unauthorised access before and after writing the examination.

Reports on thefts of examination question papers and answer scripts [10] [11] [12], different forms of examination malpractices, among others are some of the challenges that have continued to occur in the examination process [13] in Zambia. Despite efforts put in place to safeguard the examination materials, these have proved unreliable as new ways of unauthorized access to examination materials have

continued to emerge. Apart from the existing traditional way of securing examination materials through using security personnel and multiple locking systems, there is no reliable system that would assist to remotely monitor, track and ensure the security of examination materials throughout the examination process. The study evaluated and identified the current security challenges in the examination management process during transportation of examination papers. Based on the evaluation results, we introduced GPS tracking, GPRS/ Global System for Mobile Communications (GSM) and cloud technologies to propose a framework for secure transportation, and tracking of examination materials in order to improve the security of examination materials during transportation.

### III. LITERATURE REVIEW

Various literature was reviewed on the proposed technologies used in this research. Such literature as the GPS technology, GPRS Technology, Google Earth, cloud technologies as well as a review of some of the reported incidences of theft and loss of examinations while in transit.

#### A. GPS Technology

The GPS tracking has become a very essential part of any logistic business because of the advantages and facilities that it offers. GPS is considerably superior to previous tracking techniques in terms of providing extremely accurate location information for mobile objects and humans. Accuracy will improve as more devices become GPS equipped, and the system's scale and worldwide reach will benefit everyone. [14]. GPS is made up of a network of 24 satellites orbiting the Earth in six separate 12-hour orbital patterns, with at least five of them visible from every place on the globe. [15]

#### B. GSM/GPRS Technology

GSM is widely used and already provides data services, however they are limited by the usage of circuit switched data channels over the air interface. The GPRS, a data extension of the GSM telephony standard, stands out as one key advancement in the GSM standard that takes advantage of packet switching techniques to give mobile users with the desired high bit rates for bursty data transmissions. [16]

#### C. Google Earth

Google Earth is a three-dimensional representation of the earth created by Google. It is a commonly used tool to explore the geography of the world and shows satellite images of the earth's surface in varying resolutions. Although it has limitations, it is a useful tool that will be used in this research together with google maps. [17] Google Earth software and Google Map will be used in our proposed solution to show locations of transportation trucks.

#### D. Cloud Technology

Cloud computing is a web-based technology that allows users to access high-quality services, such as data and software, hosted on remote servers. [18] It gives clients access to a wide range of apps without the need for a permit, purchase,

installation, or download of any of these programs. Clients can access data from anywhere; all they need is to connect to a system, usually via the Internet.

Cloud computing incorporates a complete range of services that can be hosted in a variety of ways, depending on the nature of the service and the contracting organisation's data and security requirements. There are three types of clouds: public, private or hybrid. A cloud service provider owns and maintains a public cloud, whereas a private cloud is administered exclusively for a single enterprise. It can be run by the organization or by a third party, and it can be on-site or off-site. Private clouds, like public clouds, can seamlessly allocate storage, computing power, or other resources to deliver computing resources as needed. [19]. Hybrid clouds, on the other hand, combine public and private clouds based on the sensitivity of data and applications in each process, as well as the degree of business criticality and differentiation. These clouds (private or public) are separate entities that are associated to administer services. A new form is the public "sovereign" cloud, in which a public cloud provider pledges to retain cloud data and processing within a specified territory. This makes it easier to comply with data protection laws that prohibit personal data from being transferred across national borders. As a response to the daunting new expectations for agility, transparency, and efficiency, cloud computing may soon become crucial [19], [20], [31].

Security threats that are associated with cloud computing are among the major discouraging factors for organisations migrating to cloud. According to a joint survey conducted by IEEE and the Cloud Security Alliance (CSA) in 2010, the need for cloud computing security standards is critical and urgent, and it is impeding the expansion of cloud computing. Other security risks that have been highlighted as hindering cloud computing adoption include service availability or business continuity, data confidentiality and auditability as well as data loss and privacy breaches in the cloud. [18], [22].

#### E. Related works

Real-time and tracing systems were considered by [1] in tracking and tracing shipments. A sophisticated overview of the technology based methodology or approach for solving the complete tracking and tracing systems in the logistics and supply chain network was presented. It was noted that as a result of the use of tracking and tracing, it is possible to detect and react to any uneven situations and probably resolve the problems or at least the damage can be minimised.

To improve on the distribution of examination question papers, [23] implemented a geographic information system (GIS) that was to accomplish all of the functions performed by the manual system as well as providing a functionality to aid the efficient management of the Kenya National Examinations Council (KNEC) data. The study emphasised on efficiency in being able to determine the shortest distances and the most efficient distributions routes using spatial analysis and network analysis techniques.

[24] developed a system that remotely monitors the movement and storage of examination materials. The Secure

Exam Management system employs the use of uniquely designed electronic seals and remotely located Smart keys, as well as a centralised management software application, to not only manage the opening of examination scripts at the appropriate time before commencement of the examination, but also the time window within which examinations are to be conducted. It further geographically locates the examination venue and ensures that all opening of scripts and sealing of the answer sheets, can only be effected at these geographic locations which are predefined on the system. In this system, GPS and GIS are used to monitor the movements with the aid of satellite locating (GPS– Global Positioning System) on the Smart keys.

A lot of work has been done that relate to tracking and remote sensing in different fields which this particular research will borrow from. Many researchers have come up with different ways of remote tracking which can also be applied to tracking examination question papers and answer scripts in Zambia as we have seen how important these materials are and the security of such.

#### *F. Security Breach during transportation of Examination Materials*

A number of examination bodies have suffered loss of examination question papers and answerscripts during the transportation process. Such incidents on security breaches concerning examination question papers and answer scripts have been reported and are as many as those that cared to report about them. Some of those reviewed indicate that in Brazil, [25] reported in an article entitled “Truck Full of CFA Exams Hijacked in Rio Crime Wave” that the Brazilian branch of the CFA Institute reported in a document obtained by Bloomberg that a vehicle containing CFA Institute tests was hijacked and all the cargo was stolen, and that the prospects of recovering the material were slim.

A theft was reported by [26] in Britain where Singapore Chemistry A-Level test papers were stolen in transit to British examiner. According to the Singapore exam board, more than 200 students in Singapore had part of their British-administered school leaving exam paper stolen when it was sent to be marked in Britain. Again in Britain, a parcel van that was carrying AQA examination papers to the schools was stolen compelling them to reset the A-level and GCSE exam papers at the last minute after a van distributing the papers to schools was stolen. In 2008 AQA said it reset 40 papers in 15 subjects after a Parcelforce van in Hertfordshire was stolen. After another Parcelforce van was stolen, in 2005 the same board had to replace half a million exam papers. [27].

This phenomenon is not only in the outside countries, in Zambia a report ‘Stolen exam papers shock NGO - Daily Nation’ and ‘Robbers steal G9 exam papers’, it was reported that unknown criminals stole 2016 Grade Nine( Junior Secondary School Leaving Examination) examination papers on a containerised truck destined for the North Western Province of Zambia. It was reported that the incident happened in the night when criminals broke into the containerised truck that was ferrying the examination papers to Solwezi while in

motion at Mushishima area in Chingola [28]. This is only for reported cases as there may be other unreported cases which may have been experienced both outside and inside Zambia. It is for this reason that this research embarked on using the existing technologies and apply to the examination management process. These technologies such as GPS tracking, GSM/GPRS and cloud technologies have been used in logistic management, vehicle tracking for fleet management to mention a few but have not been used in the examination management process in Zambia.

#### IV. SCOPE OF THE STUDY

The transportation section of this baseline study considered issues pertaining to the distribution of examination materials and security related aspects during transportation to various examination centres across the country. It was important to know whether schools or district offices had specific vehicles for transporting examination materials because that was going to help in determining a viable solution for secure transportation of examinations. This research utilised both qualitative and quantitative research types.

The baseline study was carried out in each of Zambia’s ten provinces in 99 districts out of the gazetted 115 when the data were collected in June, 2019. The questionnaire was administered to the respondents with the help of research assistants who visited the provinces. The researcher also visited two provinces and administered the questionnaires there. The returns were received from 296 respondents, out of which 17 were not properly filled in and were not included in the analysis. The remaining 279 that were fully completed were used for the study which made up 275 teachers, two (2) Education standards Officers and two (2) others who were Statisticians from the District Education Board Secretary’s office. Of the 279 participants, 199 were from ordinary standalone centres and 76 were Zonal Centres which are used as zone centres for storage and distribution of examination materials and four (4) DEBS’s office.

The respondents comprised 20.1 % females and 79.9 % males. The highest level of education ranged from Certificate to Master’s Degree of whom were Teachers (98%), Education Standards Officer (1%) and other profession (1%) drawn from ordinary school, Zonal school and DEBS office.

Data obtained from the questionnaire were analysed using descriptive statistics of frequency counts and percentages. The data were analysed for statistical significance to establish the relationship found in the sample using the Chi-square tests and Cramer’s V (coefficient of association) to determine the strength of association between variables. The convention used in our research for the level of significance is  $p < 0.05$  which is the maximum level of statistical significance that is acceptable and is widely used by most social researchers [29]. The results of the baseline study contributed towards the development of the proposed model that is using GPS

tracking, GSM/GPRS and cloud technologies in the examination distribution process depicted in Fig. 2

**A. Proposed Distribution model**

The proposed business process integrates technologies such as use of GPS for tracking the movements of the vehicle and determine its location and GSM/GPRS for transmitting data to the cloud. In this proposed model, delivery of examination papers should be direct from the printing company to the provincial strongroom. With the decentralization of ECZ where service centres have been opened in all the provinces, these service centres could be used as receiving and distribution points of examinations to the provinces and districts. The boxes / containers where examination papers are packaged should be tagged with RFID tags so that data can be captured about the cartons loaded onto the transportation vehicle. Data read from the RFID tags are transmitted to the server via GSM/GPRS. The distribution vehicles should be installed with GPS Tracker to enable monitoring and tracking during the whole distribution process. Putting RFID tags will ease the process of identifying the examination papers for each centre. The information about the trucks and examination papers will be sent to the cloud server via GSM/GPRS. The proposed model is shown in Figure 2. These technologies have been used in logistics management as in [30]. We propose use of a private cloud due to the sensitivity of the data. While the cloud server is prone to attacks and manipulation even if a private cloud is used, there is need to secure it using smart and efficient techniques to avoid attacks [31].

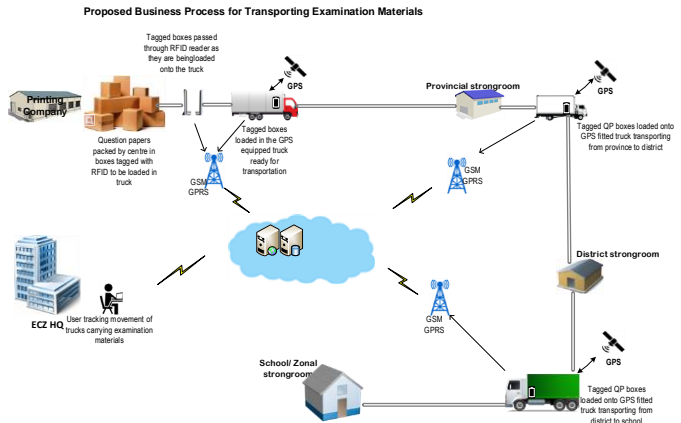


Fig. 2. Proposed model

**B. System Architecture**

The system architecture in Figure 3 shows the truck installed with GPS device to enable know its location in the distribution process. The GPS navigation system is implemented by fetching information on the location (latitude and longitude) of the transportation trucks after every specified time interval as defined by the user. The information is transmitted to the cloud server via GSM/GPRS. With Google Earth, the vehicle location will be displayed in the electronic google maps. The user at the district monitors and tracks transportation vehicles for their district, the user at the province monitors and tracks

movement of the transportation vehicles in their province while the user at ECZ-HQ tracks and monitors for the whole transportation process in the country. Any device with internet connection is expected to work with this system.

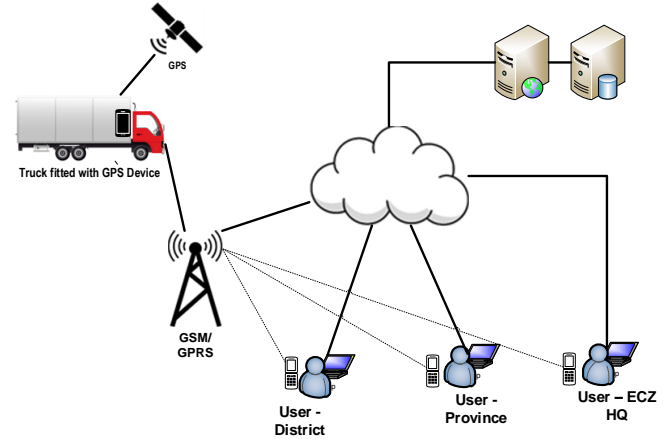


Fig. 3. System Architecture

**V. RESULTS AND DISCUSSION**

The focus of this part of the study was to understand the security systems that were existing in the distribution of examination materials, availability of designated vehicles as well as the challenges that existed in the distribution process which could lead to examination malpractices and leakages. The results of the baseline study identified poor security during delivery of examination materials (13.3%) which led to the incidence in [28] as among the challenges that could cause examination malpractices and leakages. The study results confirmed that most of the schools did not have vehicles for use to transport examination question papers and answer scripts to and from the examination centres. A bigger percentage of 67% said they did not have vehicles specifically designated for transporting examinations while 33.0 % said they had. Even those who had rely on vehicles provided by the DEBS office and those centres are not really involved in transporting examination materials.

The study also ascertained the mode in which examination papers were delivered and answer scripts collected from schools. It is clear from the study that the DEBS office is highly involved in delivering question papers to examination centres while for delivery of answer scripts to the DEBS office or at some central/ zonal strongroom schools in most cases have to do it on their own using their own transport. Participants however stated that they were satisfied with the security provided during transportation despite not having adequate transportation vehicles as 76.7 % indicated that they were satisfied while 19.0 % were not. The reasons given for not having adequate security were that they expected that the armed state security personnel should be there to provide security both when transporting question papers and also answer scripts. It appears the emphasis on security is

more on question papers and not answer scripts. Another important aspect mentioned where security could be enhanced is the use of a remote monitoring and tracking system on transportation vehicles as the vehicles were not secured. This entails that security need to be enhanced when transporting question papers as well as answer scripts.

On whether there were security threats, the study established that security challenges existed during transportation of examinations. Challenges cited among them were unreliable transport, insufficient transport from DEBS office, lack of state security personnel to escort the examinations, poor road network and late delivery, also the absence of a remote monitoring system during transportation as show in Table 1. Participants also indicated that the costs incurred were also a factor as schools are expected to provide money for fuel. In addition other government vehicles have to be used to beef up the transport situation. The inference made is that there is inadequate transportation vehicles and security in the distribution process which need to be critically addressed so that proper measures could be put in place to secure the examinations.

TABLE I. CHALLENGES DURING TRANSPORTATION OF EXAMINATIONS

	<i>Challenge</i>	<i>Frequency</i>	<i>Percent</i>
1	Ministry of General Education should engage Zambia police so that they guard all the time	35	14.8
2	Lack of reliable transport	57	24.2
3	Late delivery of examinations	5	2.1
4	Lack of Funds	11	4.7
5	Poor road network and long distances covered poses a risk	27	11.4
6	No Monitoring systems	6	2.5
7	No Challenges	95	40.3
	Total	236	100.0

#### A. Statistical Significance

The level of independence of variables like having designated transport and security during transportation between examination malpractices could not be established even after applying the Chi-square test where p-value,  $p < 0.966$  for designated transport and for adequate security when transporting examination papers the p-value,  $p < 0.081$ . For both variables the p-value is above the significance level of 0.05 that we adopted in the study.

Table II examined the relationship between adequate security when transporting examination question papers and answerscripts and examination malpractices. After applying the Chi-square test the p-value of  $p < 0.081$  was obtained. This value is slightly above the significance level of 0.05 that was adopted in the study. This suggests that the connection between having adequate security when transporting examinations and examination leakages cannot be established.

However, it is important to note that there are two types of errors that can be made when inferring statistical significance known as Type I (risk of rejecting the null hypothesis when it should be confirmed) and Type II ( risk of confirming the null hypothesis when it should be rejected) errors. The author [29] alludes that using a  $p < 0.05$  level of significance means we are more likely to make a type I error than when using a  $p < 0.01$  level of significance because with 0.01 there is less chance of falsely rejecting the null hypothesis thereby increasing the chance of making Type II error. Our proposition in this study is that Type I error was committed and hence our proposal to secure the transportation process.

## VI. CONCLUSION

The study concluded that there were insufficient transportation vehicles to be used by schools to transport examination materials. Furthermore, the security provided during the process was inadequate as it mainly focused on one aspect which is physical security. The aspect of having a remote monitoring system during transportation was missing. The results of the study were used to propose a more secure transportation model for examination materials in Zambia which integrates technologies that have been used in other fields such as GPS tracking, GSM/GPRS and cloud technologies. It is hoped that with enhanced monitoring and tracking of the movement of the examination materials, a more secure environment will be attained and information will be available in near-realtime for quick action should anything occur on the way like what happened in [28]. This in turn should reduce examination leakages that are related to insecure transportation of examinations.

## VII. RECOMMENDATION

The study recommends that the proposed tracking system be adopted and developed into a fully-fledged system so as to enhance the security of examinations while in transit. More transportation vehicles dedicated for examination materials should be acquired to make it easier to monitor. A private cloud is recommended for the implementation of this system. Examination bodies should not fear to put their systems on the cloud but instead put measures in place to ensure safety and availability of the systems. The backup servers can be locally hosted so that if the cloud service is unavailable, the systems would continue running and data would be synchronised once the cloud service is available. Further works should be undertaken to take into account the enhancement of security in storage rooms as well.

TABLE II. SECURITY DURING TRANSPORTATION VS EXAMINATION MALPRACTICE

Have you had any examination malpractices in your area?		Yes	No	Not Sure	Total	
Do you think that there is adequate security provided to secure examination materials during transportation to and from your school?	Count	98	80	33	211	
	Expected Count	101.3	78.3	31.5	211.0	
	% within adequate security in transit	46.4%	37.9%	15.6%	100.0%	
	% within examination malpractices	74.2%	78.4%	80.5%	76.7%	
	Standardized Residual	-.3	.2	.3		
	Count	28	21	4	53	
	Expected Count	25.4	19.7	7.9	53.0	
	% within adequate security in transit	52.8%	39.6%	7.5%	100.0%	
	% within examination malpractices	21.2%	20.6%	9.8%	19.3%	
	Standardized Residual	.5	.3	-1.4		
	Count	6	1	4	11	
	Expected Count	5.3	4.1	1.6	11.0	
	% within adequate security in transit	54.5%	9.1%	36.4%	100.0%	
	% within examination malpractices	4.5%	1.0%	9.8%	4.0%	
	Standardized Residual	.3	-1.5	1.8		
	Total	Count	132	102	41	275
	Expected Count	132.0	102.0	41.0	275.0	
	% within adequate security in transit	48.0%	37.1%	14.9%	100.0%	
	% within examination malpractices	100.0%	100.0%	100.0%	100.0%	

\*\*\*Pearson Chi-Square (X<sup>2</sup>) test statistics 8.316 (p-value = 0.081)

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REFERENCES

[1] Government of Zambia, Constitution of Zambia (Amendment) No.2 of 2016, Lusaka: Government of Zambia, 2016.  
 [2] A. Shamsuzzoha and P. T. Helo, "Real-time Tracking and Tracing System: Potentials for the Logistics," in 2011 International Conference

on Industrial Engineering and Operations Management, Kuala Lumpur, 2011.  
 [3] Examinations Council of Zambia, Guidelines for the Administration and Management of Examinations in Zambia, Lusaka: Examinations Council of Zambia, 2018.  
 [4] M. J. Kelly, Education in a Declining Economy, Washington DC: World Bank, 1991.  
 [5] Government of the Republic of Zambia, The Laws of Zambia - Examinations Council of Zambia Act, Lusaka: Government of the Republic of Zambia, 1983.  
 [6] Ministry of Education, Educating our Future, National Policy on Education, Lusaka: Zambia Educational Publishing House, 1996.  
 [7] Ministry of Communications and Transport, National Information & Communication Technology Policy, Lusaka: Ministry of Communications and Transport, 2006.  
 [8] Malawi Government, Malawi National Examinations Board Act (Cap30:04), Conduct of Examinations Regulations, Lilongwe: Malawi Government, 2008.  
 [9] J. R. Vacca, Computer and Information Security Handbook, New York: Morgan Kaufmann Publishers, 2009.  
 [10]Zambian Watchdog, "Grade seven exam papers stolen in Kawambwa," Zambian Watchdog, 27 October 2009. [Online]. Available: <https://www.zambianwatchdog.com/grade-seven-exam-papers-stolen-in-kawambwa/>. [Accessed 22 September 2018].  
 [11]Zambian Watchdog, "Police pick up 22 pupils, a teacher and guards for stealing exam papers," 5 November 2012. [Online]. Available: <https://www.zambianwatchdog.com/police-pick-up-22-pupils-a-teacher-and-guards-for-stealing-g7-exam-papers/>. [Accessed 08 August 2018].  
 [12]D. Mwendabai, "4 Pupils, guard arrested," Zambia Daily Mail, vol. 22, no. 286, p. 1, 29 November 2018.  
 [13]Examinations Council of Zambia, "2016 Examinations Performance Review Report – General Performance Analysis," Examinations Council of Zambia, Lusaka, 2017.  
 [14]N. Chadil, A. Russameesawang and P. Keeratiwintakorn, "Real-Time Tracking Management System Using GPS, GPRS and Google Earth," in IEEE Xplore, 2008.  
 [15]"GPS Tracking and Logistics Business," GPS Tracking Journal, February 2018. [Online]. Available: <https://www.gpstrackingjournal.com/news/gps-tracking-and-logistics-business/>. [Accessed 17 October 2019]  
 [16]B. Ghribi and L. Logrippo, "Understanding GPRS: The GSM Packet Radio Service," Computer Networks, vol. 34, pp. 763-779, 2000.  
 [17]Google Earth, "Using Google Earth for infrastructure planning," [Online]. Available: [https://www.eawag.ch/fileadmin/Domain1/Abteilungen/sandec/publikationen/SESP/Urban\\_Sanitation\\_general/Using\\_Google\\_Earth\\_for\\_Infra\\_Planning.pdf](https://www.eawag.ch/fileadmin/Domain1/Abteilungen/sandec/publikationen/SESP/Urban_Sanitation_general/Using_Google_Earth_for_Infra_Planning.pdf). [Accessed 22 October 2019].  
 [18]M. Mujinga, "Developing Economies and Cloud Security: A Study of Africa," Journal of Emerging Trends in Computing and Information Sciences, vol. 3, no. 8, pp. 1166-1172, August 2012.  
 [19]S. Ghule, R. Chikhale and K. Parmar, "Cloud Computing in Banking Services," International Journal of Scientific and Research Publications, vol. 4, no. 6, pp. 1-4, June 2014.  
 [20]S. Patani, S. Kadam and P. V. Jain, "Cloud Computing in the Banking sector : A survey," International Journal of Advanced Research in Computer and Communication Engineering, vol. 3, no. 1, pp. 5640-5643, February 2014.  
 [21]A. Rastogi, "A Model based Approach to Implement Cloud Computing in E-Governance," International Journal of Computer Applications, vol. 9, no. 7, pp. 15-18, November 2010.  
 [22]M. Armbrust, A. Fox, R. Griffith, A. D. Joseph, R. Katz and A. Konwinski, "A view of cloud computing," Communications of the ACM, vol. 53, no. 4, p. 50-58, 2010.  
 [23]D. N. Kuria, M. M. Ngigi, W. J. Wanjiru and R. K. Kasumuni, "Managing distribution of national examinations using geospatial technologies: A case study of Pumwani and Central divisions," International Journal of Computer Engineering Research, vol. 2, no. 5, pp. 82-92, 2011.  
 [24]"Smartlock Exam Management," June 2018. [Online]. Available: <https://www.specfile.co.za/wp-content/uploads/2018/06/smartlock-Exam-Management-2018.pdf>. [Accessed 28 August 2018].

- [25]K. Leal and J. Leite, "Truck Full of CFA Exams Hijacked in Rio Crime Wave," 07 December 2017. [Online]. Available: <https://www.bloomberg.com/news/articles/2017-12-07/rio-crime-wave-hits-unexpected-target-a-truck-full-of-cfa-exams>. [Accessed 17 July 2018].
- [26]Conventry News, "Singapore Chemistry A-Level test papers stolen in transit to British Examiner," 23 February 2018. [Online]. Available: <https://www.coventrytelegraph.net/news/coventry-news/exam-papers-stolen-warwick-university-3082226>. [Accessed 17 July 2018].
- [27]R. Adams, "Exams rewritten after van containing papers stolen," 11 June 2015. [Online]. Available: <https://www.theguardian.com/education/2015/jun/11/exams-rewritten-after-van-containing-papers-stolen>. [Accessed 19 July 2018].
- [28]Zambia Daily Nation, "Stolen Exam Papers Shock NGO," 25 September 2016. [Online]. Available: [https://web.facebook.com/dailynationnews/posts/stolen-exam-papers-shock-ngo/894002080729778/?\\_rdc=1&\\_rdr](https://web.facebook.com/dailynationnews/posts/stolen-exam-papers-shock-ngo/894002080729778/?_rdc=1&_rdr). [Accessed 17 July 2018].
- [29]A. Bryman, *Social Research Methods*, 5th ed., New York: Oxford University Press, 2016.
- [30]C. L. Muyunda and J. Phiri, "A Wireless Sensor Network Based Grain Inventory Management System for Zambia's Food Reserve Agency," *International Journal of Innovative Research in Science, Engineering and Technology*, vol. 5, no. 3, pp. 3519-3526, 2016.
- [31]Y. Agarwal, K. Jain and O. Karabasoglu, "Smart vehicle monitoring and assistance using cloud computing," *International Journal of Transportation Science and Technology*, vol. 7, pp. 60-73, 2018.