Challenges Associated With the Use of Radio Frequency Identification Tags and Vehicular Access Control Systems: A Case Study of Two Ghana Universities

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Abstract:- The Kwame Nkrumah University of Science and Technology (KNUST) and the University of Ghana (UG) have embraced the use of electronic tags to grant users access to their campuses via electronic vehicle access-control gates. This introduction has not only granted or denied users entry into the university community, but has helped increase security, monitored movement of vehicles, kept records, reduced the rate of vehicle theft and unnecessary traffic jams. That notwithstanding, there are some challenges. This study focused on analysing the existing vehicular access-control systems in both universities and the challenges faced with the use of the systems. The qualitative research method and the descriptive research design were employed in the study. In all, one hundred and forty (140) users of the access-control systems: seventy (70) from each university, were selected for interview using the convenience, snowball, and purposive sampling techniques. The findings of the study showed that out of the 140 respondents, fifty-four (54) respondents representing 39% indicated they have encountered one or more of these challenges: system authentication failure, delay in system operation, interrupted power supply, tag abuse and/or theft. These are coupled with challenges of the safety of the equipment adapted. In this regard, this paper resulted in a clear picture of the technology adopted by the two institutions, their pros and cons, as well as user friendliness and sustainability. This is followed by constructive recommendations regarding sustainable components for the vehicular access-control systems such as improvement in the bio data reading technology, more active chips, energy efficiency, and more effective but durable systems. This is expected to improve the institutional/employee security of such institutions as wells provide information on the RFID technology, its use and challenges to other institutions who are yet to embrace the system.

Keywords:- *Vehicular access-control system, Identification tags, radiofrequency sensor, Security.*

I. INTRODUCTION

Radio Frequency Identification (RFID) was first used during World War II to identify friendly aircrafts (Schindler *et al.*, 2013). According to Lou *et al.* (2011), RFID is a wireless data collection technology used to identify physical objects in a variety of fields. It is a term used to describe any information that can be sensed at a distance by radio frequency with few or no problem of obstruction or disorientation (Kumar *et al.,* 2009). The technology has evolved over the years and it is now been used in electronic gates or barriers to restrict movement of unauthorized vehicles within institutions (Rouse, 2010: Domdouzis *et al.*, 2007).

It started especially with the development and commercialization of the automated toll payment systems, and later with other uses of radio frequency identification such as tracking vehicles, containers and livestock (Ahuja & Potti, 2010). According to Krishnamoorthy *et al.,* (2016) the advent changes of technologies have raised different access control scenarios. Latest technologies have brought costs down and standards are being developed (Ahuja & Potti, 2010). Today, the use of the RFID technology for vehicular access control in institutions have become broad, including monitoring and tracking, preventing counterfeiting use of vehicle identification electronic tags, reducing vehicle theft, among others (Masum *et al.,* 2013).

Ghana has also embraced this technological advancement especially in some notable tertiary institutions to improve security, monitor the movement of vehicles, keep records, reduce the rate of vehicle theft and reduce unnecessary traffic jam in the academic community.

Currently, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana and the University of Ghana have adopted the use of radio frequency identification technology for vehicular access in their various campuses. Although this introduction has helped achieved its purposes, there are still challenges associated with the use. This study therefore was focused on determining the challenges associated with the use of the access-control systems in both institutions, and how can the

existing RFID technology for vehicular access in both universities be improved.

II. METHODS

A Questionnaire was developed and administered to the users of the electronic access-control systems for vehicles of both universities. This questionnaire was intentioned to solicit the challenges faced by the users. In this regard, The convenience, snowball, purposive sampling techniques were considered for the study. The target populations for the study comprised of all users of the vehicle access-control system in both universities but 140 were successfully accessed. The above stated sampling techniques were all employed to select and interview the users from both institutions who have used the system for at least six months. This was to ensure that they have used the system long enough the experience challenges. Interviews and observations were the instruments used to collect data for the study. In order to understand the challenges of the users, there was a proactive study to assess the existing vehicle access-control systems in both universities. in this regard, the Users' demographic data, the nature of the vehicular access control systems in institutions, their components, mode of works, advantages and disadvantages.

III. RESULTS AND DISCUSSION

The nature of the Kwame Nkrumah University of Science and Technology vehicular access control system is not different from that of the University of Ghana when it comes to who the system operates. But there is slit difference in components which can be seen in table 1.

Through the study, it was found out that the introduction of the vehicle access control systems in both institutions has really helped to tighten security, monitor the movement of vehicles, keep records, reduce the rate of vehicle thefts and reduce unnecessary traffic jam in and around the academic community.

However, there exist some challenges associated to the use of this access control system by users. They include; system authentication failure, delay in system operation, interrupted power source and tag (sticker/card) theft.

➤ *Nature of the vehicular access-control systems*
The University of Ghana vehicular access-control system as seen in figure 1 consists of an electronic card (E-card) with sticky materials which is fixed at either the right or left corner of a vehicle's windscreen. The next is a card reader (sensor) which is positioned mostly at the right side of the linear actuator (barrier) at the checkpoint as seen in figures 2 and 4. Also is a LED screen to display the vehicle's registration number and the expiry date of the E-card, and a mini traffic indicator positioned on the left side of the barrier. The traffic indicator gives the final signal when it recognizes a valid electronic card.. When an approaching vehicle has a valid E-card, the light shows green and allows entry, but shows red when the vehicle has either an expired E-Card or does not have the card at all, denying entry into the campus in both circumstances. This can be seen in figure 2

When a vehicle with an electronic card approaches the barrier, the E-Card (which has the credentials of the user) is brought close approximately 5–10 meters to the card reader. The reader upon recognition authenticates the validity of the electronic card and sends a signal to a control panel which regulates the movement of the linear actuator to either grant or deny access. The traffic indicator then gives the final signal by showing green or red, granting or denying access respectively. Every successful access displays the vehicle's registration number and the expiry date of the scannable E-card on the LED screen positioned about 15 meters away from the barrier. The nature of the vehicular access control system at KNUST is not very different from that of the University of Ghana. Table 1 shows the similarities and differences identified.

UG Access system	KNUST Access system
Linear actuator **present**	Linear actuator **present**
RFID reader/ sensor **present**	RFID reader/ sensor **present**
Chip embedded in a card (E-card)	Chip embedded in sticker (E-sticker)
Led screen **present**	Led screen **absent**
Traffic indicator **present**	Traffic indicator **absent**
Infrared/Photo sensor **present**	Infrared/Photo sensor **present**
E-Card is read to grant access	Electronic sticker is read to grant access

Table 1:- UG and KNUST vehicular access control systems

Fig 1:- UG vehicular E-card   Fig 2:- UG electronic vehicular access-control system

Fig 3:- KNUST vehicular E-sticker

Fig 4:- KNUST electronic vehicular access control system

➢ *Assessment of the use of the Radio Frequency Identification Tags and the Vehicular Access Control Systems*

It became necessary after studying the nature of the existing UG and the KNUST vehicular access control systems to find out from the respondents how good the system is. The results showed that the introduction of the system helped improve security, monitor the movement of vehicles, keep records, reduce the rate of vehicle thefts and unnecessary traffic jam in and around the academic community. The responses were categorized into three key groups; security and record keeping, access regulation and meeting international standards. The 140 respondents: 70 from each institution were made to choose one o the intentions of the vehicular access-control system. Table 2: Shows response obtained from workers of institutions.

Categorized Response	LEGON		KNUST	
	No. of Responses	Percentage (%)	No. of Responses	Percentage (%)
Improvement in Security & Record Keeping	42	60%	42	60%
Improved in Access Regulation	27	39%	28	40%
Conformity to International standard	1	1%	0	0%
Total	**70**	**100%**	**70**	**100%**

Table 2:- Response obtained from University of Ghana respondents

From Table 2, out of the total accessed sample (140), eighty-four (84) users from both institutions representing 60% of the respondents indicated that introduction of the electronic vehicle access-control system has helped improve the security and record keeping on campus. They believe the introduction has helped protect members and properties of the university as security and record keeping of vehicles on campus has improved. They are of the opinion that the security system is better as compared to a couple of years back when there was no such system to control movement. Twenty-seven (27) representing 39% and twenty-eight (28) representing 40% of users from UG and KNUST respectively also indicated that, the introduction has helped improve vehicle access regulation on their campuses and they commend the university board for such great introduction. They indicated there were times both private and commercial drivers used the campus route,

as a shortcut to their various destinations which resulted in traffic jams from the campus to the main road. One (1) of the users representing 1% from UG also indicated that the introduction has helped put the institution at a good level to match or meet international standards as this technological system already exist in most developed foreign universities.

➢ *Challenges associated with the use of the vehicular access-control system*

Out of the total 140 sample size, 86 respondents representing 61%, 42 and 44 from UG and KNUST respectively stated they had not faced any challenge using the system while the remaining 54 which represents 39%: 28 and 26 from UG and KNUST respectively acknowledged that they had encountered one or more challenges using the access system. This is summarised in figure 5.
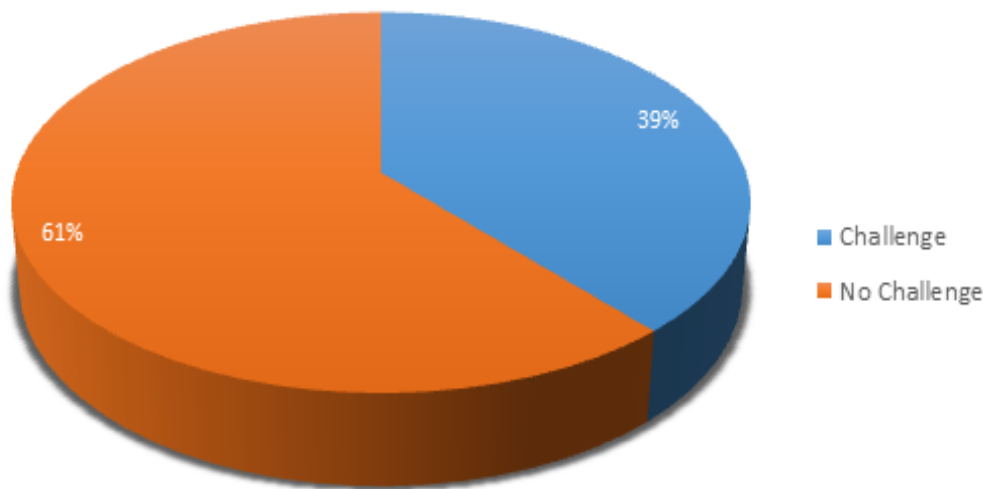

Fig 5:- The percentage response regarding the problems associated with using the vehicular access control system

From the 54 respondents who indicated they had encountered one or more challenges using the access control system, twenty-eight (28) were from UG and twenty-six (26) from KNUST.

Responses given were categorized into four; system authentication failure, delay in system operation, interrupted power supply and tag (sticker/card) theft as shown in figure 6.
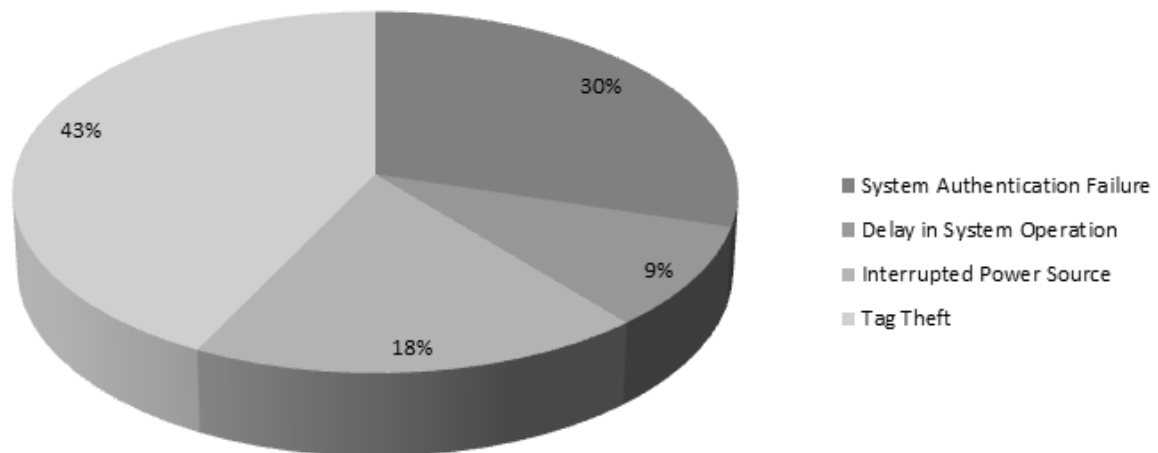
Fig 6:- Problems associated with the use of the KNUST and the University of Ghana vehicular access control system

Out of the 54 respondents, sixteen (16) of them, seven (7) and nine (9) from UG and KNUST respectively representing 30% indicated system authentication failure as a challenge they have encountered using the system. they indicated that, sometimes the access cards could not be recognized by the reader to authenticate its validity and they had to fall on the security at post to use their cards to grant them access. They attributed this to poor or weak ability of the sensor to pick signal from the electronic card. Five (5) out of the remaining 38 respondents, two (2) and three (3) from UG and KNUST respectively representing 9% of the respondents stated that the access-control system delays in its operation. They indicated that they have been victims of being delayed at the barrier after a successful authentication but the linear actuator (barrier) delayed before pulling up to grant them entry or exit. They further indicated that this problem might be due to the programming of the timing of the device to respond to the command.

Ten (10) out of the remaining 33 respondents, five (5) from both institutions representing 18% also stated interrupted power supply as a challenge they had encountered while using the system. They said in an event of power outage, the system temporarily does not function and this forces the security men at post to open the barrier and allow for access even to unauthorized vehicles.

The remaining twenty-three (23) respondents, fourteen (14) and nine (9) from UG and KNUST respectively representing 43% indicated tag theft and abuse as their challenge. The electronic sticker or card is the only means by which one can get access to campus by road through the main gates, so the need to have it is very high. Some card users complained of card theft during the interview. They explained that since the electronic card grants access into the university community, people especially private commercial drivers are eager to own one although they may not be eligible. They further stated that private commercial drivers and students are the likely persons responsible for the card theft.

Fourteen (14) out of the 23 respondents who indicated tag theft and abuse as their challenge are from the University of Ghana and they further indicated that because their electronic tags are portable, some of their staff and students abused the use of the access-control system by giving their E-cards to relatives or friends to use. On the part of security, this sometimes creates problems since the registered vehicle number may not match the approached vehicle number at the barrier, although the card may have already granted access. In such situations, the security may deny entry or exit when detected early.

➢ *Recommendations from respondents on challenges encountered using the access-control systems.*

• *System authentication failure*
Sixteen (16) of the respondents, representing 30% who had encountered system authentication failure as a challenge recommended to the Physical Development and Municipal Services Directorates (PDMS) of UG and the University Information Technology Service (UITS) of KNUST to regularly service the systems to effectively pick signals from an approaching vehicle with a sticker or card for efficient authentication, thereby granting easy access.

They further suggested that the department in charge and the developers can opt for very sensitive sensors that can easily pick signals from any approaching electronic sticker at least 5 meters away from the sensor, more specially, the case of KNUST.

• *Delay in system operation*
Five (5), representing 9% of the respondents who had encountered the above stated challenge recommended to the department in charge of the system to re-programme the software that controls the access system to respond quickly to command after a successful authentication of an approached credential. This they believe will reduce the unnecessary traffic jam normally formed behind the barrier.

- *Interrupted power supply*

Ten(10) of the respondents, representing 18% recommended that an alternative power source like solar energy be added to the existing energy source to keep the electronic system running even when there is general power outage or an electrical fault in the university community. They believe this will help improve the effectiveness to restrict unauthorized vehicles who take advantage of the temporal faults to undermine the purpose of the control system to ply the roads of the institutions.

- *Tag theft and abuse*

The remaining twenty-three (23), representing 43% of the respondents also cited that they were troubled with card or tag theft and abuse. They recommended that the system be upgraded by further adding a fingerprint device to the already existing components. This they believed would be a second step to finally grant access after a successful authentication of an approached credential by the sensor since theft issues can never be resolved but minimized. This meant that stealing a card or sticker alone would not allow full access to the university community. Again, there will not be a problem of mismatch of user's credentials on the LED display screen, releasing the security men at post of extra burden. All these measures will drastically reduce theft of E-cards and stickers, hence, strengthening security on the campuses.

IV. CONCLUSION

RFID use in institutions is spreading worldwide, and Ghana has embraced it in notable academic institutions like KNUST and UG to improve security, deny entry to restricted areas within campus, monitor the movement of vehicles, keep records, reduce the rate of vehicle thefts and reduce unnecessary traffic jam in and around the academic community.

The introduction of this RFID technology for vehicular access in both KNUST and UG has helped achieved their purposes; nonetheless there still exist some challenges associated with its use per the findings of this study. The study reveals that out of the total 140 accessed sample size, eighty-six (86) representing 61% are very satisfied and have never encountered any challenge using the access system while the remaining fifty-four (54) respondents in all from the two institutions representing 39% indicated they have encountered one or more of these challenges; system authentication failure, delay in system operation, interrupted power supply, tag abuse and/or theft. It could be concluded that the RFID technology for vehicular access in both KNUST and UG caused more good than harm.

RECOMMENDATIONS

It is also recommended that quality components be used for the access-control system construction and regular servicing be done to always keep it in good shape for effective functioning. It is further recommended that a fingerprint device be added to the already existing

components at the universities to put an end to tag abuse or to avoid theft of vehicles. For proper monitoring and good record keeping, it is recommended to the UITS of KNUST to include LED display screen to project some basis details of every accessed user for further probing in case there are doubts. Furthermore, there should be an alternative power source like solar energy to supplement the existing power supply for frequent functioning of the access control system even in case of power outage or an electrical fault.

The system is therefore recommendaed for other corporate institutions and gated communities that have not yet introduced an electronic vehicular access-control system to embrace it to help improve security, monitor vehicle movement, and reduce theft, among others.

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