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Effects of Electronic Immunization Registry On Vaccines Availability In Tanzania: The Case Of Tanga City Council

Thesis submitted to the University of Rwanda, in partial fulfilment of the

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By

TESSUA, Emmanuel Yohana (B. Pharm., MPharm)

Reg Nr: 218014676

School of Public Health, College of Medical and Health Sciences, University of Rwanda, Kigali-Rwanda.

Supervisor: Dr. Omary Swalehe

Academic Year: 2018-2019

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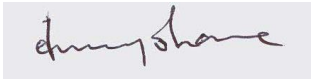
Signature: 

Date: 27 September, 2019

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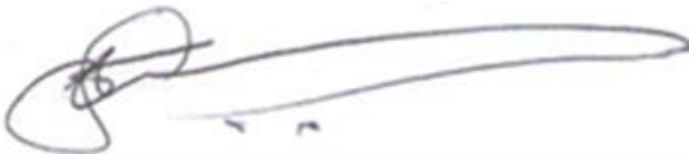
Signature: 

Date: 27 September, 2019

Dedications

I dedicate this dissertation to my parents and aunts who taught me to always aim high. Thanks all.

Acknowledgement

This dissertation could have not been possible had it not for the academic assistance of Dr. Omary Swalehe of Mzumbe University, my supervisor for the information and guidance he gave me throughout this dissertation at University of Rwanda. Thank you Prof.

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ABSTRACT

Background

The electronic immunization registry in Tanzania was established in some part of Tanzania especially the northern zone since 2015. Despite the advantages of the electronic registry which has been explained in other areas of health and other parts of the world there has been no research which has been done to assess the impact of the electronic immunization registry on the availability of immunization commodities especially vaccines.

Main Objective

The main objective of this research was to assess the effects of using Tanzania Immunization Registry in improving vaccines availability in Tanga City Council health facilities.

Methodology

The research assessed the utilization and challenges of using Tanzania Immunization Registry (TImR) in improving vaccines availability in the selected facilities in Tanga City Council including checking the availability of vaccines at the facility after the introduction of the new electronic system and comparing electronic data of the inventory with mandatory manual one using questionnaire. Data was cleaned and analyzed using SPSS version 20 for windows.

Results

A total of 27 health facilities were assessed in which the use of electronic TImR at the health facilities were 100%. There was correlation between the vaccines available at the health facilities and NBS given target population. Also there was correlation between the doses available and electronic child registration. The mean number of children registered by TImR at the health facilities were 1.3-3 times higher than the National Bureau of Statistics (NBS) given target population.

The electronic system for vaccines and immunization data management has some challenges such as internet connectivity and regular troubleshooting and maintenance which are not commonly done at the facility. It is advised to ensure there is integration of the TImR system used at the health facilities with the Vaccines Management Information System (VIMS) system used at higher levels be it council, regional and national level should be done immediately so that there will not be duplication of efforts in vaccines and immunization data management. Despite the new electronic system introduced more than two years the all

facilities were still using manual tools in immunization data management such as immunization tally sheet, vaccines store ledger and health facility monthly report form. The manual tool which was not used anymore because of the electronic system introduction was Health Management Information System (HMIS) Book 7 which is a child registers.

Conclusion

Electronic immunization registration used in Tanzania registered many children than the target given by National Bureau of Statistics and this show that the new electronic system in the facilities can ensure vaccines are ordered as per the needs. Also the manual and electronic ledger had different information on vaccines stock status. This may be due to the challenges related to the system use or preference of using one system over the other.

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Abbreviations and Acronyms

BCG	Bacillus of Calmette and Guerrin
bOPV	bi-Oral Polio Vaccine
DPT-HepB-Hib	Diphtheria –Pertusis -Tetanus Hepatitis B-Hemopphilus Influenza type b (Pentavalent) Vaccine
EAC	East Africa Community
EIR	Electronic Immunization Registry
eLMIS	Electronic Logistics Management Information System
H_o	Null hypothesis
H_1	Alternative Hypothesis
GAVI	Global Alliance for Vaccines and Immunization
HPV	Human Papilloma Virus Vaccine
IPV	Inactivated Polio Vaccine
MR	Measles-Rubella vaccine
NBS	National Bureau of Statistics
PATH	Program for Appropriate Technology in Health
SPSS	Statistical Package for the Social Sciences
TImR	Tanzania Immunization Registry
VIMS	Vaccines Management Information System

CHAPTER ONE: INTRODUCTION

Chapter one explains the background information on the new electronic system in Tanzania with information on the regions which has so far introduced the TImR system. The flow of data from the health facilities to the national level both in paper and electronic system is highlighted.

1.1 Background of the study

Tanzania introduced electronic immunization registry to capture the real time immunization data at health facility level in phased approach since 2015. The purpose of the registry was to improve immunization data quality and utilization (1). The initiative started in the northern region of Arusha and then roll-out to the other regions such as Kilimanjaro, Tanga and Dodoma. For the 2019, the focus of the Ministry is to introduce the new electronic system in Dar es Salaam, Lindi, Shinyanga, Mwanza, Morogoro and Iringa at health facilities.

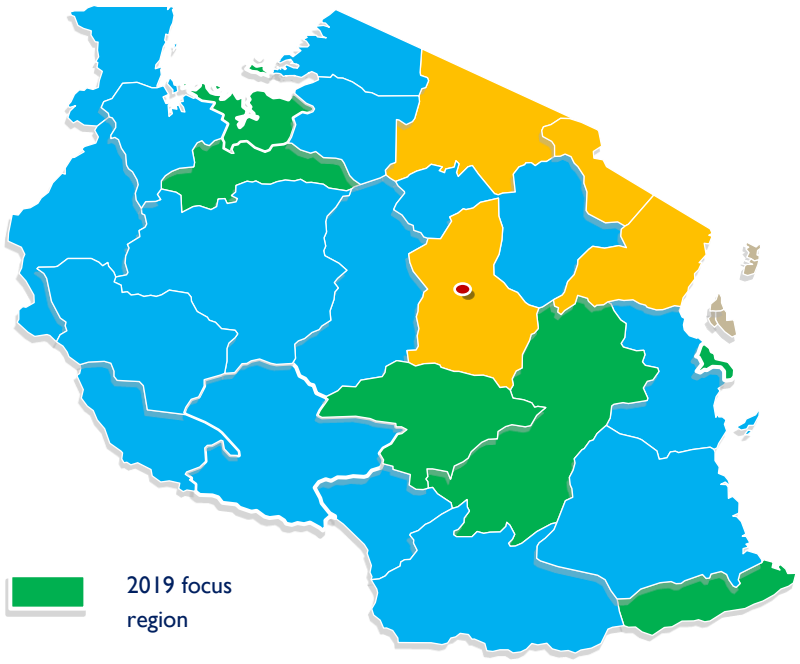


Figure 1: Map of Tanzania showing the regions with or to be installed with EIR system

Before the introduction of the EIR in immunization in Tanzania, the routine health and supply chain data were done manually using paper forms especially at the health facilities and then compilation done at the council/district level using excel sheet called District Vaccines Data Management Tool. The flow of data was shown by Figure 3 below.

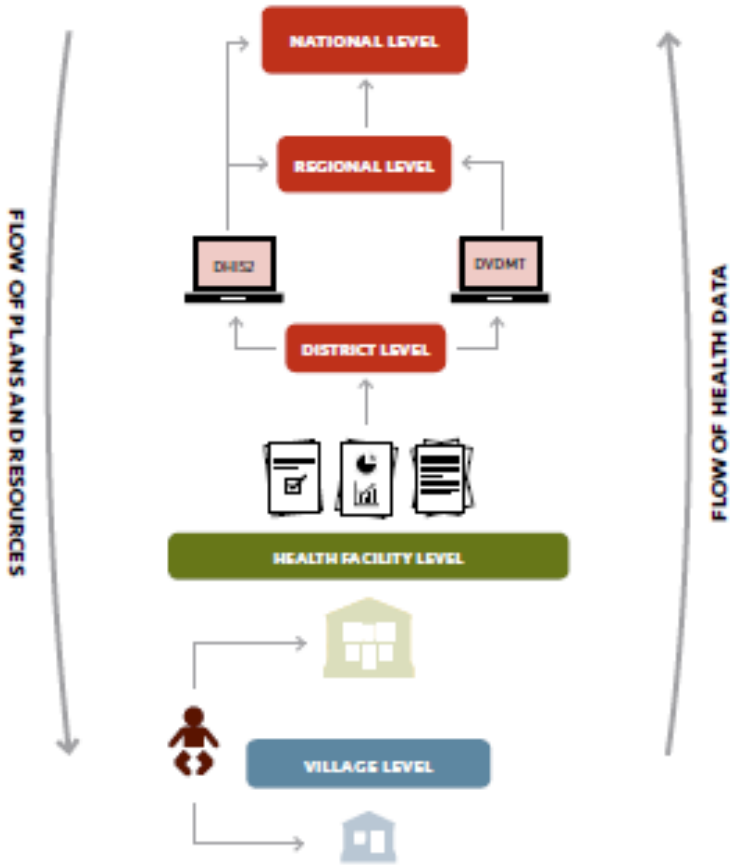


Figure 2: The flow of data in paper system

(Source: BID Initiative Briefs: Recommendations and Lesson Learnt (2))

With the introduction of the new system both the manual paper-based and electronic systems are now being used to ensure data are captured. It was expected that all the data from the mandatory manual ledger would be the same with the electronic immunization registry and the physical count at any one time after the introduction of the EIR. Apart from the electronic immunization registry and other systems in immunization, the essential medicines have enjoyed improved data use from the facilities due to the use of electronic logistics management information system (eLMIS) (3) which can also benefit immunization services.

Comparing with manual paper-based system of recording of the vaccines and other commodities, TImR provides real time data for the supply chain of the commodities and other health information and make it easier for rapid data collection and analysis (4). With the TImR

system there is expectation that vaccines management practices such as quality of data in ledger will also improve as the information on supply chain would be streamlined. This is due to the more accurate consumption data and registered target to be immunized in the following months. The improvement of the logistics management information system would hence improve availability of stock and consumption data for immunization commodities at the health facilities (5). Hence the new system of electronic immunization registry would ensure availability of vaccines and hence reduce stock-out which has been shown in many countries services delivery points (6).

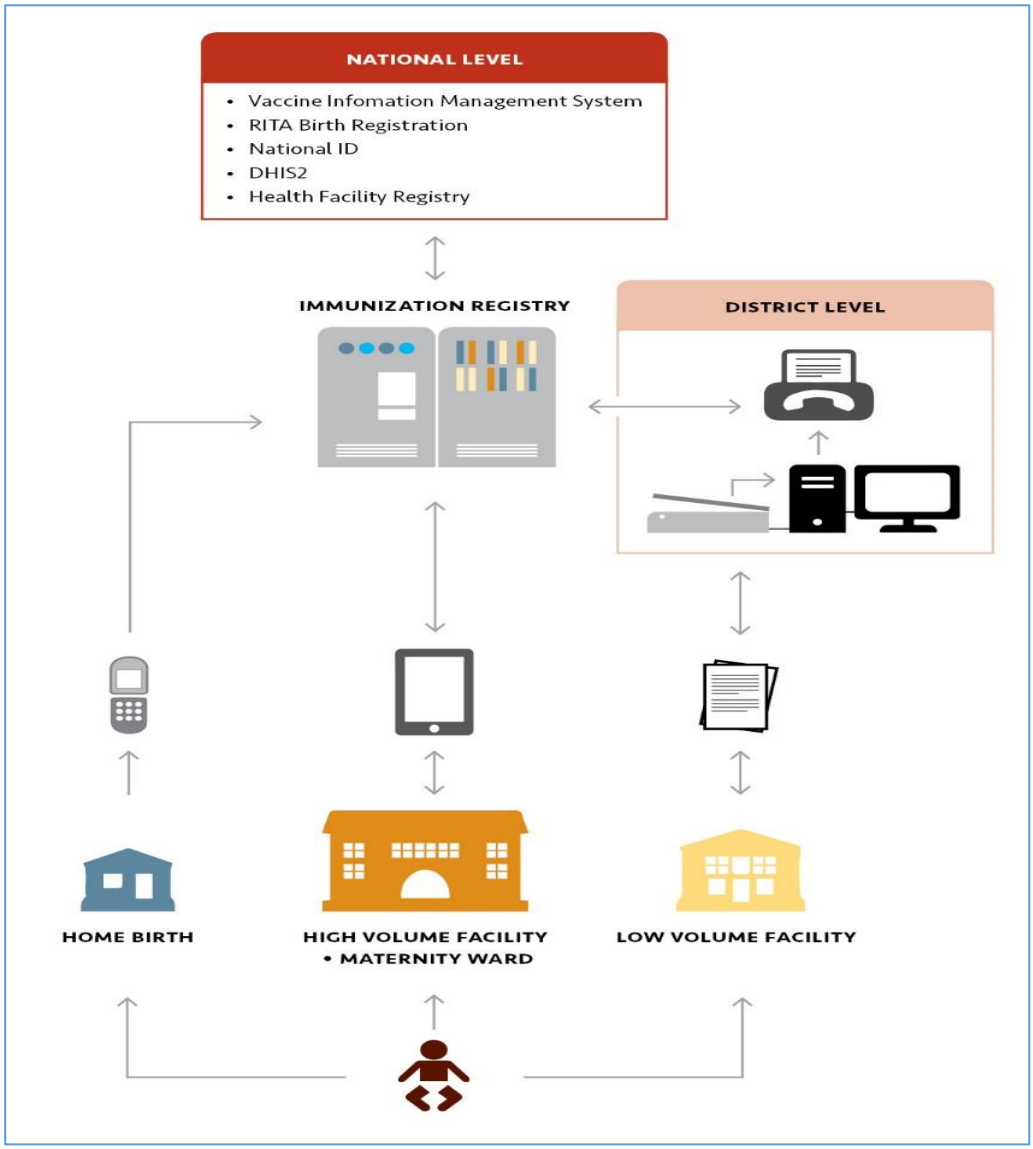


Figure 3: Flow of information after EIR introduction

(Source: BID Initiative Briefs: Recommendations and Lesson Learnt (2)

Continuing using manual system for vaccines management affect quality of data generated because of the challenges related to the distribution of the target population used as denominator as was explained in study done in Tanzania and Zambia (7). This can result into under stocking or overstocking of the commodities at the facilities leading to shortage or wastage respectively which can easily be corrected if the electronic system is in use as it increase visibility (8). The increased stock visibility is one of the strategy to ensure immunization supply chain is improved in the country as the changes in the vaccines stock can be acted upon and this has been shown in other countries such as Nigeria and other countries in the world (9). This electronic system of data collection from service delivery level can also help to align vaccines supply with client demand (10). Electronic immunization registry is also important in ensuring there is better and timely data for planning, lack of which has been noted in other countries to affect the immunization supply chain (11) as it improves reporting and hence reduce risks associated with poor service delivery (12).

The main objective of this research was hence to assess the effects of using Tanzania Immunization Registry in improving vaccines availability in the selected facilities in Tanga City Council.

1.2 Problem statement

After introduction of the Tanzania Immunization Registry in the country the impact and challenges on the vaccines availability which is one of the important parameter of the supply chain and hence service delivery has never been established. The contribution of the use of the new TImR system in ensuring the mandatory vaccines and commodities ledger is updated is not known or has yet to be established (13).

Tanga City Council being one of the first councils to introduce the electronic system for immunization data collection and monitoring the vaccines supply chain among other parameters could offer a good information on the importance of the system.

1.3 Purpose

The purpose of the research proposal was to find how the electronic immunization registry (EIR) used in Tanzania has improved the vaccines availability (and other immunization supply chain parameters) and the associated challenges to the health workers in Tanga City Council.

The system ensures that all health and logistical data are easily collected from the service delivery point and timely transmitted to the higher levels.

Tanzania government in collaboration with PATH introduced EIR (now named TImR, Tanzania Immunization Registry) in phased approach in 2014-2019 in Arusha, Kilimanjaro, Tanga and Dodoma with the intention of improving primary immunization data collection. It was envisioned that the new system would improve immunization supply chain as correct consumption data, stock on hand data and loss and adjustment will be collected on time and data visibility can be assured at all levels. All these aspects are related with improved ordering and hence availability of immunization commodities.

1.4 Research questions

i. Has Tanzania Immunization Registry improved availability of vaccines in health facilities in Tanga City Council?
ii. Has the number of doses available at the health facilities in Tanga City Council similar to those recorded in the manual ledgers?
iii. Are there challenges in using TImR at the health facilities in Tanga City Councils?

1.5 Specific objectives

The specific objectives were to;

i. Assess stock levels of selected childhood vaccines such as BCG, bOPV, DPT-HepB-Hib, MR and HPV after the introduction of TImR
ii. Compare manual recording system and TImR data with physical counts in term of record keeping
iii. Compare the number of target population given by National Bureau of Statistics with TImR recorded child registration in the past three month
iv. Find out challenges of using TImR in recording immunization data in the facility

1.6 Significance of the study

The study on the impact and effect of the utilization of the TImR system in improving immunization supply chain especially availability of vaccines would help immunization programme to evaluate how the use of electronic immunization system in Tanga City Council affect the mandatory manual ledger system and vaccines availability. This will be important in

ensuring the immunization programme apply the recommendation generated from this study in improving the data from health facilities and also roll-out in other councils.

Also because no other study has assessed the vaccines availability at the facilities this study will increase the understanding of the effect the TImR system has on the vaccines availability.

The beneficiaries of the study would be the health workers, district, regional and national immunization supervisors and partners.

1.7 Limitations

In conducting of this study the following limitations were encountered

i. The funding for the research can be limited as there was no financing from the sponsors or other partners. In this we financed the research from the salary and other family support especially during data collection.
ii. Also the time for conducting the research was limited as the researcher had to continue the office work during the data collection, analysis and report writing. In this we confided to only one council of Tanga City which had all the urban, semi-urban and rural environment.
iii. High number of clients in the facility in some health facilities impaired data collection as some health workers were not comfortable in leaving their work for the interview.

1.8 Delimitation of the study

The study was confided to only one council (Tanga City Council) which had all the urban, semi-urban and rural environment. Due to the setting of the council the results can be generalized to all councils in Tanzania.

CHAPTER TWO: LITERATURE REVIEW

Chapter two shows the literature review highlighting the overview of the Tanzania Immunization Registry, factors for the successful implementation of the electronic systems and conceptual framework for the study.

2.1 Overview of the Tanzania Immunization Registry

The aim of the immunization supply chain is to ensure right product (vaccine), quantity, quality, place, time and cost are assured at all levels of the service delivery (14) and hence reduce some of the immunization problems which have been noted in many areas of Africa such as Uganda (15). The immunization supply chain ensure that the vaccines are available at all time in the facilities so that when the child visit the facilities the adherence to the agreed schedule is assured as per the Ministry of Health guidelines (16) and hence the national target of above 95% coverage is attained. The use of electronic immunization systems and supply chain is important as it allow data to be easily collected, analyzed and used for planning (4). The presence of the electronic system for health commodities in Tanzania such as Epicor9 at national level, electronic management information system (eLMIS), vaccines management information system (VIMS) at the regional and district level has had positive impact in improving health commodities supply chain and data management at their respective levels (3) and ensure the six rights of the supply chain are attained. This is due to the improved reporting of the stock by the respective level and fast electronic ordering (17) and improved visibility and collaboration at all levels of immunization supply chain. This improved visibility and collaboration is likely to decrease inventory instability and bullwhip effects due to poor coordination by the immunization managers (18).

In Tanzania, the challenges has been on the service delivery at the health facilities level where lack of visualization of supply chain activities, complexities related to the data collection tools, defaulter tracing and incomplete data complicated vaccines availability (19). All these issues result into medicines and vaccines stock-out and wastages in the health facilities (20). The availability of electronic data has had positive impact in some other areas in the world in improving health supply chain and other immunization service delivery (21) and (4) as it has solved many challenges in immunization supply chain including stock-out which has been shown to exist in many programs in Africa(22). Due to increased efficiency, in India it has also been noted that with the use of digitalization in immunization supply chain the average

replenishment duration decreased by about 50% (23). These innovation and data for immunization supply chain are priority of the GAVI for the 2016-2020 and financing to Africa countries have been strengthened in these areas (23).

Many researchers have shown the electronic system and other technologies could improve immunization program parameters as it has positive effect on data collection, analysis and application (24), (25) and (26) and hence the coverage of children under the age of one year (21). As Tanzania struggles to reach the last child in immunization there is a need to improve data collection tools and supply chain management information system so that the vaccines and other commodities are available in the immunization area at the time of immunization. This problem of the supply chain was also explained as one challenge in developing countries and affect the provision of service and herd immunity of the community (21).

The electronic tools at the health facilities level such as TImR are important because registration of all the target population to be immunized would easily be effected and hence the possibility of reaching all the target population as the estimates done electronically is more realistic (27) . This would decrease wastage of vaccines and other immunization commodities. Also EIR might help in tracking other interventions related to child health

Poor data in the health facilities has caused the poor quantification and forecasting of vaccines and related commodities in third of the countries affecting the availability in the health facilities (28). Other studies have also shown the problems and challenges of adopting the technologies in ensuring the health services including supply chain is can result to poor accessibility and equity (29).

The government has introduced Tanzania immunization Registry but its impact in the improvement of the health supply chain management parameters such as vaccines availability and quality of manual recording tools are yet to be quantified. It was expected that electronic registry system would also enable the health information and supply chain data to be captured and easily stored and hence retrieved any time needed (19).

With the introduction of Tanzania Immunization Registry (TImR) and Vaccines Information Management Information System in Tanzania (VIMS) and Tanga been one of the first region for roll-out, the immunization supply chain might be improved due to the proper estimation of the target in each respective level. Alberto E. Tozz et al noted that only few countries have been successful in using electronic data to improve immunization services (24) and this study would

help to understand the impact and challenge of the tools in supply chain management in Tanga. The use of these information system and electronic registry would save the cost of managing immunization system and other health systems (30).

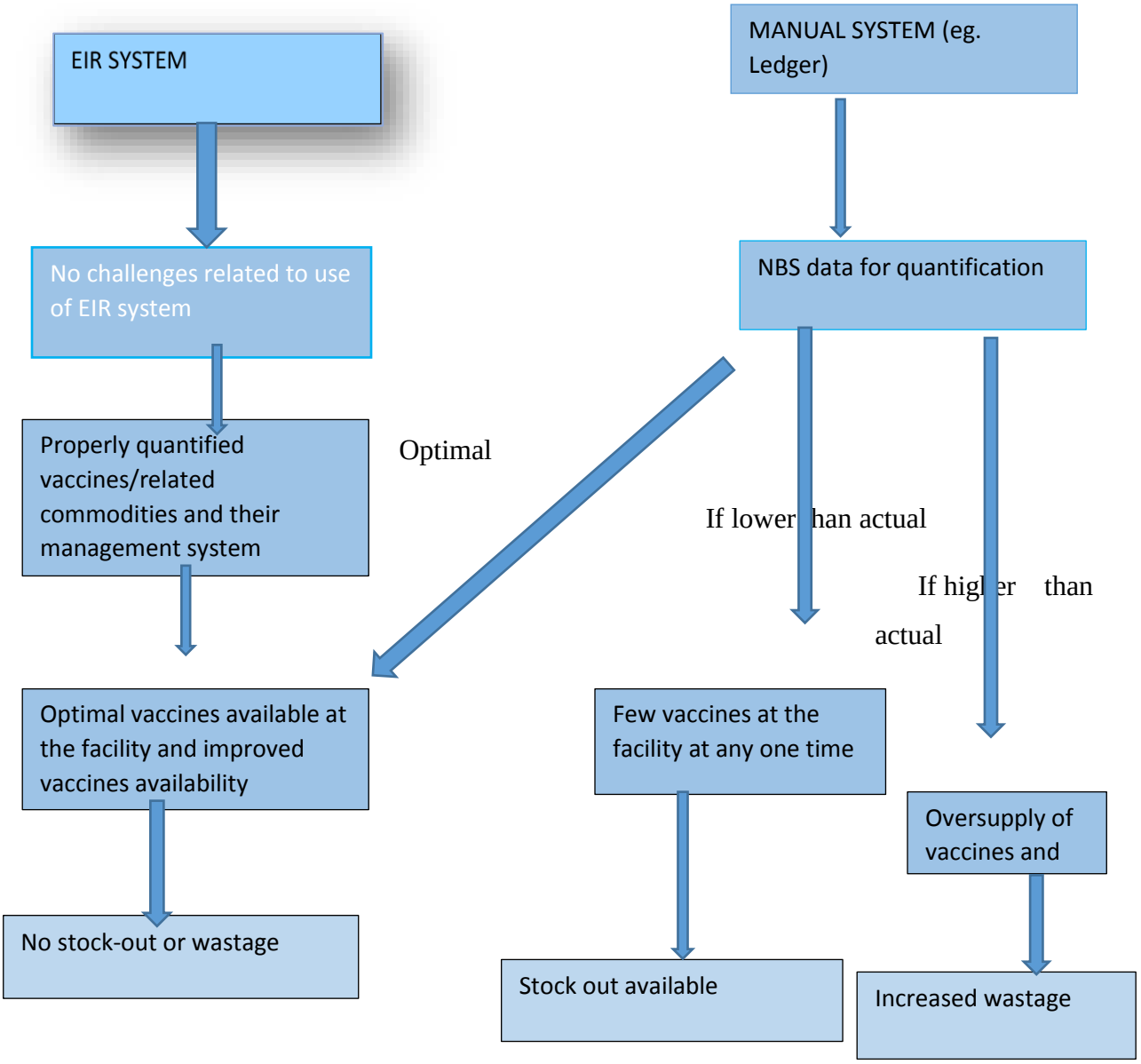
2.2 Factors for successful implementation of EIR

Implementation of EIR has been shown to be associated with some challenges especially in Latin America (31). For the successful implementation of the immunization registry many authors have shown the need to ensure that there is mobile network and devices, barcodes on the vaccines to trace the vial to the health facility level and internet availability and other technologies in use in other parts of the world (32) and (8). To be successful many of these electronic health records such as TImR would require to address the different issues such as cost, resistance to change by the health workers and issues related to using of the new data collection system among other things (33).

Also with the increased immunization supply chain data visibility it has been shown that the improvement in vaccines availability is assured and hence immunization status (9) because this would allow information exchange to be fast and accurate (34). This would ensure that there is no shortage or excesses of the immunization commodities. Other factors related to the successful implementation of the electronic immunization registry are partnership with other partners in technology industry, integration with other health systems in place, flexibilities and compatibility, needs of the health system and the users and affordable (35).

However, other authors have urged that the electronic health records such as TImR might not have reduce the cost of service provision especially when not accompanied by accountability and accessibility of the data (36).

2.3 Conceptual framework of the study



The electronic immunization system used in the facilities involved the registration of all targets for immunization which mean that the number of vaccines distributed in the facilities from the district level is optimal. Hence the EIR/TImR system is expected to reduce the number of stock out at the health facilities as it improve the quality of the data while serving the cost and time of the process (37).

For the manual system which is currently used in many facilities, the quantification of vaccines and related commodities depends either on National Bureau of Statistics targets or consumption data which can be low or high and hence understocking or overstocking. In this case stock-out or increased wastage respectively is the expectation. Also the manual system

has had the challenges of data visibility at the higher level and hence the possibility of stock-out when overstocked commodities are available in the health facilities because no sharing of commodities as the district immunization manager cannot conduct redistribution of commodities in such event.

This study would try to explore the effect of the EIR system in ensuring the optimal availability of vaccines in the study council/facilities.

2.4 Identified literature gap

As shown in the literature above and conceptual framework, the new electronic immunization registry in Tanzania may have some challenges and advantages related to supply chain parameters such as availability of vaccines. These challenges and advantages might impact vaccines availability, wastages and services delivery at the health facility level. Researching on how the new system (TImR) has impacted immunization supply chain is necessary in this time where the new system is been rolled out to other regions facilities in country.

CHAPTER THREE: METHODOLOGY

3.1 Study design

To accomplish this study a cross-sectional descriptive study was employed. Questionnaires to assess the effects of using the TImR was administered to the health care workers. The data from immunization/health commodities ledger and TImR data was also be used to obtain the information for the study.

3.2 Study sites

The participants of this study were health facilities providing immunization in Tanga City Council. The respondents were health care workers working at the reproductive and child health clinics in the facilities. The data from the vaccines manual ledger and TImR system were also studied. Vaccines studied were BCG, DPT-HepB-Hib, bOPV, Measles-Rubella and HPV. These vaccines were selected to represent each visit a child come to the facility for the immunization services. BCG and bOPV are given at birth, DPT-HepB-Hib and bOPV given on 6, 10 and 14 weeks after birth, Measles-Rubella given at 9 and 18 months and HPV is given at 14 years. Except for BCG and bOPV which are procured by the government of Tanzania all other vaccines under this study are procured under GAVI co-financing policy.

3.3 Sample size

Tanga City Council has 28 health facilities giving immunization services. The representative sample size in this study was calculated by the Yamane's formula

$n = N/(1 + N\mathrm{e}^2)$

Where,

n=Sample size

N=Population size

e= margin of error

Hence

The sample size needed $=28/(1+28*0.05^2)$

=36/(1+0.09)

=36/1.09

=26.2

The calculated sample size for the health facilities to participate in this study was 27 and were selected by simple random sampling method.

Also some questions were administered to district vaccines officer for the Tanga City Council to check how the new system has improved the vaccines availability and documentation.

3.4 Data collection instrument

Questionnaires were prepared and administered to the health facilities workers who are providing immunization at the health facilities in Tanga City Council. Also the data in electronic registry system and vaccines manual ledger books and related with immunization supply chain was be collected for the research. To ensure the reliability of the information was collected by the questionnaires from the health facilities and also the qualitative data was confirmed from the council immunization and vaccines officer. The qualitative and quantitative information was analyzed to provide the results.

3.5 Data Management and Analysis

The data collected was checked for consistency and clarity before been analysed. The data were coded to keep track of participants' responses and information. Data were then analyzed using computer statistical program IBM SPSS version 20.0.0.0 for windows. Descriptive statistics were used to report measures of central tendency and dispersion. All comparative statistics such as evaluating the possible differences between electronic and manual systems were analyzed using the difference between the means as necessary. Student's t test was used for the analysis of all continuous data. For categorical variables in the study Chi square test was used. A significance level of 0.05 was used.

The correlations were done using Pearson's correlation while quantitative data were transcribed by coding, checked for errors and analyzed. The qualitative data were those said by the personnel at the clinic or the district immunization and vaccines officer (DIVO).

3.6 Ethical consideration

The study subjects who are health workers involved with immunization were provided with clear information about the study, its purpose and advantage of the project before the questionnaire administered to them. Research clearance and permit (Annex 1) were obtained from School of Public Health-University of Rwanda, Mzumbe University. The information obtained from this study would be kept confidential to the researchers and no information would be communicated to other people unrelated to the study. Health workers were asked to give verbal consent (Appendix 5) for participating to this study which was voluntary. Council Immunization and Vaccines Officer was also interviewed to give some information on the operation of the new electronic system.

CHAPTER FOUR: RESULTS

4.1 Stock level of selected vaccines

All the 27 facilities (100%) had DPT-HepB-Hib vaccine at the time of the visit which was the middle of the month. The number of doses available at the health facilities increased with the target.

The study also showed that there were correlation between amount of vaccines available at the health facilities and target population. As the number of the target population increased so was the doses of the vaccines available at the facility. The correlation was significant at 95% confidence interval. Table 1 below show the correlation between the number of doses of DPT-HepB-Hib and the target population of the visited facilities

Table 1: Correlation between the number of doses of DPT-HepB-Hib and the target population

		Target population	DPT-HepB-Hib Physical count
Target population	Pearson Correlation	1	.944**
	Sig. (1-tailed)		.000
	N	24	21
DPT-HepB-Hib Physical count	Pearson Correlation	.944**	1
	Sig. (1-tailed)	.000	
	N	21	24

**. Correlation is significant at the 0.01 level (1-tailed).

The number of doses of vaccines available at the facilities increased with National Bureau of Statistics given target population as shown in figure 4 and 5. Figures 4 and 5 shows the relationship between the doses of bOPV and DPT-HepB-Hib with target population. The facilities with small target population has relatively low number of doses compared with those

with large population. And hence this show that there is good availability of vaccines at the facilities and also good supply chain management.

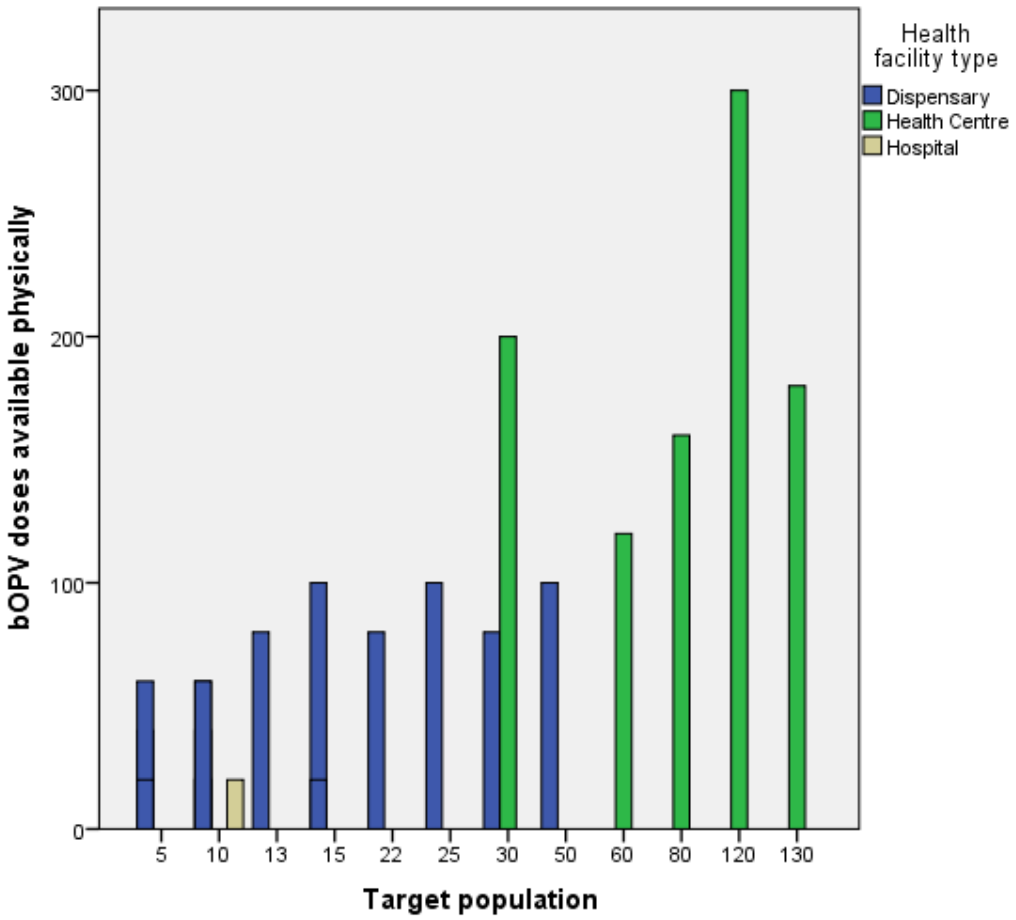


Figure 4: Mean bOPV doses available at the facility compared to the target population

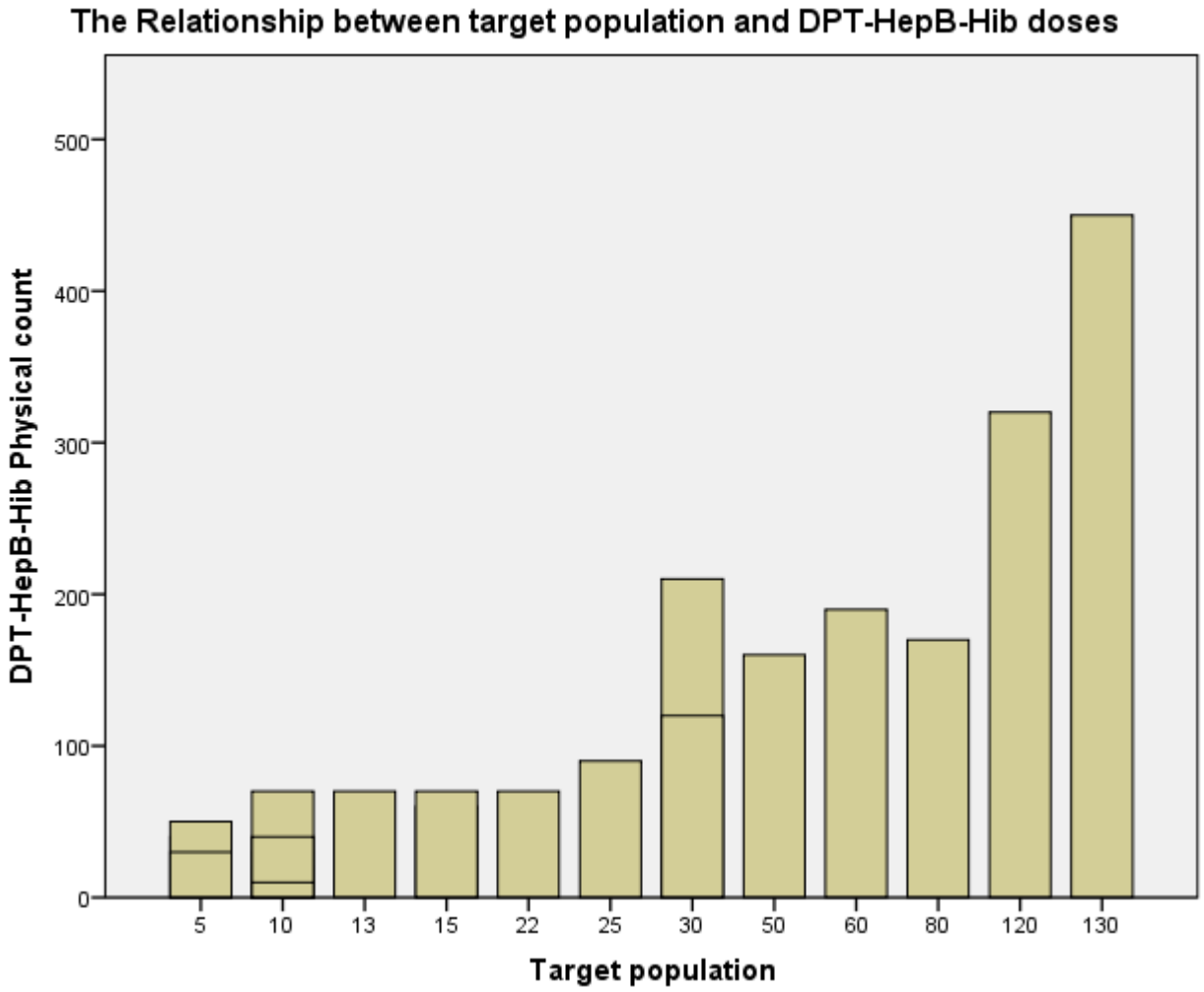


Figure 5: Relationship between target population and DPT-HepB-Hib doses available at the facility

Also the number of doses available at the health facilities under this study also increased with the number of registered children indicating that the new system might have some effect on the vaccines availability. This is well illustrated in Figure 6 for the relationship between DPT-HepB-Hib and child registration

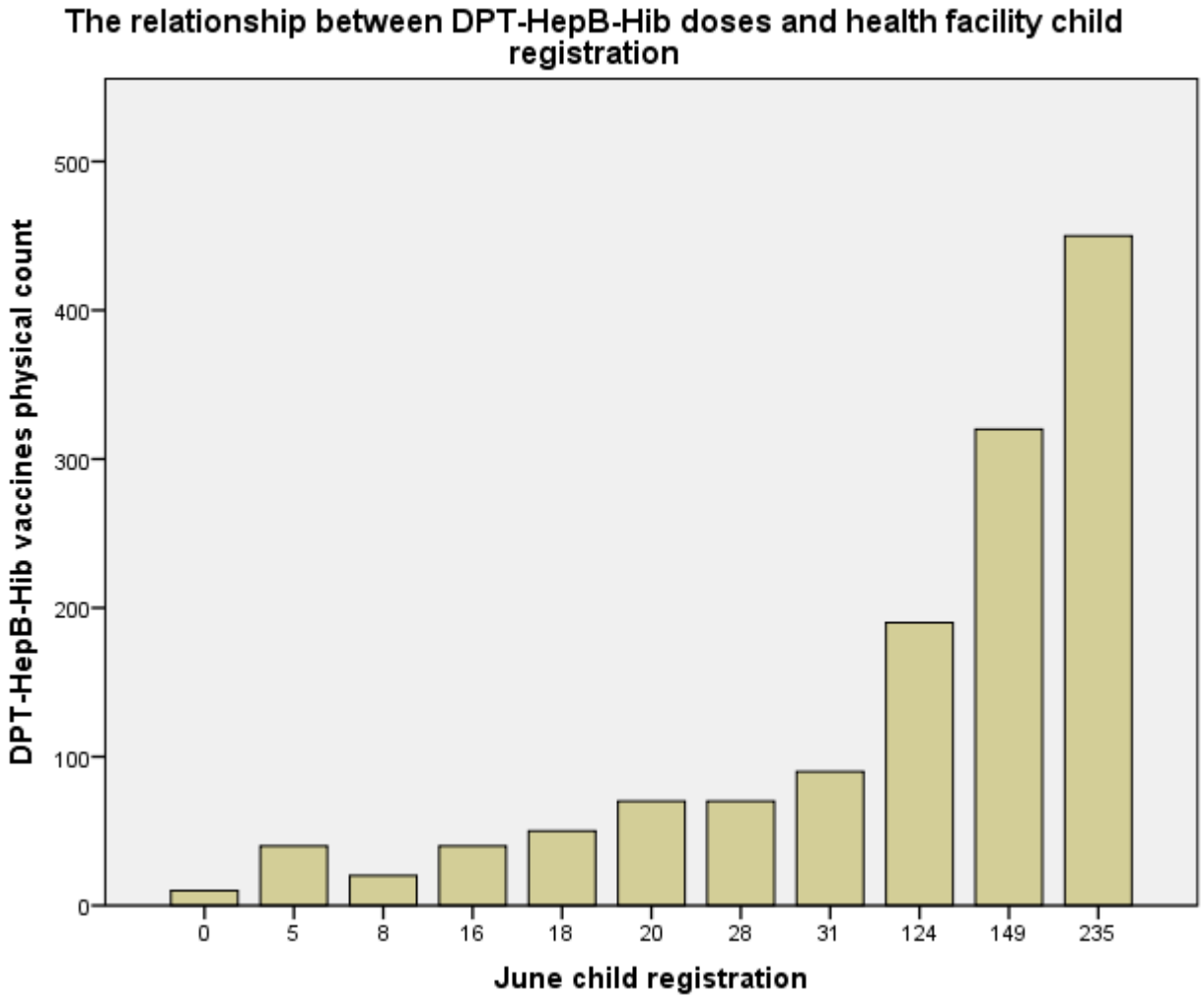


Figure 6: Relationship between facility child registrations and DPT-HepB-Hib doses available at the facility

4.2 Comparison between recorded data and physical counts

There was differences in the number of doses of each vaccine in the two systems of electronic TImR and manual ledger as compared to the actually available doses for all vaccines as shown in figure 7, 8, 9 and 10.

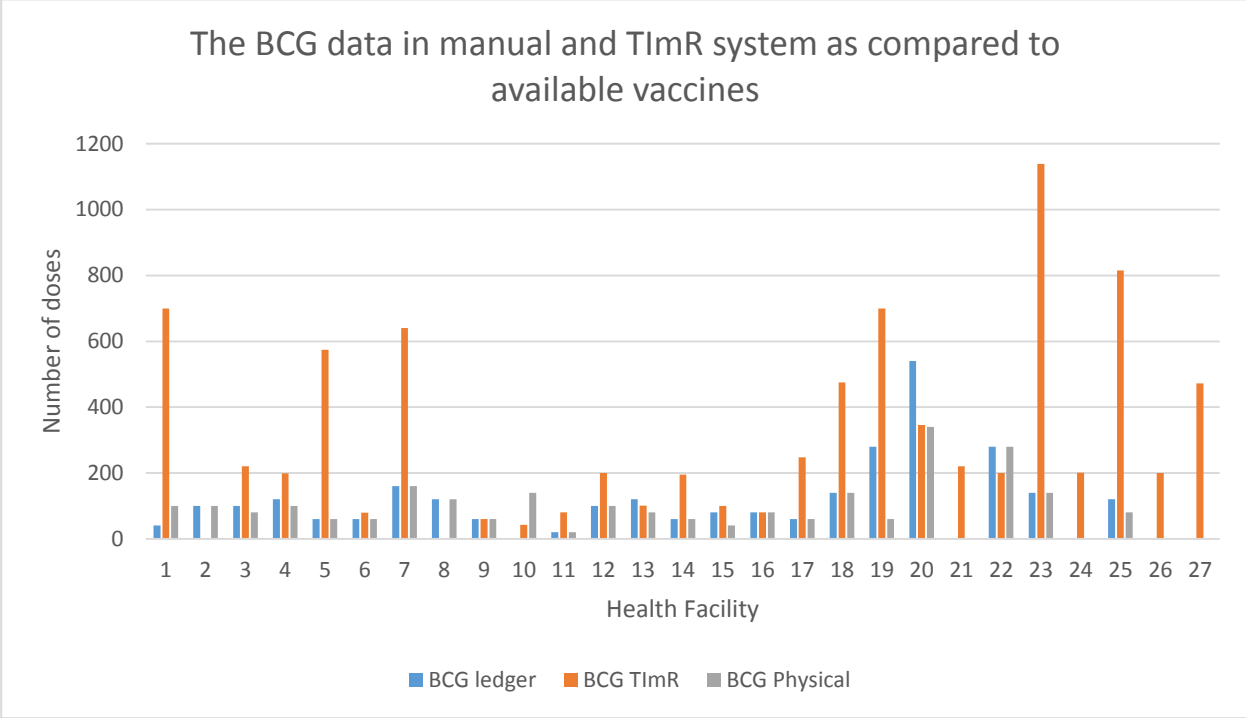


Figure 7: BCG data in manual ledger and TImR systems as compared to the available doses

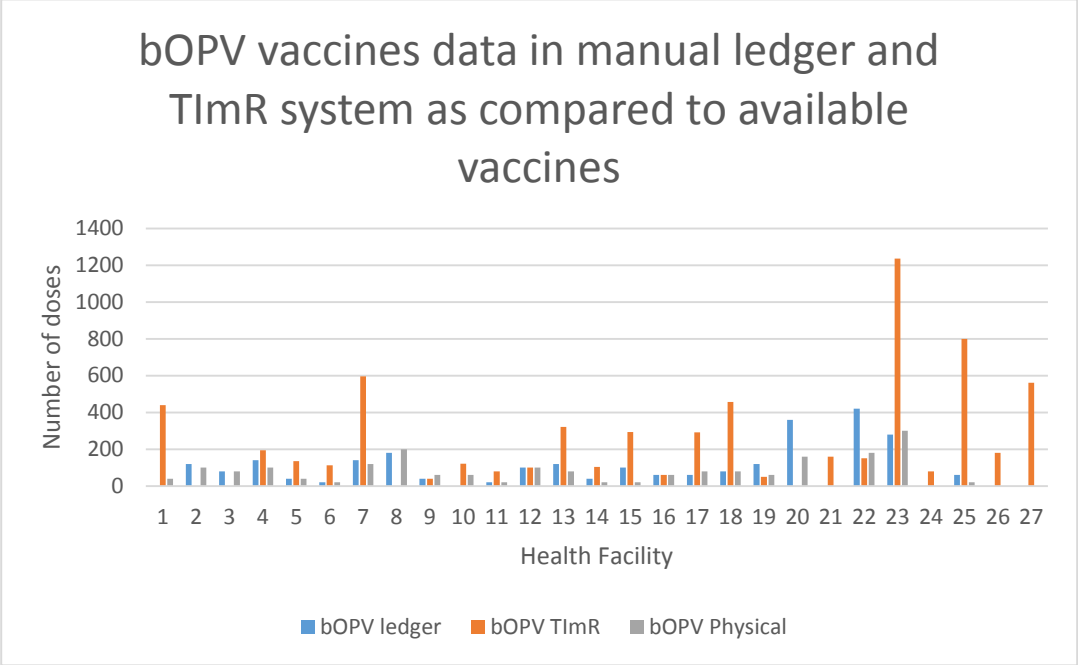


Figure 8:: bOPV data in manual ledger and TImR systems as compared to the available doses

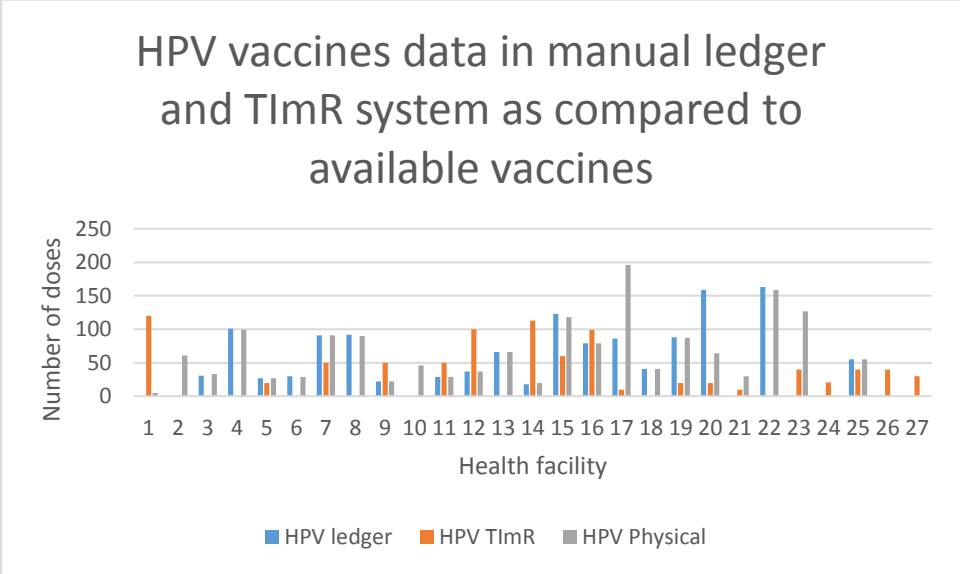


Figure 9: HPV data in manual ledger and TImR systems as compared to the available doses

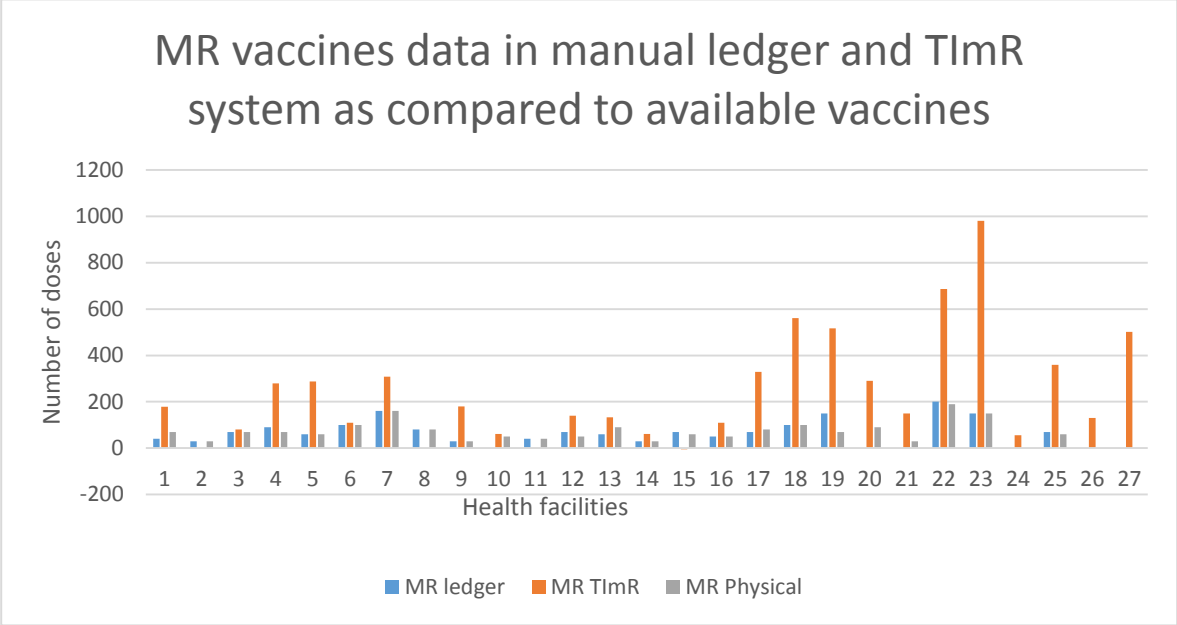


Figure 10: Measles-rubella data in manual ledger and TImR systems as compared to the available doses

Figures 7, 8, 9 and 10 show the graphs for the BCG, bOPV, HPV and measles rubella vaccines in the manual ledger and electronic TImR record for the facilities as compared with physically available vaccine at the time of the visit. There were noted differences in the two systems as compared to the actual available vaccines in the facilities. The electronic TImR data was very high for BCG and measles rubella vaccines in the facilities. This may may due to the facilities not conducting adjustments of the TImR data after sessions or not conducting on-time individual immunization data update due to internet challenges.

The doses of bOPV in the manual ledger was compared with those in the new TImR system with the mean doses for both compared. There were differences in the mean doses for the two systems. Also comparing to the actual available doses the differences were noted such that the mean doses in the ledger was 108.2, TImR mean doses were 285.9 and physically available doses were 69.5.

Table 2: One-Sample Statistics for mean bOPV doses in ledger and TImR as compared with physically available

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
bOPV ledger	5.084	21	.000	117.273	69.30	165.24
bOPV TImR	4.417	26	.000	243.000	129.91	356.09
bOPV physically available	5.878	23	.000	83.333	54.01	112.66

Tables 2 above shows the mean doses for the bOPV doses in the manual ledger, TImR and physically available. As it can be shown the mean doses are very different from the two documents as compared to the physically available number. The analysis shows that the mean doses of bOPV available in the TImR is three times higher than the actually available doses at the facilities. The difference is significant at 95% confidence interval as the p value is less than 0.05.

Table 3: One-Sample Statistics for mean BCG doses in ledger and TImR as compared with physically available

	N	Mean	Std. Deviation	Std. Error Mean
BCG ledger	22	129.09	112.754	24.039
BCG TImR	27	306.89	287.349	55.300
BCG Physical	24	102.50	75.138	15.337

Table 4: One-Sample Statistics for mean BCG doses in ledger and TImR as compared with physically available

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
BCG ledger	5.370	21	.000	129.091	79.10	179.08
BCG TImR	5.549	26	.000	306.889	193.22	420.56
BCG Physically available	6.683	23	.000	102.500	70.77	134.23

For BCG vaccines the mean doses available in the electronic TImR system was also three times more than available physically in the facilities. The manual ledger was also closer to the physically available doses than the electronic doses. The analysis shows that the mean doses of BCG available in the TImR is three times higher than the actually available doses at the facilities. The difference is significant at 95% confidence interval as the p value is less than 0.05.

Table 5: One-Sample Statistics for mean HPV doses in ledger and TImR

One-Sample Test

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
HPV ledger	6.483	19	.000	66.900	45.30	88.50
HPV TImR	4.614	26	.000	33.074	18.34	47.81

Table 5 show the one sample statistics for the HPV vaccines in the two records as compared by physical available vaccines. The mean difference between the manual and TImR ledger records were in the ratio of 2:1.

4.3 The relationship between NBS given target population and TIMR child registration

The child registration done by the new electronic TImR system was higher than the National Bureau of Statistics given target. This is shown in table 6 below

Table 6: The relationship between mean target population and child registration

One-Sample Test

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Monthly NBS Target population	4.053	23	.000	28.958	14.18	43.74
April 2019 registration	1.614	10	.138	36.545	-13.90	86.99
May 2019 registration	2.776	11	.018	48.167	9.98	86.36
June registration	2.600	11	.025	55.333	8.50	102.17

Table 6 show the mean target population for this study was less than child registered for the immunization in each three preceding month of the study (April, May and June, 2019). The registration ranged from 1.3 to 2 times higher compare to the National Bureau of Statistics given target population for the health facilities. Except for April 2019 registration, the mean differences are significant as the p value is within the acceptable region (p=0.05)

4.4 Reported challenges of the use of TImR system

Health care workers providing immunization services indicated the following challenges in using the electronic immunization registry. Some of these challenges were noted even during the data collection of the study. Some of the common challenges noted were related to internet connectivity where by some areas have no or poor internet services which results to taking too long in capturing the clients or stock to the system, the tablet used were not capturing the vaccines received in the system and hence this resulted to the mismatch between the quantity of vaccines available physically and those captured in the system, the generated reports were not realistic to what were expected, out-of the catchment area clients were not available in the system despite the area where the client came have used the same TIMR system *[… kweli zinasumbua, watoto wa kituo kingine cha jirani nikiwatafuta kwenye mfumo ili niwape huduma siwapati. Saa nyingine huwezi kupokea chanjo kwenye mfumo, Noted one vaccinator],* some localities such as villages are not available in the system, deletion of some information sometimes occurs when updating the system. Other challenges are some vaccines are not seen in the system, some clients are coming from other countries and location such as Kenya which have different system of child registration. These challenges are very rampant during working hours necessitating providing services without the use of gadget and retaining the child cards for electronic data capture in other time.

Some health workers also reported getting challenges in using some features of the system and generating the reports for their facility data use, some used the system to capture data only without using it got report generation and data use for the facility, a frequent problem of the system results in returning the gadget to the district for maintenance, bundles for internet connectivity, lack of proper maintenance of the gadget, training on minor troubleshooting of the gadget or system not given to the health workers, lack of some important reports in the TIMR system such as number of HIV exposed children in the system provide a challenge during monthly report generation and submission to the district level and some barcodes are not functional as they have worn out.

CHAPTER FIVE: DISCUSSIONS

The health facilities in Tanga City Council had enough vaccines. This is because TImR system can generate stock-out report which is very crucial in managing supply chain of the immunization commodities such as vaccines. Also the dashboard can show the quantities of vaccines and other commodities available at the facility. These features can increase availability of immunization commodities at the facilities as they improve decisions and responses by the health workers during ordering and managing stocks. This has also been shown in other settings and countries such as Nigeria by Sarley D et al, (10) who showed that implementing electronic system would ensure vaccines availability. Also one review has clarified that poor vaccines management at the services delivery level results into stock out of vaccines (38).

The results of this study showed that there were correlation between NBS given target population and the available doses of vaccines at the health facilities. The number of doses of vaccines increased with increase in target population at the facility. Also the correlation was positive with the number of registered children using the electronic system. This improved availability of vaccines at their health facilities is due to automatic calculation of the vaccines needed at any one time by the electronic system. The availability of vaccine would hence improve immunity to the community as any time the child visit the facility would be vaccinated. This result is also consistent with Figure 9 which has showed 88.5% of the respondents use the new system of electronic immunization registry for reporting stock-out. This result has been consistent with other sister system for essential medicines called eLMIS which has been shown to improve the supply chain parameters after one year of implementation (3). This is very important in ensuring vaccines adequacy at the health facilities and there is improved accuracy in ordering at any one time and has been shown in other studies (39).

The number of doses for different vaccines in TImR and immunization manual ledger were very different but comparing to those available physically the immunization ledger was very close to the physical data. For example for the bOPV vaccines the electronic immunization registry had a record which showed that value is about four times the number of vaccines present in the facilities. For the ledger the records showed about 1.5 times when compared to the physical count. This differences were noted for all vaccines available under this study and available in the facilities. This can be explained that the health workers are still using manual

ledger. Also electronic immunization register has many challenges in using it at the health facility. The continuing using the manual ledger despite been the government policy impede the fully implementation of the electronic system because the health workers at the facilities feel that using the two systems duplicates their works. Also the difference in number of doses in the two systems can be explained by the internet connectivity. In this situation health workers were obliged to collect the child health cards and perform electronic registry in the afternoon when the internet was stable. This affect the real time data visibility at the higher level and hence the decisions in the supply chain as has been studied noted by other authors such as Thiyagarajan A and Bhattacharya S KD (40).

Through this study the number of registered children were higher than the target population given to the facilities for immunization. The difference were up to 2 times as shown in Table 6. This increased number of children to be vaccinated compared to the target number given may be due to challenges of distribution of the target population and because service users are free to get services everywhere they want. These issues were also noted by Aporphia Namageyo-Funa, Anita Samuel et al (27) who showed that they are all prevalent in Africa. The increase in the number of target population as compared to the given target can result in the decrease in number of vaccines available at any time at the facility if there is no supervisor accessing the dashboard for vaccines availability. The uncertain target population and inadequate supply chain management was also reported by other authors in Tanzania and Zambia such as Seymour D, Werner L, and Mwansa FD et al (7) and was the reason behind the introduction of TImR in the country.

Despite the use of TImR electronic system in managing vaccines and its advantages in improving the availability of vaccines in health facilities in Tanga City Council there has been many challenges related to the new system such as internet connectivity. The internet connectivity was mentioned by most of the health workers involved in immunization as one of the challenge affecting the new system. Other challenges which were noted were too many papers for manual data entry despite the new electronic system, human resources constraints and breakdown of the gadget for data collection tool at the facilities which needed regular troubleshooting by district supervisors as has been reported by other countries (41). These challenges have also been noted in other developing countries which are using EIR and sometimes results into under-reporting and hence under-registration as reported by Dolan SB, Carnahan E and Shearer JC et al (42) and Trumbo SP, Contreras M and Garcia A (43).

Addressing the internet connectivity is not a challenge which can only be solved by the health sector only as it involved many stakeholders in the communication sector including private sector. Addressing the challenges would ensure system coordination is implemented for the exchange of health and supply chain information in and outside the geographical area and hence improving ordering and inventory management as highlighted by other (26).

Due to these challenges it was noted that paper based tools except HMIS Book 7 are used concurrently with electronic TImR system. This has made the paper based records becoming better than electronic records due to high number of clients in the facilities. The high number of clients with internet challenges was noted to cause facilities health care workers to collect the child health cards for updating the records after the clinic session affecting the quality of data. This result was also consistent with the one study conducted in Ethiopia for ART clinic (44) which showed the paper and electronic tools are used parallel.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The stock of vaccines available at the facilities in Tanga City Council was enough to provide immunization services in their respective facilities because of the positive correlation with the target population and the electronic child registration.

The mean doses for the vaccines under study were different in the TImR and manual ledger. However, the manual ledger records were closer to the physical available data than the electronic records. For example, for BCG the mean doses available at the health facilities was 102.5 while the manual ledger was 129 and TImR 306.9. This differences are due to the challenges of managing the TImR system at the facility due to among other internet connectivity problems.

The number of electronic registered children at the facilities were fewer than NBS targets given. This electronic child registration is hence important in ensuring enough vaccines are distributed to the facilities when the NBS target is unrealistic.

Most health workers in the facilities providing immunization services were very happy with the new TImR system in use despite of the challenges they experienced in the use of the system. Some of the challenges were related to the internet connectivity, human resources, preventive maintenance of the gadget for data collection and support services.

6.2 Recommendations

The Ministry of Health

i. Should integrate TImR system at the health facilities with the system used at higher levels be so that there would not be duplication of work in vaccines and immunization data management.
ii. Should introduce the pull system for vaccines requisition rather than the current push system in vaccines distribution. In the current system the facilities do no order immunization commodities they need rather, the district/council immunization and vaccines officer visit the facility each month to refill the needed doses of the vaccines and other immunization commodities.

iii. Should increase the number of equipment for TImR use at the facilities which have high number of clients so that the system can also be used when there are concurrent services are going on. For example the fixed and mobile services can be implemented at the same time.

Council management

i. Should map all the health facilities which have no or few any challenges such as internet connectivity and drop the manual system used in the facilities.
ii. Should hire the technician/system engineer who would be available to provide system support and maintenance of the gadget to be used by the facilities. This will ensure the down time for the equipment is minimal.

These recommendations should be implemented under short and medium term basis (in less than 3 years' time).

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Annexes

Annex i: Research Permit and Introduction Letter

MZUMBE UNIVERSITY
(CHUO KIKUU MZUMBE)
DAR ES SALAAM CAMPUS COLLEGE
Office of the Principal

Tel: + 022 2152586 DIRECT
Tel: + 022 2152582 GENERAL
Fax: + 022 2152584
Email: dcc-Principal@mzumbe.ac.tz
Website: http/www.mzumbe.ac.tz

Plot No.941/2
Upanga, Olympio Street
P. O. BOX 20266
DAR ES SALAAM
TANZANIA

Ref. No: MU/DCC/OF/S.2/4/5

05th June, 2019

TO WHOM IT MAY CONCERN

Dear Sir/Madam,

RE: INTRODUCTION OF MR. EMMANUEL YOHANA TESSUA

Reference is made on the above subject matter.

With due respect, I am writing this letter to introduce the above named person who is studying MSc- Health Supply Chain Management from University of Rwanda, College of Medicine & Health Sciences, School of Public Health-EAC-RCE-VIHSCM, since October 2017.

Mr. Emmanuel Yohana Tessua is undertaking a research study to investigate the "***EFFECTS OF ELECTRONIC IMMUNIZATION REGISTRY ON VACCINES AVAILABILITY IN TANZANIA: THE CASE OF TANGA CITY COUNCIL".*** This is partial fulfilment to the award of his degree. He is supervised by Dr. Omary Swallehe of Mzumbe University-Dar Es Salaam Campus College.

This letter therefore, serves as an introdution to the researcher to be allowed to access and collect data from the specified Health Facilities in Tanga City Council. The data to be collected will treated with maximum confidentiality and meant only for the intended purpose.
It is my sincere expectation the letter will serve the purpose and should you have any question please contact the undersigned:

Dr. Omary Swallehe

For Principal

Annex ii- Time Table for the Research Thesis

Time Period	**Activities/ Procedures**
Jan– April 2019	Literature Review and Proposal Development and endorsement
May-June 2019	Ethical Clearance application
June– July 2019	Data collection and analysis
Jul-19	Draft 1 thesis report and manuscript development
August –2019	Report writing and manuscript development
September– 2019	Dissertation and manuscript submission

Annex iii -Questionnaire for Health Facilities

EFFECTS OF ELECTRONIC IMMUNIZATION REGISTRY ON VACCINES AVAILABILITY IN TANZANIA: THE CASE OF TANGA CITY COUNCIL

Facility name:…… Facility type: Disp……HC……Hosp……..

Name of respondent:……. Tittle of respondent…….…….

Phone number of respondent ……Interview date: ……..

Age: …… Sex:……

Under one target population per month (NBS)……

Average population registered by EIR/TIMR ……

1. When did you start using the TImR?
    a) 1 years ago
    b) 2-3 years ago
    c) More than 3 years ago
2. What can TImR capture?
    a) The number of children to be vaccinated
    b) The number of children vaccinated
    c) Number of vaccines available
    d) Number of vaccines to be ordered
    e) OTHER……. Mention: ……..

3. Number of children registered with TImR in the past three month

Month	Number registered
Month 1 ……	
Month 2……	
Month 3 ……	

4. The number of vaccines in the ledger, TImR and Physical count

Vaccines	Amount in Ledger (doses)	Amount in EIR (doses)	Physical count (doses)
BCG			
bOPV			
DPT-HepB-Hib			
Measles-rubella			
HPV			

5. Does the TImR system develop stock-out report?

   YES:……. NO:……..

   If YES which many vaccines were stocked-out in at last seven day?

6. Has TImR improved the availability of the health supply chain in your health facility?

   YES:……. NO:……..

   If YES, How? ……

7. What are the challenges in using the TImR in ensuring vaccines are available in your facility?

   a) ……..

   b) ……

c) …….

8. When was the last time the immunization ledger updated?

   a) Today

   b) Within one week

   c) Within one month

   d) More than one month

9. When is the last time you have used the electronic immunization registry in providing immunization services?

   a) Today

   b) Within one week

   c) Within one month

   d) More than one month

10. Do the facility generate report for defaulters tracing?

YES:……. NO:……..

11. In your opinion has the introduced TImR helped in reducing wastage of vaccines in your facility?

    Yes…….. No……

12. Does the district level send back the summary of the children immunized to the facility?

Yes…….. No……

13. Can the TImR system generate order of vaccines to be used at the facility?

Yes…….. No……

If Yes

14. How many vaccine were received from the district level after your last order? Fill the table below

Vaccines	Amount of vaccines requested last month (doses)	Amount of vaccines received after the last order
BCG		
bOPV		
DPT-HepB-Hib		
Measles-rubella		
HPV		

15. What register which was manual but now is not used because it is electronic? [Tick what applies]
    a) Tally sheet
    b) Ledger
    c) Health facility monthly report form for immunization
    d) Other

Annex iv: Questions for the district immunization officers

1. Which reports related to vaccines availability do TImR generate for health facilities?
2. What proportion of the health facilities send manual health facility monthly report.
3. How do you audit the facility electronic vaccines availability report before distribution?
4. How do you use the EIR report to ensure vaccines is available in the facility?
5. Which challenges related to the use of TImR in your councils

Annex v: Research budget

Item	Estimated Costs (in TSh)	Covered How /By Whom
Proposal Development and endorsement	500,000	To be determined
Printing questionnaires	200,000	To be determined
Data collection	2,300,000	To be determined
Data analysis	1,000,000	To be determined
Report writing	200,000	To be determined
Dissertation submission	0	To be determined
Supervision	1,000,000	To be determined
Contingency	520,000	To be determined
Total	**5,720,000**	

Annex vi: Consent/Assent form

FOMU YA KUKUBALI KUJIUNGA KWA HIARI KATIKA UTAFITI

Kukubali kujiunga katika utafiti wa **KUFUATILIA FAIDA ZA MFUMO WA UKUSANYAJI WA TAARIFA ZA CHANJO KWENYE VITUO VYA MANISPAA YA TANGA**

Salaam! Jina langu ni …… mimi ni mtafiti katika utafiti huu wa kuangalia faida na changamoto za mfumo wa ukusanyaji wa taarifa za chanjo (TImR) kwenye upatikanaji wa chanjo.

Malengo ya utafiti:

Vituo 34 vya utoaji wa chanjo kwa manispaa ya Tanga wanashirikishwa katika utafiti huu wa kuangalia utumiaji na changamoto za kutumia mfumo wa ukusanyaji wa taarifa za chanjo hasa upatikanaji wa chanjo na ujazaji wa vitabu vya chanjo. Matokeo ya utafiti huu yatasaidia kujua matumizi ya mfumo wa ukusanyaji wa chanjo wa TImR kwenye kuboresha upatikanaji wa chanjo nchini.

Ushiriki wako katika utafiti huu:

Kwa kushiriki katika utafiti huu utaulizwa maswali ambayo yanahusu utumiaji wa mfumo wa TImR, upatikanaji wa chanjo, changamoto za utumiaji wa mfumo na uhuishaji wa leja ya chanjo kituoni kwako.

Usiri:

Taarifa zote zinazohusu changamoto na mfumo wa utumiaji wa chanjo unazotumia, utazifahamu wewe na sisi tunaofanya utafiti.

Madhara ya utafiti huu:

Hakuna madhara yoyote yanayotokea kwa kushiriki katika utafiti huu.

Kukubali kwa hiari kushiriki kwenye utafiti:

Kujiunga kwenye utafiti huu ni hiari. Unaombwa kukubali kwa hiari.

Faida za utafiti:

Ukikubali kujiunga na utafiti utakuwa mmojawapo wa wale watakaofanikisha kuboresha mfumo wa kielektroniki wa chanjo katika kituo chako na katika sehemu yoyote Tanzania.

Utasaidia kuwawezesha watunga sera na wataalamu wa afya kufanya maamuzi yenye faida kwa utunzaji wa chanjo na dawa nchini.

Hatutegemei utaingia gharama zozote kwa kushiriki kwenye utafiti huu.

Kama una swala lolote kuhusu utafiti huu wasiliana na:

Mwongozaji wa utafiti,

Emmanuel Yohana TESSUA, Shule ya Afya ya Jamii, Chuo, Chuo Kikuu cha Rwanda SIMU Namba +255 753 557725

Dr. Omari Salehe, Chuo Kikuu cha Mzumbe. Simu +255 713254168