



FIRE EARLY WARNING DEVICES: SYMBOLS OR SAFETY ASSETS FOR FIRE HAZARDS MANAGEMENT IN THE HIGHER LEARNING INSTITUTIONS?

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Abstract: Fire outbreaks have been a worldwide safety challenge ever since we waded into the 21st Century. Using fire early warning devices to take precautions before a fire breaks out is one of the most important mitigation strategies. Several nations, including Tanzania, have turned to fire warning systems, though it is unknown how well the installed devices works for that purpose. This research primarily assessed the functionality of early warning systems installed in higher learning institutions in Dodoma City to determine whether they are actually functional (assets) or are not working (symbols). In order to gather information from 75 participants, the research used key informant interviews, observation, documentary reviews, and questionnaire surveys. Findings revealed that 80% of the respondents were aware of the installed early warning devices. Also, 50% of them confirmed that the installed devices were functioning. Furthermore, insufficient financing, inadequate training, and a lack of maintenance and routine inspections hindered the installation and use of early warning systems. It is concluded that the installed early warning systems were beneficial in controlling fire outbreaks. The research suggests offering education and training to use them to both students and staff in order to increase functionality. Early fire warning programs should be implemented by institutions, and internal policies should address disaster management and related problems.

Keywords: *Hazard management, Early Warning Devices, Hazard.*

1.0 Introduction

Early warning systems (EWS) have been used to improve disaster preparedness globally since the mid-1980s and gained traction in the 1990s during the International Decade for Disaster Risk Reduction (ISDRR, 2006), as well as in 2015 under the Sendai Framework for Disaster Risk Reduction (UNSDR, 2015). In practical ground, EWS for all disasters such as fire, floods, drought, to mention a few, encompass risk knowledge, monitoring and prediction, and the dissemination of information and response (Waidyanatha, 2010; UNSDR, 2015). Furthermore, Pearson (2012) reports that fire EWS installations are embedded within buildings/structures that constitute both local and modern installed devices such as fire alarms, smoke detectors, bells and whistles among others.

In Africa, fire EWS installations in buildings have attained greater significance following the unprecedented levels of fire breakouts and unrests which resulting in human deaths and injuries (Becker, 2010). Following these events, some African countries (such as Kenya,



Uganda, South Africa, Tanzania, and Zambia) began to install fire EWS in their building including the higher learning institutions in order to reduce the hazards' threats (Kachenje and Nguluma, 2010; Lumbroso, 2016).

In Tanzania, higher learning institutions as to other offices/organizations are also vulnerable to fire outbreaks that have potential effects on lives and properties. Moreover, many institutions in the country have limited capability and resources in the case of fire EWS installations (URT, 2008; Ringo *et al.*, 2016). However, if effectively deployed, it would minimize the loss of life and damage to properties in the event of an emergency or hazards, especially fire incidents which have been rampant in schools and higher learning institutions.

Dodoma City has higher learning institutions (universities, colleges, and institutes) which have been increased since the 2000's. Their operations have been done by the government and the private sector. The administration of these institutions has been aware of enhancing efforts to ensure the effective installation of fire EWS devices to reduce the effects of hazards and/or disasters on people, property, and the environment once they occur. These efforts include the installation of fire alarms, smoke detectors, and socket breakers (Ringo *et al.*, 2016). The question in mind is, do the people in those higher learning institutions in Dodoma City know and use those systems? And do those devices work to meet the expectations? Or are installed just as symbols? It is from those questions that the reviews that have done revealed a little knowledge on that area. Therefore, this study is of paramount importance to fill this information gap as we are strongly persuading the Sustainable Development Goals No. 9 and 11, i.e., *Building resilient infrastructures and promoting sustainable industrialization*, as well as No. 11, *focusing on making cities inclusive, safe, resilient, and sustainable*.

2.0 Methodology

2.1 The Study Area

This study was conducted in Dodoma City, involving three higher learning institutions: St. John's University (SJUT), the Institute of Rural Development Planning (IRDP), and the University of Dodoma (UDOM). Both the public sector (UDOM and IRDP) and the private sector are in charge of running these organizations. The SJUT, IRDP, and UDOM were picked because they are the higher educational institutions in Dodoma City with higher learning students who contributed a variety of perspectives relevant to the study, assisting researchers in gathering enough and trustworthy data. Similarly, these institutions were involved since their buildings were prone to fire because at whatever place that involves people with different activities, comprising buildings with fire harmful materials, fire fates are expected. Also, these organizations were reachable and had fire EWS devices in the buildings.



Geographically, Dodoma City is situated at 6°10'23"S and 35°44'31"E and is the administrative centre of the Dodoma Region. There have been numerous earthquakes, flash floods, and traffic accidents among the city's dangers. The fire and rescue force, local level disaster management committees, and private organizations have all been used by the City's administration to combat them.

2.2 Data Collection

In order to collect data for this research, a variety of methods and tools were used, including observation, questionnaire surveys, documentary reviews, and key informant interviews. Researchers have inspected the early warning systems at all three institutions through observation. The observations were guided by the observation schedule in order to identify the current EWS devices as well as functional and malfunctioning devices. Photos were taken as required. For the surveys of the students, 75 respondents were chosen at random and given questionnaires to complete. The respondents were carefully chosen from among students in various academic programs and years of study. Their social characteristics, knowledge of the installed early warning devices and functionality were all covered by the questionnaires having open and closed ended questions. Regarding key informant interviews, 15 formal interviews were held with the heads of academic departments, heads of human resources, procurement and supply officers, and deans of students from each institution. A checklist was used to guide the interviews, encompassing the status of the installation and maintenance of the early warning devices, the functionality of those devices, the awareness of the existing early warning devices, and the financial allocation for installing early warning devices. Additionally, reviews of books, articles, and reports with a statement about EWS and their usability were used to gather secondary data.

2.3 Data Analysis

Both qualitative and quantitative data were collected, which necessitated the use of both qualitative and quantitative data analysis techniques. Quantitative data was entered into the SPSS package and processed, where codes and templates were developed. Descriptive statistical analyses were conducted and used to obtain means and percentages. In order to identify patterns of the major issues raised by research participants, content analysis and memoing were used to analyse the qualitative data. The data was displayed using tables, charts, and graphs.

3.0 Results and Discussions

3.1 Social Characteristics of the Respondents

Table 1's findings indicate that 68% (n=75) of respondents were males and 32% were females. This situation might have occurred by chance. These findings are in line with the fact that males outnumber females in higher education institutions in some regions of



African society for both socio-cultural and economic reasons. Also, the same scenario is happening in the fire and rescue team and units where male group appears to be high than females (Ndibalema, 2015).

Table 1: Social characteristics

Institutions	Sex (n=25)		Age (n=25)		Level of Education of Respondents (n=25)			
	M	F	18-34	35-60	C	D	BD	MD
IRDP	72.00	28	88.0	12.0	35.0	13.0	48.0	4.0
SJUT	68.67	32	92.0	8.0	17.0	19.0	56.0	8.0
UDOM	64.33	36	96.0	4.0	10.0	6.0	80.0	4.0
Total	204	96	276	24	62	38	184	16.0
Average (%)	68.00	32.00	92.00	8.0	20.6	12.6	61.3	5.3

n=sample, M=Male, F=Female, C=Certificate, D=Diploma, BD=Bachelor Degree, MD= Master's Degree, and (%) =percentage.

In terms of age, the majority of them (92%) were between the ages of 18 and 34 (Table 1). This indicates that the majority of them were grown enough to give views pertinent to early warning devices in their institutions. Furthermore, referring to education, the results in Table 1 indicate that more than half (61.3%) of them were pursuing bachelor's degrees, while 20.6% and 12.6% involved certificate and diploma programs, respectively. This implied that most of them were educated to the extent that they could be able to give out diverse views about early warning devices.

Most of them (92%) were between the ages of 18 and 34 in terms of age (Table 1). This shows that the majority of them were of an age where they could express opinions about devices used in early warning systems in their institutions. In addition, when it comes to schooling, Table 1's findings show that more than half of them (61.3%) were pursuing bachelor's degrees, while 20.6% and 12.6% of them were enrolled in certificate and diploma programs, respectively. This suggested that the majority of them were well-educated enough to be able to express a variety of opinions about functionality of the EWS devices.

3.2 Existing Early Warning Devices

We investigated respondents' knowledge of EWS systems. Figure 1's findings showed that most of them (80%) were aware of the early warning systems put in place in their buildings. Given that the EWS devices are placed and most residents are aware of their presence, this suggests that there is a chance of an emergency in the learning buildings. According to the findings at the institutional level, 88% (n=25) of respondents from UDOM, 84% from IRDP, and 68% from SJUT indicated knowledge of the installation of early warning devices. Those from the University of Dodoma were found to be more aware,



probably because the University of Dodoma offers a bachelor's degree program on environmental disaster management, which could make them more aware as they had also had practical sessions on the installed devices. This is in line with research from Sarevitz *et al.* (2010) and Genevieve (2018), which found that having a variety of EWS available within the institution increases knowledge of the problems associated with early warnings in terms of location and time.

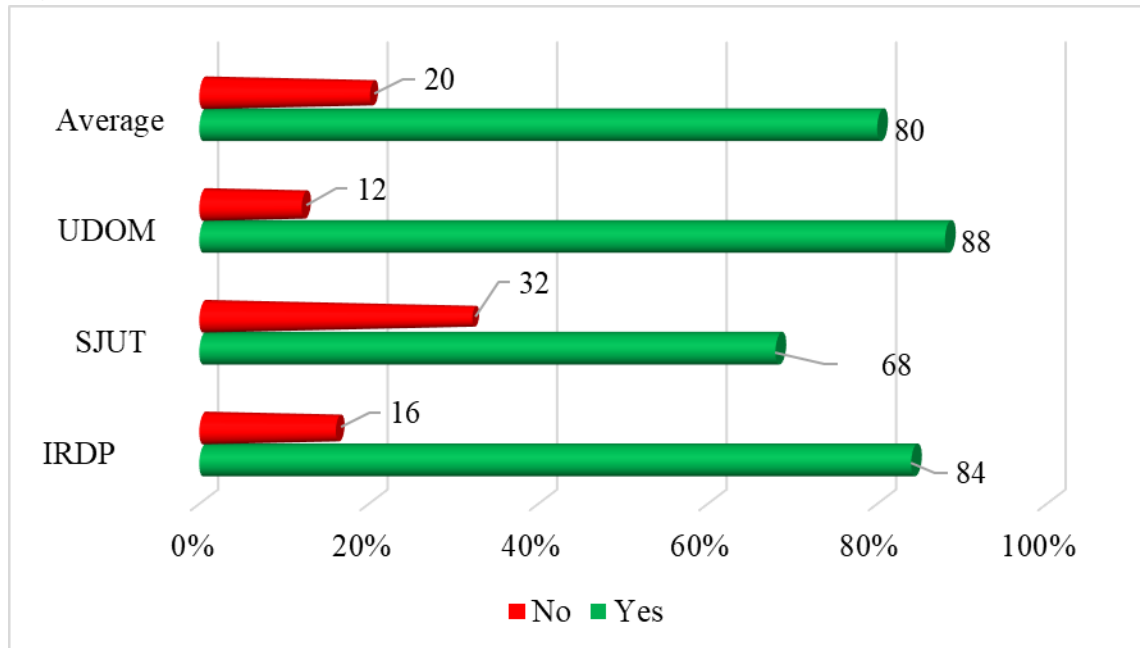


Figure 1: Awareness of the existing early warning devices.

Additionally, respondents noted the presence of early warning systems in their institutions, such as socket breakers, escape doors, smoke detectors, and fire extinguishers (Table 2). Fire alarms were also the highest rated among them (32.8%, Table 2). The current research also discovered that administrative offices, lecture halls, cafeterias, libraries, and dorms all had fire alarms installed.

Table 2: Early warning devices installations in the study area

Available EWS at the Institution	Fire Alarms	Fire Extinguishers	Exit Doors	Smock Detectors	Socket Breakers
IRDP (n= 25)	32.4	31.0	4.2	18.3	14.1
SJUT (n=25)	23.8	66.7	0	4.8	4.8
UDOM (n=25)	42.3	13.5	11.5	25.0	7.7
Total	98.5	111.2	15.7	48.1	26.6
Average (%)	32.8	37.1	5.2	16	8.9

n=sample, IRDP=Institute of Rural Development Planning, SJUT=Saint John's University of Tanzania, UDOM=University of Dodoma, and %=percentage.



Regarding the institutions' specific levels again, 42.3% of the respondents from the University of Dodoma mentioned fire alarms more than the other two institutions. This is most likely due to UDOM having a large number of new structures which complied the call of the building standards which requires installations of fire detection devices. Also, this sides up to the findings by Ringo *et al.* (2016) that in contrast to the university hostels, which have fire alarms, the majority of SJUT and IRDP students were living in off-campus hostels without fire alarms something danger to their life. Such danger is clearly presented by Nyariki, (2016) reported that students who were living off campus in Kenyan schools were the most affected by the fire outbreaks as they did not have the information that could be provided by the installed fire alarms if installed by the house/hostel owners. Additionally, the findings showed that 37.1% of the survey areas had access to fire hydrants and horse reels as fire extinguishers. We have seen them accessible during field trips in the cafeterias, libraries, administrative offices, lecture halls, and hostels.

Smoke alarms were also installed, as well (table 2). Regarding the aforementioned gadgets, we have also seen them in dormitories, classrooms, workplaces, cafeterias, and libraries. Additionally, the IRDP and UDOM received more responses of smoke alarms. Furthermore, smoke detectors were reported more often at the IRDP and UDOM. The reason for this variation could be the presence of many new buildings at those institutions when compared to the SJUT. In addition, Tanzania may have benefited from the African Monitoring for the Environment for Sustainable Development program by having a satellite receiving station installed at the Ministry of Natural Resources and Tourism for the purpose of early warnings and prompt response to fire occurrences. This could explain why there are so many devices in new buildings. Since then, new buildings have been built based on this concern. This aids decision makers in planning and making suitable decisions for fire prevention and control based on reliable information (Kekilia, 2016). Moreover, discussions with the Dean of Students at SJUT remarked:

"...The institution is facing financial deficiencies due to its dependence on student loans; hence, the construction of new buildings has to be slow, and the installation of early warning systems in those buildings is an alarming problem."

Additionally, socket breakers (8.9%) were present in the study areas. They are also present in the offices, libraries, cafeterias, lecture halls, and dormitories, as we have seen. Additionally, the current research found that the majority of the socket breakers responded automatically to any occurring electric signals. Exit doors were also noted as being present in the study area's buildings. None of the respondents regarding SJUT noted the presence of exit doors. However, researchers saw exit windows and entrances at SJUT, which were accessible over the nearby buildings. Unfortunately, the escape doors that were visible were not flashing to let people know they were okay to use in an emergency



and others had no arrows indicating safe paths to use in case of fire emergency. In the meantime, the SJUT Human Resources Manager explained during interviews that their institution has escape doors located throughout the buildings, and that the keys are left in the walls near those exit doors so that everyone can have access in case of an emergency. This is also an issue because it will be challenging to remember where the keys are in an emergency. The exit doors would therefore remain unlocked for this purpose.

We have also ranked the respondents' views on the available devices in their institutions (Table 3). Results revealed that the most common devices found in all institutions involved fire alarms and fire extinguishers. The situation might exist because fire outbreaks used to be a common source of emergencies in the study areas. Conversely, results indicate that exit doors were the least common device to be in place. The reason for this could be that the majority of the exit doors were placed in hostels, whereas the study was carried out in lecture halls and office buildings.

Table 3: Ranked early warning devices installations in the study area.

IRDP (n= 25)					
Available EWS	Fire alarms 32.4	Fire extinguishers 31.0	Smoke detectors 18.3	Socket breakers 14.1	Exit doors 4.2
SJUT (n= 25)					
Available EWS	Fire extinguisher 66.7	Fire alarms 23.8	Smoke detectors 4.8	Socket breakers 4.8	Exit doors 0
UDOM (n=25)					
Available EWS	Fire alarms 42.3	Socket breakers 25.0	Fire extinguishers 13.5	Exit doors 11.5	Socket breakers 7.7

n=sample, IRDP=Institute of Rural Development Planning, SJUT=Saint John's University of Tanzania, UDOM=University of Dodoma, and %=percentage.

3.3 Functionality of the Installed Early Warning Devices

The functionality of the early warning devices was assessed as it is the hub for having EWS. According to the findings in Figure 2, about half (50.7%, n=75) of the respondents believed the installed early warning systems were in operation. However 41.3% of respondents argued that they were unaware of the installed gadgets' capabilities. The smallest percentage of them (8%) thought the installed gadgets were not working. The implications of these findings are complex because nearly the same proportion of respondents who claimed that the devices were working also claimed not to be aware of it. This may be related to the fact that the majority of respondents who claimed they were unaware of how early warning systems worked had never been in an emergency situation where the systems might have been activated. Hence, their knowledge was somewhat limited to early warning systems. However, during field visits, particularly at UDOM, we discovered that the installed devices were still operational despite their lack of routine



maintenance. Additionally, the Director of the Institute of Rural Development Planning's Department of Development Planning and Management provided evidence that:

"...The installed devices at our institution are functioning, and the fire fighting and rescue force come twice a year to check if they are working or outdated."

Moreover, the Head of the Department of Geography at SJUT reported that there had been no emergencies at the institution, which could have affected the known functionality of the early warning devices since they are only triggered in emergency situations. This is a terrible situation and experience because, in the event of an emergency, it may exacerbate serious risks that could have been reduced earlier with early expert inspections. This illustrates a dearth of knowledge regarding the use of early warning systems and routine check-ups.

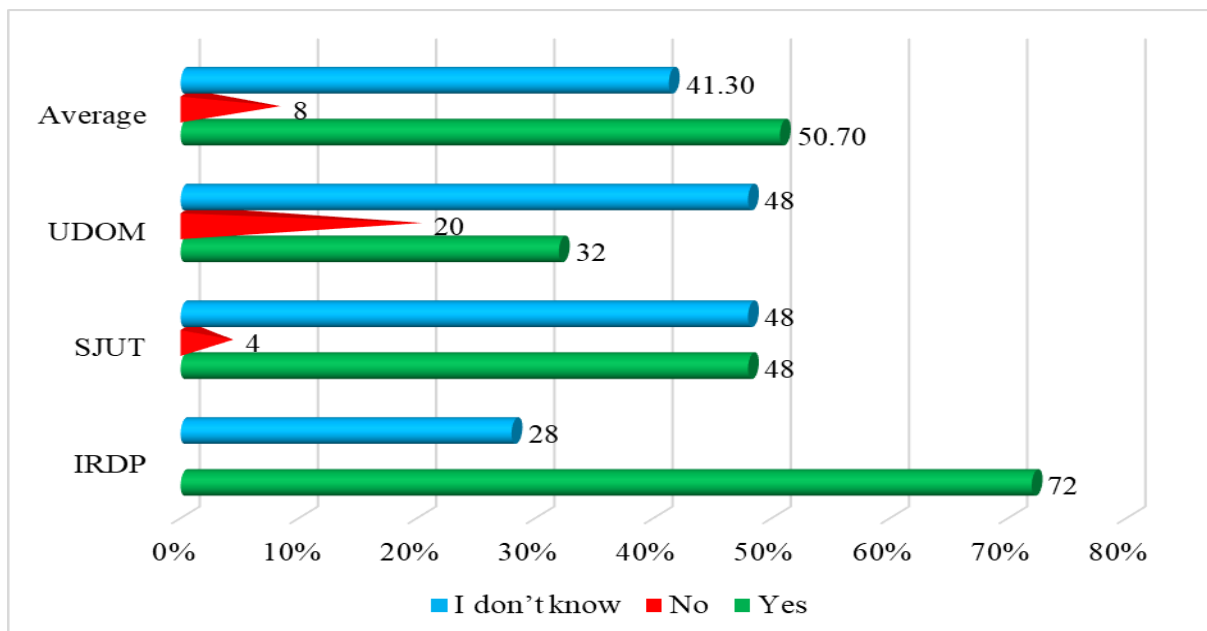


Figure 2: Views on the functionality of the installed early warning devices.

Furthermore, respondents were requested to state whether early warning devices were functioning. Results revealed that fire extinguishers were the most functional devices, as ranked by 37.9% (n=75) of them (see table 4). Fire alarms, exit doors, smoke detectors, and socket breakers are additional devices that should be considered in order of significance.

According to conversations with the lecturers, the director of the department of development planning and management, and the dean of students at IRDP, the installed fire devices used to undergo annual inspections by the fire fighting and rescue force. This might suggest that because of routine maintenance and inspections, fire extinguishers devices could be functional at any time. This is related to the idea that keeping early



warning systems operational helps ensure effective preparation for disaster response, as stressed by WMO (2005) and Ndibalema (2015).

Table 4: Early warning devices functioned

EWS which are functioning	Fire Alarms	Fire Extinguishers	Exit Doors	Smock Detectors	Socket Breakers
IRDP (n= 25)	32.3	32.4	5.9	16.2	13.2
SJUT (n=25)	25.0	62.4		6.3	6.3
UDOM (n=25)	50.0	18.8	18.7	12.5	
Total	107.3	113.7	24.6	35	19.5
Average (%)	35.7	37.9	8.2	11.7	6.5

n=sample, IRDP=Institute of Rural Development Planning, SJUT=Saint John's University of Tanzania, UDOM=University of Dodoma, and %=percentage.

Additionally, 35.7% of respondents stated that their fire alarms were working. However, it was asserted that those fire sirens caused confusion by shouting, especially when electricity was restored after being turned off, making it difficult for people to tell whether an emergency existed or not. Due in part to their lack of trust in the signals, it was unknown if they would be useful in an emergency. Additionally, in such circumstances, fire alarms should periodically be tested to make sure they are functioning correctly. Similar to this, Ringo *et al.*, (2016) stated that the public should be made aware of the early warning systems that are used in emergencies and that the systems should be tested beforehand to ensure that the public fully comprehends their significance and is prepared to act appropriately in an emergency.

Furthermore, smoke detectors were thought to be working at the time of our research (11.7%). However, it was revealed during the course of interviews with the Wardens at the UDOM that the majority of the smoke detectors in the institution were broken by the students who cook in the hostels, which is illegal. As a result, they are unable to activate and provide alerts that there is smoke in the room, which will have effects even in times of emergency because they were deactivated. Even in places with effective capacities for forecasting, detecting, and monitoring hazards and appropriate technologies for disseminating advanced warnings, translating warnings into actual local action is crucial, according to a study elsewhere by Sattelle *et al.* (2015) and a report by UNISDR (2016).

Similarly, 8.2% of the interviewees said that exit doors functioned. However, it was observed that some of the emergency exits and doors had not been used in a while and some of them were wire-locked (see figure 3). Due to the fact that they had not been used in a while, it was unknown if they could be used successfully in an emergency. As a result, Victor (2005), Mwachang (2015), and UNSDR (2015) proposed that emergency and exit



doors be tested yearly to make sure they are functioning correctly. The aim is to reduce deaths, injuries displacement, and property damage or loss.



Figure 3: Exit door locked with wire in the hostel.

Another device that was reportedly functional was a socket breaker. This study discovered that socket breakers were accessible in every building at the three institutions. The majority of the socket breakers, particularly at UDOM, deactivated the sockets when there were shocks or when students connected a device that was not working correctly. Sattelle *et al.* (2015) stress that the technical reliability of early warning systems (EWS) is a result of the failure probabilities of individual components and configurations in the system, and the inherent reliability of EWS is their ability to detect dangerous events and avoid their negative effects. The closer related emphasis was also raised by the study of Seyedin *et al.* (2020).

Table 5: Ranked functioning early warning devices

IRDP (n= 25)						
Device	Fire extinguishers	Fire alarms	Smoke detectors	Socket breakers	Exit doors	
	32.3	32.2	16.2	13.2	5.9	
SJUT (n= 25)						
Available EWS	Fire extinguishers	Fire alarms	Smoke detectors	Socket breakers	Exit doors	
	62.4	25.0	6.3	6.3	0	
UDOM (n=25)						
Available EWS	Fire alarms	Fire extinguisher	Exit doors	Smoke detectors	Socket breakers	
	50.0	18.8	18.7	12.0	0	

n=sample, IRDP=Institute of Rural Development Planning, SJUT=Saint John's University of Tanzania, UDOM=University of Dodoma, and %=percentage.

We have similarly ranked the devices that were more functional. Results in Table 5 revealed again that fire extinguishers and fire alarm devices were mostly functional. This is



because maintaining fire extinguishers and alarms is less expensive than maintaining other devices. For instance, the human resources manager explicitly stated in the IRDP that they yearly maintain the fire extinguisher by changing the extinguisher gas because it is more cost-effective for them than other devices. In contrast, the devices perceived as least likely to function were socket breakers and exit doors. The situation may be due to the fact that most of them were installed in the hostels, where they were few and others depreciated because stayed longer without maintenance.

To improve the functionality of the early warning devices, respondents and key informants had the view that there should be a provision of education and training related to EWS for both students and staff in the learning institutions (See figure 4). They have put forward the idea that institutions should introduce programs about early warning systems. Similarly, they proposed the establishment of unit(s) within the institution dealing with disaster management and related issues for a safer and resilient community against disasters.

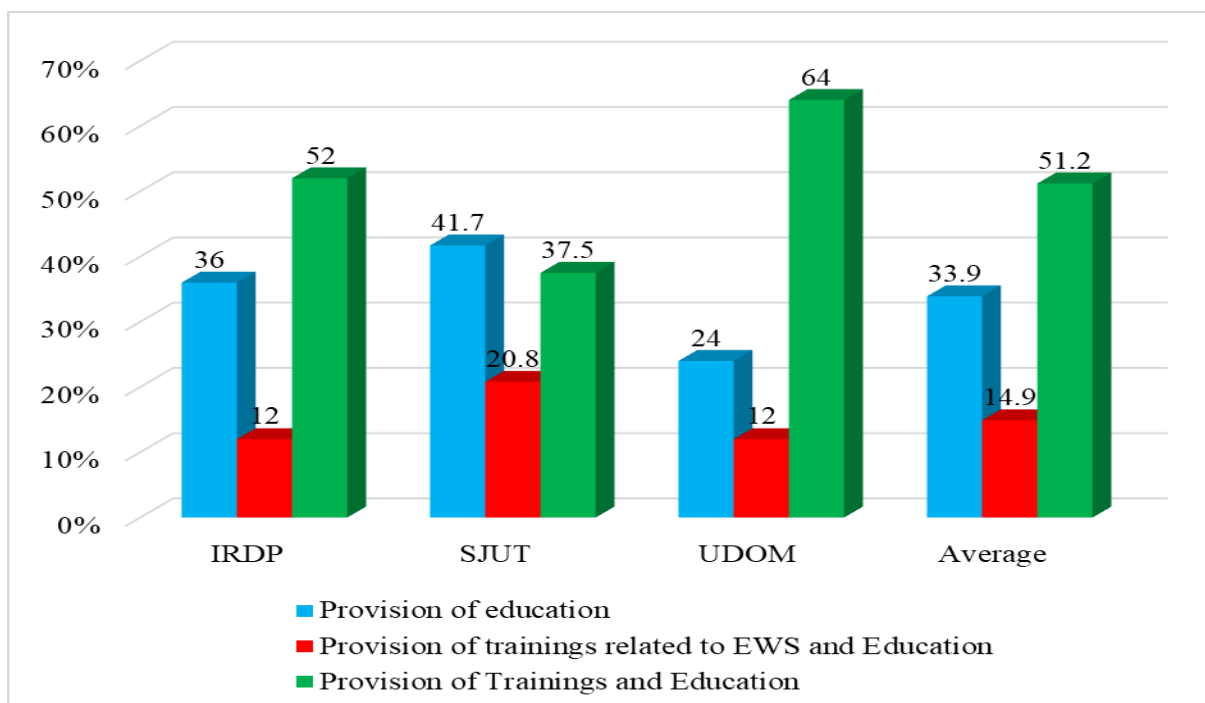


Figure 4: Suggestion to improve functionality of early warning devices.

4.0 Conclusion

It is evident from this study that early warning devices play an important role in all aspects of preparations for emergencies, hazards, and disasters in general, as well as the actual response during them. Effective installation of early warning devices and training to use them are similarly crucial for disaster management as people gain access to the security of their lives and resources. However, limited funding, inadequate training, insufficient regular check-ups, and a lack of disaster units in the learning institutions hinder the



effective operation of early warning devices. It is advised that the higher education institutions in Dodoma City organize programs to train both students and staff on the use of early warning systems, maintain regular inspections of the installed early warning devices, and coordinate issues related to disasters in higher education. These programs should be coordinated with the fire and rescue force. To help the community in Dodoma become familiar with early warning systems, institutions and organizations that deal with disasters should promote community-centred early warning systems in which the community is involved at every step.

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Conflict of Interest

Authors declare that this publication has no any conflict of interest and that they are responsible in case arise.

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