

# Assessing Non-Revenue Water Reduction Strategies by Water Service Providers in Kenya.

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## Abstract

This study assessed the Non-Revenue Water reduction strategies used by Water Service Providers in Kenya. High NRW affects the financial sustainability of many WSPs in Kenya. The objectives of the study are to ascertain the NRW reduction strategies being used and establish the level of NRW reduction strategy implementation. The study used mixed methods approach in conducting this study. The study also used stratified random sampling to select a sample of 61 companies from a target population of 81 active water companies in Kenya. The research design for this study was both descriptive and analytical in nature. A semi structured questionnaire was sent online to collect both qualitative and quantitative data from the respondents and analysed using SPSS. A reliability test was also done on the research instruments using factor method analysis. Four theories were reviewed during the study and the key ones being the Managerial Efficiency Theory and the Theory of Constraints. The findings of the study confirmed that all the NRW reduction strategies are being used by the water companies in Kenya. However, other strategies are widely used more than others. The findings also revealed that there are various factors that hamper the full implementation of NRW reduction strategies. The study recommends that management should allocate adequate resources and prioritize NRW reduction activities and fully implement NRW reduction strategies. Managers should also develop policies, procedures and build structures that help in implementation of NRW reduction interventions, leverage technology and ensure that the budget making process takes care of all NRW reduction strategies.

**KeyWords:** Non-Revenue Water, Strategic Water Loss Management, Sustainability Of Water Service Providers

## Introduction

The United Nations General Assembly set up Sustainable Development Goals (SDGs) which were adopted by all member countries in 2015 as a universal call for action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity by the year 2030 (UNDP, 2015). In line with the blueprint, “sustainable development goal number six (6) stresses on provision of safe and affordable drinking water for all by the year 2030 and requires that the member states invest in adequate water infrastructure, provide sanitation facilities, and encourage hygiene.”

According to Kingdom, et al., (2006) “the global volume of Non-Revenue Water (NRW) is staggering with more than 32 billion cubic metres of treated water being lost each year through leakages from distribution networks and an additional 16 billion cubic metres per year is delivered to customers but not invoiced because of theft, poor metering and, or corruption.” The agency report gave a conservative estimate of the total annual cost to water utilities worldwide as US\$ 14 billion and in some low income countries, this loss represent about 50-60% of the total water supplied, with a global average estimated at 35% (Sewilam & Rudolph, 2011). According to Shilehwa (2013), one of the major issues affecting most Water Service Providers (WSPs) in the developing countries is the high levels of NRW which means large water volumes are being lost hence seriously affecting the financial sustainability of most Water utilities.

Also, “Kenya’s Vision 2030 recognizes that this country is water scarce and therefore emphasizes on water conservation and prudent use of the limited available commodity (WASREB, 2020)”. In “the Auditor General’s Report 2017/18, it warned that high levels of NRW pose a threat to the financial sustainability of

the water sector and reiterated that such losses are also a significant risk to the nation's water security" (OAG, 2018). Given the current levels of NRW, "the sector would need to increase water production to two and a half times the current level to meet the existing demand in the country." OAG, (2018) report pointed out that "investing in water production and creation of new assets without solving the issues at the heart of NRW could jeopardize water access for future generations and affirmed that water is a limited resource and if not well preserved, then Kenyans will face a 30% gap between available freshwater supply and demand by the year 2030."

The government of Kenya in equal measure instituted specific strategies to raise the standards of the country's overall water supply and resource management among others. The National Water Resources Management Strategy (NWRMS) and the National Water Services Strategy (NWSS) as dictated for by the water act, 2016, which aim at ensuring that the water resources are conserved, maintained and NRW is reduced to 25% which is the acceptable level in Kenya (GoK, 2016). Accordingly, the Ministry of Environment, Water and Natural Resources in conjunction with the Japanese International Cooperation Agency (JICA) developed NRW management strategies and consistently help to plan, monitor and offer support to many WSPs in Kenya in order to reduce NRW and avail more water that could otherwise be lost to consumers (MEW&NR & JICA, 2014).

WASREB, (2019b) pointed out that "despite the efforts by the Kenyan government to bring reforms in the water sector through enactment of the water Act 2016, establishment of the sector benchmark approach by the Water Services Regulatory Board (WASREB) and the support by experts in implementing NRW reduction strategies, NRW is still a threat to the sustainability of many WSPs in Kenya". Researchers world over have conducted studies in the area of NRW. Al-Washali et al., (2019) carried out a study on the influence of the amount of water supplied to a distribution system on the reported level of NRW in The Netherlands. Another study was carried out on Parameter Classification System for NRW Management in Water Distribution Networks in China (Jang, 2018). On the same note, González-Gómez et al., (2016) undertook a study on why NRW is so high in so many cities in Europe in 2011. Equally, Veriava, (2019) did a study on NRW and non-revenue life, a reflection on the making and mitigating of water losses in Johannesburg, South Africa. Wambui, (2013) also carried out a study to assess the various factors in water provision that influence revenue generation by WSPs in Nyeri County, Kenya. Most of the scholarly articles published focused on practical guidelines on how to reduce NRW, while others focused on the processes required to design and implement an NRW losses strategy. (Farley & Trow, 2003; AWWA, 2006). None of the studies focused on assessing the effectiveness of the NRW reduction strategies.

This study therefore sought to assess whether all the strategies prescribed over the years by the government and other water sector partners are effective in the reduction of NRW in Kenya or just a few work and others do not work, because some WSPs managed to contain NRW to acceptable levels while others are still struggling with the implementation of the NRW reduction strategies hence not meeting their financial obligations and becoming sustainable in their operations.

### **Objectives of the Study**

The general objective of this study was to assess the Non-Revenue Water reduction strategies by Water Service Providers in Kenya.

### **Specific Objectives**

1. To Ascertain the Non-Revenue Water reduction strategies used and establish their level of implementation by Water Service Providers in Kenya.
2. To identify the drivers of Non-Revenue Water Reduction Strategies by Water Service Providers in Kenya.

## **Ethical Considerations**

While conducting this study, the researcher sought consent from the respondents before administering the questionnaires. The researcher also guaranteed confidentiality to the respondents and the information they provided. Protection guarantee and recourse to the respondents was duly granted by the researcher. The researcher got ethical clearance from the Ethics Review Committee of Pwani University which is accredited by National Commission for Science, Technology and Innovation (NACOSTI) after complying with all research codes and regulatory requirements.

## **Major Findings related to Non-Revenue Water Reduction Strategies used and the Level of Implementation by the Water Service Providers in Kenya**

### **1. Non-Revenue Water Reduction Strategies Used**

The findings of the study confirmed that all the NRW reduction strategies are being used by the water companies in Kenya. However, other strategies are widely used more than others. Those widely used by majority of the respondents are seven which include; Proactive Repair of Leaks and Bursts, Mobile meter reading, Impact Analysis and NRW Reporting, Formation of an NRW team, Creating NRW awareness and Use of GIS technology. The NRW reduction strategies that are not widely used are; Active Leak detection, Use of pressure management techniques, Formation of DMAs, Doing Water balancing, Meter Testing and Servicing, Location of Customer Meters at off-take points, Conducting Customer Identification Surveys and Outsourcing of NRW management.

### **2. Implementation Levels of NRW reduction Strategies**

The study findings revealed that (31%) of the respondents confirmed that the NRW reduction strategies that are fully implemented by most WSPs include; Benchmarking with other WSPs, Proactive repair of leaks and bursts, Mobile meter reading, Impact analysis and NRW reporting, Formation of a NRW team, Creating NRW awareness among Stakeholders and Use of GIS technology. The same strategies used by majority of the water companies were proved by (24%) of the respondents on average to be the same strategies implemented to a large extent by most of the water companies. According to (47%) averagely of the respondents, the strategies that are not implemented at all by most water companies are; Active Leak detection, Use of pressure management techniques, Formation of DMAs, Doing Water balancing, Location of Customer Meters at off-take points, Conducting Customer Identification Surveys and Outsourcing of NRW management services. The remainder of the average respondents (22%), confirmed that all fifteen (15) NRW reduction strategies are implemented by all the water companies but at different levels that is either implemented a little, half way or to a large extent within the water organizations.

## **Major Findings related to the drivers of Non-Revenue Water reduction by Water Service Providers in Kenya.**

The findings of the study revealed that there are various factors that hamper the full implementation of NRW reduction strategies. The study confirmed that the factors which impede the implementation of NRW strategies as given by the respondents are either human resource related such as lack of employee commitment, organisational policy related issues such as inexistence of policies and guidelines, financial constraints, or organisational structure related. Technological reasons, operational challenges and managerial or governance related issues were also mentioned as drivers of NRW reduction by water companies.

The study affirmed that the Boards of Directors in water companies have more responsibility in implementing NRW reduction Strategies. The findings also confirmed that Managing Directors/CEOs, Senior Managers, Middle Managers and Junior Staff have a great responsibility in implementing NRW reduction strategies. Over half of the water companies dedicate over 50% of their time in NRW management activities compared to the time allocated to other activities in the organisation. According to the findings, over 50% of the respondents also allocate more financial resources in combating NRW and place high priority on NRW management activities. Ultimately, the study confirmed that less than a tenth of the water companies in Kenya have their NRW level below the sector bench mark of 25% leaving nine tenths of all water companies above

the acceptable sector benchmark. The study gave the average NRW level for all water companies in Kenya at 42.31%.

### Conclusion

The NRW reduction strategies commonly used and implemented in full by majority of the water companies are only seven out of the fifteen strategies prescribed for use while the remainder, eight NRW reduction strategies are either not implemented at all or implemented but at different levels. The strategies being implemented in full are; Benchmarking with other WSPs, Mobile meter reading, Impact analysis and NRW reporting, formation of a NRW team, creating NRW awareness among stakeholders, and use of GIS technology. NRW reduction strategy implementation is affected by some drivers.

These drivers are financial resources, human resources, technological factors, organisational policies, organisational structure and technological factors. Other drivers of NRW reduction strategies include the level of responsibility by both the Board of Directors, the Managing Directors/CEOs, Senior Managers, Middle Managers and Junior Staff in water companies. Time allocation, financials resource allocation and prioritization of NRW reduction measures also proved to be key drivers in implementation of NRW reduction strategies. Finally, very few of the water companies in Kenya have their NRW levels below the sector benchmark of 25% leaving majority of all water companies above the acceptable sector benchmark which is an average of 42.3%. Finally, there is no apportionment of expenditures for NRW interventions in the budget to reflect the strategy focus hence making it difficult to measure the cost effectiveness of the NRW reduction strategies to be used by the water companies in Kenya.

### List of Tables

**Table 1: Response rate\**

	Number of questionnaires	Percentage
Response	52	85.2%
Non-response	9	14.8%
<b>Total</b>	<b>61</b>	<b>100%</b>

**Table 2: NRW reduction Strategies used by WSPs**

	NRW Reduction Strategies	Strategies Used (%)	Strategies Not Used at all (%)
X <sub>1</sub>	Leak Detection	60.80%	39.20%
X <sub>2</sub>	Proactive Repair of Leaks and Bursts	84.00%	16.00%
X <sub>3</sub>	Use of Pressure Management Techniques	54.90%	45.10%
X <sub>4</sub>	Establishment of District Metered Areas	64.70%	35.30%
X <sub>5</sub>	Doing Water Balancing	60.80%	39.20%
X <sub>6</sub>	Benchmarking with other WSPs	92.20%	7.80%
X <sub>7</sub>	Creating NRW Awareness among Stakeholders	82.40%	17.60%
X <sub>8</sub>	Mobile Meter Reading	84.30%	15.70%
X <sub>9</sub>	Meter Testing and Servicing	68.60%	31.40%
X <sub>10</sub>	Location of Customer Meters at Off-take Points	12.00%	88.00%

X <sub>11</sub>	Establishing a NRW Team	80.00%	20.00%
X <sub>12</sub>	Conducting a Customer Identification Survey	41.20%	58.80%
X <sub>13</sub>	Geo-mapping of Networks and Connections	82.40%	17.60%
X <sub>14</sub>	Doing Impact Analysis and NRW Reporting	86.30%	13.70%
X <sub>15</sub>	Outsourcing of NRW Management Activities	62.70%	37.30%

**Table 3: Implementation levels of NRW reduction Strategies**

Strategy	Not implemented at all	Implemented a little	Implemented half way	Implemented to large extent	Implemented in full
Leak Detection	39.20%	17.60%	25.50%	5.90%	11.80%
Proactive Repair of Leaks and Bursts	16%	22%	10%	28%	24%
Use of Pressure Management Techniques	45.10%	19.60%	17.60%	9.80%	7.80%
Establishment of District Metered Areas (DMAs).	35.30%	11.80%	27.50%	13.70%	11.80%
Doing a Water balance	39.20%	15.70%	23.50%	11.80%	9.80%

**Table 4: Part (ii) Implementation levels of NRW reduction Strategies Used.**

Strategies	Not implemented at all	Implemented a little	Implemented half way	Implemented to large extent	Implemented in full
Bench Marking with other WSPs.	7.8	15.7	31.4	29.4	15.7
Creating NRW Awareness among stakeholders	17.6	9.8	25.5	21.6	25.5
Mobile Meter Reading	15.7	11.8	11.8	15.7	45.1
Meter Testing and Servicing	31.4	5.9	15.7	21.6	25.5
Location of Customer Meters at off-take points	88	6	4	2	0

**Table 5: Part (iii) Implementation levels of NRW reduction Strategies Used**

Strategies	Not implemented at all	Implemented a little	Implemented half way	Implemented to large extent	Implemented in full
Establishment of NRW Team	20	18	18	14	30
Conducting a Customer Identification Survey (CIS).	58.8	2	13.7	9.8	15.7
Formation of a Geographical Information System (GIS) unit	17.6	15.7	17.6	23.5	25.5
Doing Impact Analysis and NRW reporting.	13.7	15.7	17.6	21.6	31.4
Outsourcing / Contracting of NRW management	37.3	3.7	23.5	15.7	19.6

**Table 6: Drivers of Active leak detection**

Drivers	Percentage
Inadequate staffing	8
Lack of system automation	11
Poor Commitment and seriousness by staff	6
Lack of leak detection equipment	42
Inadequate staff training on leak detection	10
Low implementation of recommendations	7
Lack of knowledge on handling equipment	16

**Table 7: Drivers of Proactive repair of leaks and bursts**

Drivers	Percentage
Slow response by staff	38
Large coverage area	34
Not all burst are attended	18
Minimal patrols	3
Non-reporting of bursts	7

**Table 8: Use of pressure management techniques drivers**

Drivers	Percentage
Leaks are attended when they happen	22
Timely inspections	17



Staff Patrols	11
Slow team reaction to complains	20
No pressure gauge	8
Lack of monitored flow	6
Lack of appropriate equipment	13
Lack of pressure management	3

**Table 9: Drivers of Established district metered areas**

Drivers	Percentage
Lack of right equipment	21
Lack of established DMA zones	12
Lack of adequate budget	18
Lack of commitment	23
Loops in the system	17
Non-implementation of proposals	3
Lack of proper demarcations	3
Non-detection of DMAs	5

**Table 10: Drivers of Doing water balancing**

Drivers	Percentage
Lack of a well-trained team	18
Adequate and strategic position	23
Non-quantification of losses	6
Lack of DMAs	2
Inadequate equipment	3
Data errors	11
Difficulties in comprehensive water balance	8

**Table 11: Drivers of Benchmarking with other WSPs**

Drivers	Percentage
Frequent benchmarking	21
Good relationship with stakeholders	12
Implementation of proposals and recommendations	18
Participation in WASPA workshops	5
Inadequate funding	23

Poor planning	17
Non-implementation of policies	3
Inadequate staff cooperation and Team work	3

**Table 12: Drivers of Creating NRW awareness among stakeholders**

Drivers	Percentage
Community sensitization and support	37
Awareness campaigns	28
Community and stakeholder engagement	11
Public forums in liaison with community leaders	10
Interdepartmental team building	3
Training and advocacy	8
Non-discussion of NRW	3

**Table 13 Drivers of Mobile Meter Reading**

Drivers	Percentage
Electronic meter reading (mobile phones)	43
Verification of reading before billing	19
Implementation of ERP systems	26
Manual meter reading (not using system)	5

**Table 14: Drivers of Meter testing and servicing**

Drivers	Percentage
Staff target on meter queries	31
Meter servicing	19
Qualified staff and meter testing	3
Lack of meters for replacement	38
Lack of meter testing equipment	8
Failure to address customer complaints	1

**Table 15: Drivers of Location of customer meters at off-take points**

Drivers	Percentage
Old fittings used	13
Cost complications	11



No value for money	21
Lack of customer willingness	18
Inadequate resources	28

**Table 16: Drivers of Meter Reading Anomalies Reduction Programme**

Drivers	Percentage
Address all anomalies	53
Follow ups of queries	17
Frequent checks and follow ups	13
Meter reversing	14

**Table 17: Drivers of Conducting a Customer Identification Survey**

Drivers	Percentage
Implementation challenge	53
Financial limitations	21
Management not concerned with CIS	17
Inadequate corporate sponsorship	9

**Table 18: Drivers of Geo-mapping of Networks and Connections**

Drivers	Percentage
A GIS technology in place	20
90% mapping of areas	31
Lack of validation of GIS	28
Non-implementation of systems	18
Lack of technical expertise	3

**Table 19: Drivers of Impact Analysis and NRW Reporting**

Drivers	Percentage
Lack of Input analysis	18
NRW ratio calculations not conclusive	12
Monthly reports	33
Training in the sections	21
Team commitments	16

**Table 20: Drivers of NRW Team formation**

Drivers	Percentage
Fully fledged team for NRW management	11
Unavailability of Equipment	28
Lack of responsible personnel	23
No proper job description	18
Lack of cooperation in the team	20

**Table 21: Time allocated on NRW Management by water companies.**

Time allocated	Frequency	Percentage	Measure of central tendency	Standard deviation
100%	9	17.3	Mean 58.85  Media 60  Mode 40	27.46
80%	11	21.2		
60%	9	17.3		
40%	14	26.9		
20%	9	17.3		

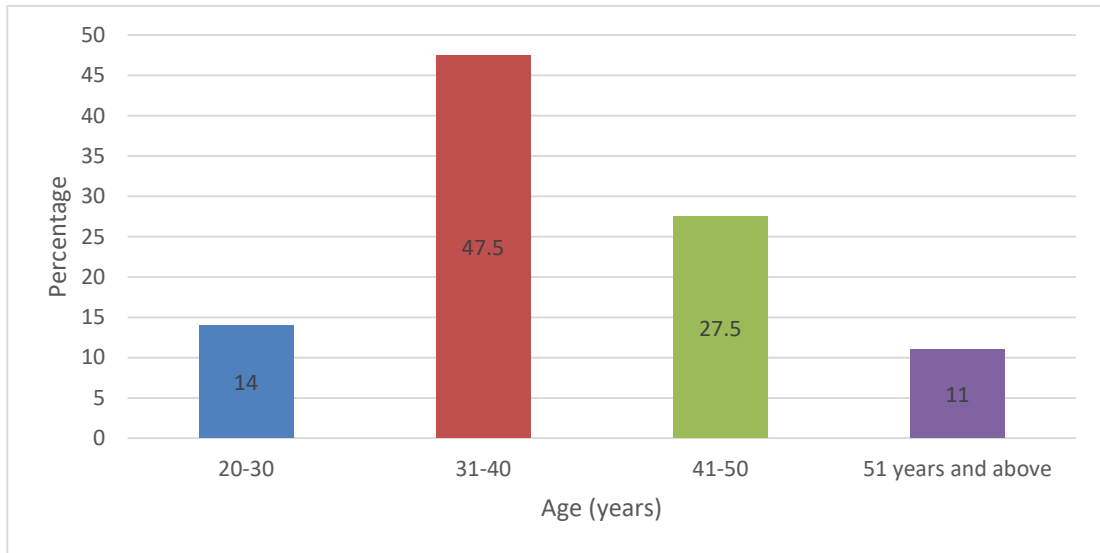
**Table 22: The NRW performance against benchmark.**

The overall NRW score (%)	Frequency	Percentage	Measure of central tendency	Std. Deviation
15	1	1.9	Mean 42.31  Median 40.50  Mode 37	13.712
18	1	1.9		
19	1	1.9		
23	1	1.9		
25	1	1.9		
27	1	1.9		
28	2	3.8		
30	2	3.8		
31	2	3.8		
32	1	1.9		
33	2	3.8		
35	2	3.8		
36	1	1.9		
37	5	9.6		
38	1	1.9		
40	2	3.8		
41	1	1.9		
42	3	5.8		
43	1	1.9		
44	1	1.9		
45	2	3.8		
47	1	1.9		

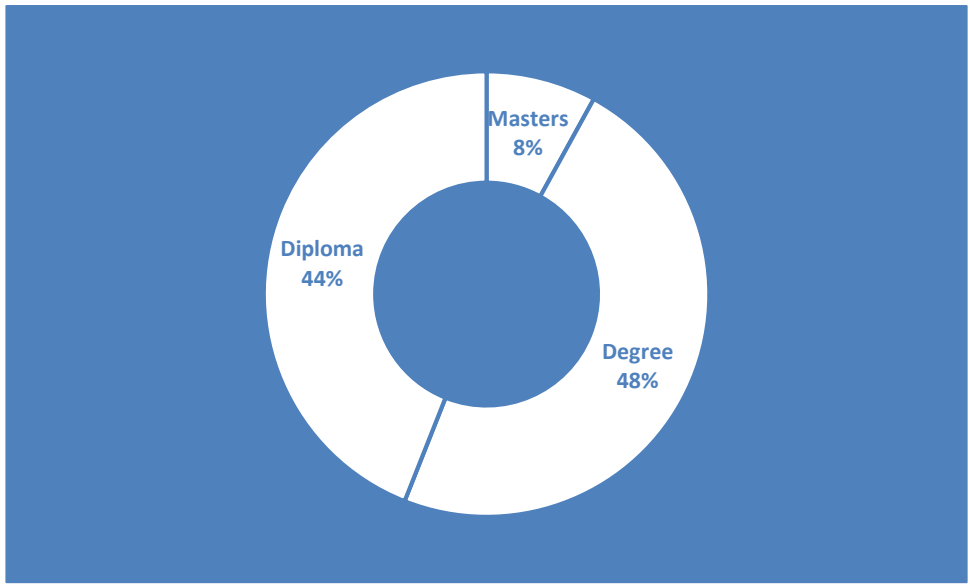
48	1	1.9		
51	1	1.9		
52	1	1.9		
53	1	1.9		
54	1	1.9		
57	2	3.8		
58	4	7.7		
59	1	1.9		
62	1	1.9		
65	1	1.9		
67	1	1.9		
69	1	1.9		
71	1	1.9		
<b>TOTAL</b>	<b>52</b>	<b>99.1</b>		<b>13.712</b>

**LIST OF FIGURES**

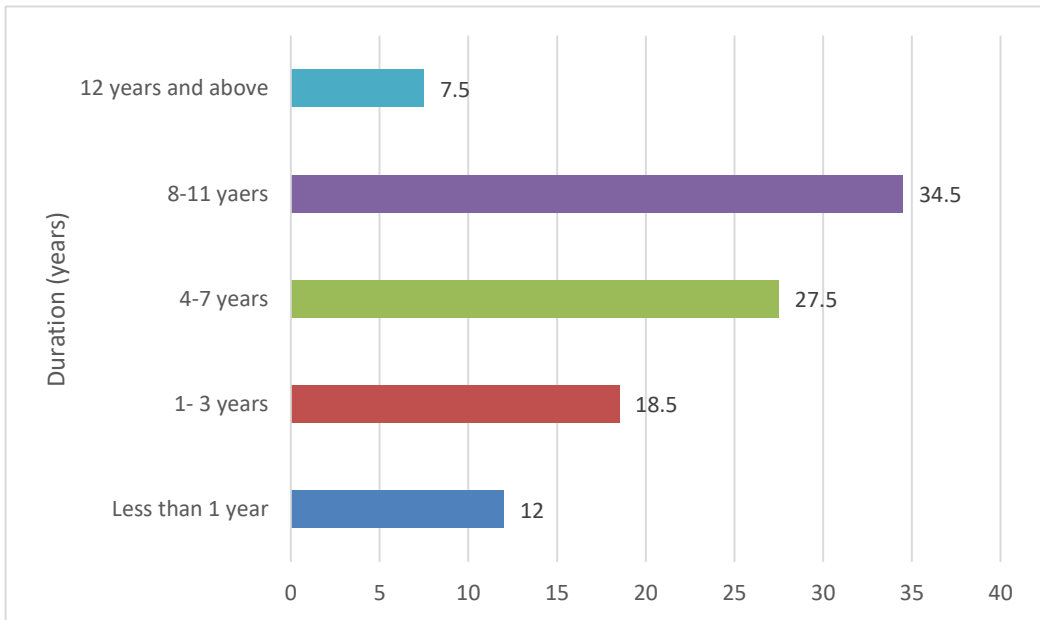
**Figure 1: Distribution of respondents by Age**



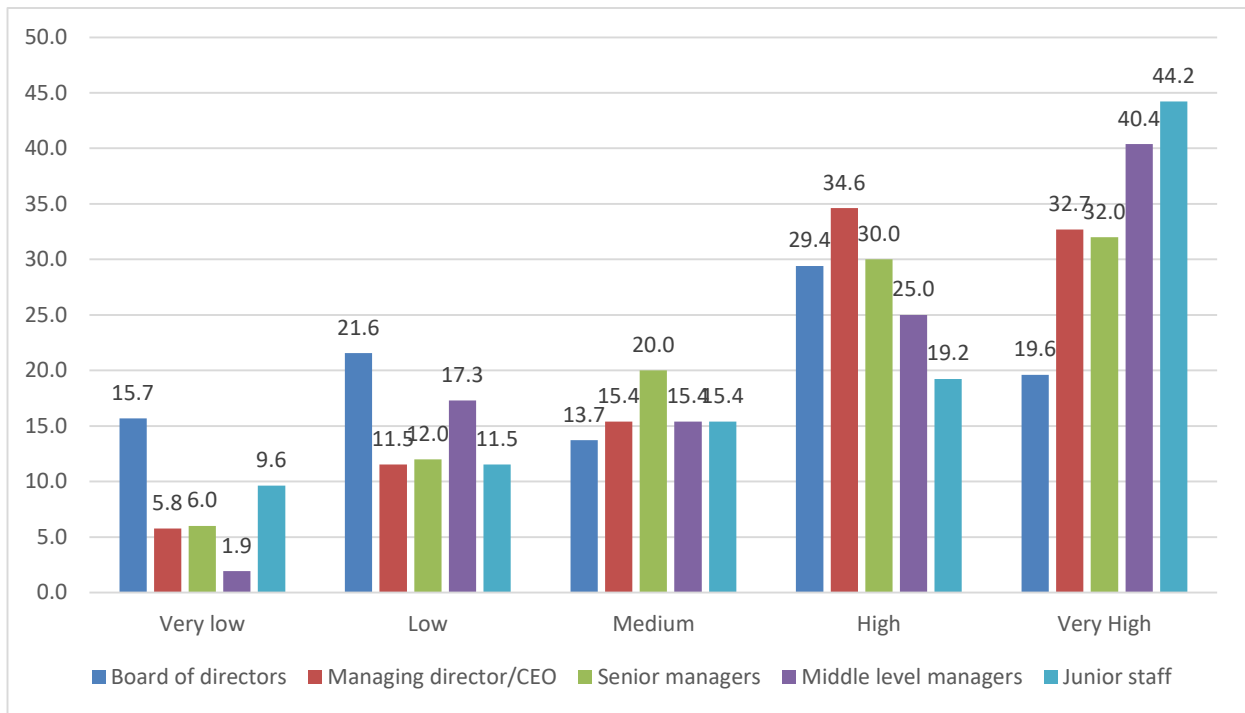
**Figure 2: Distribution of the respondents by Education Levels.**



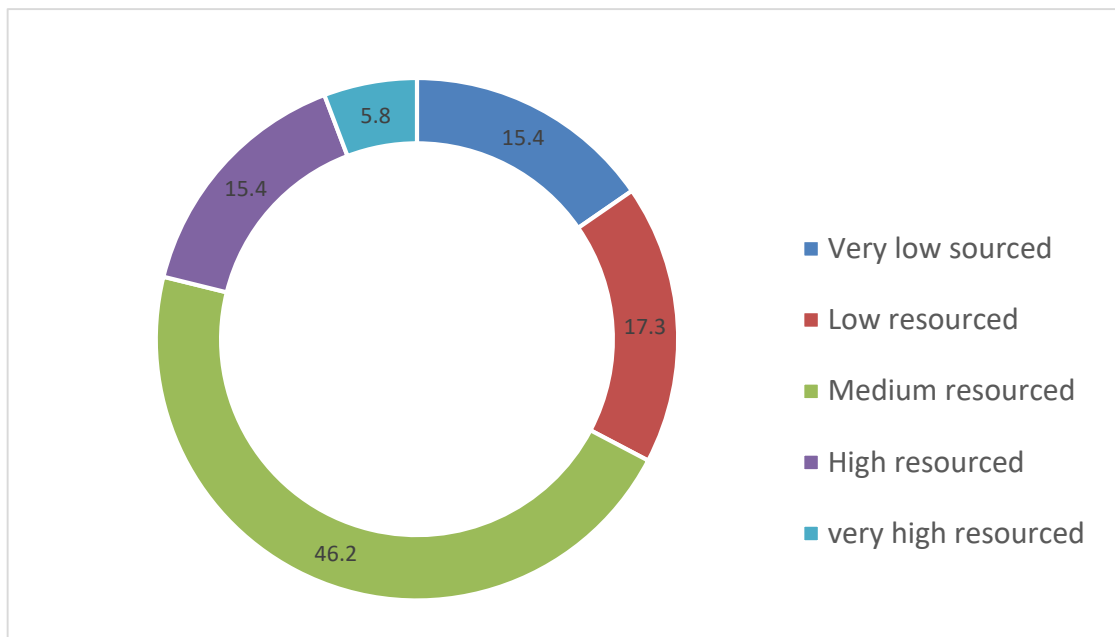
**Figure 3: years of experience with the organization**



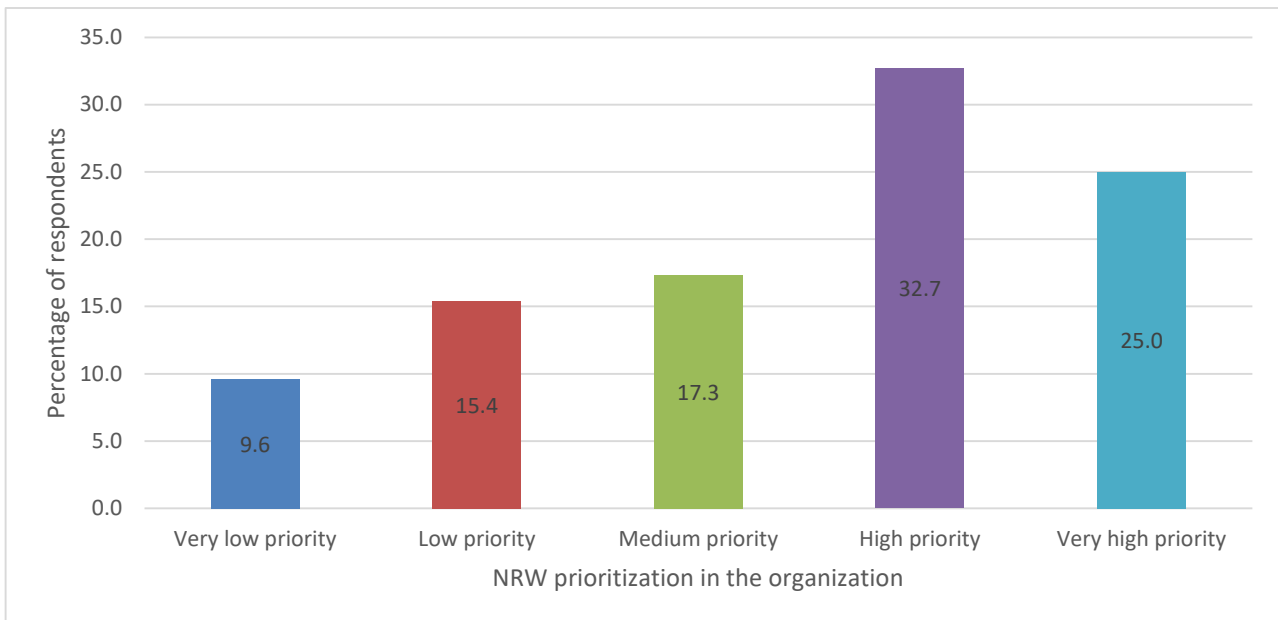
**Figure 4: Level of responsibility in implementing NRW reduction strategies**



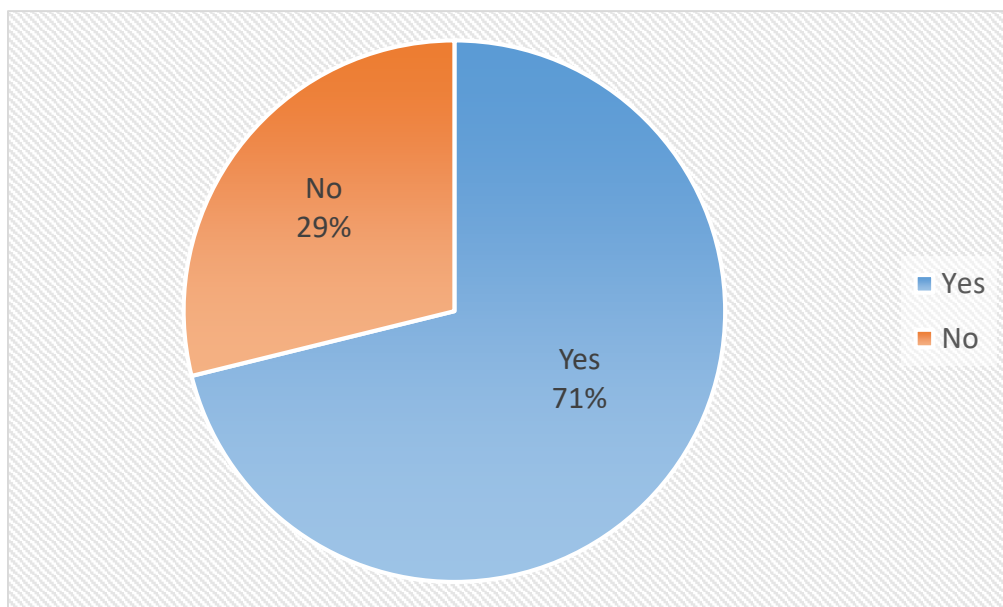
**Figure 5: Financial Resources deployed to Combat NRW**



**Figure 6: Prioritization of NRW reduction Strategies used in the companies.**



**Figure 7: Budget allocation for NRW activities**



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