Incidents and Impacts on Operator Revenue in the Telecommunications Sector

A Multiple Case-Study Approach

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Abstract: This study adopted a multiple case-study approach to investigate incidents, their impacts on performance, and revenues in the telecommunications sector using data from Ghana. The study used open-ended qualitative interviews and document review methods. The study performed a thematic analysis with the Atlas TI software program to analyse the qualitative dataset. The findings resulted in a model dubbed the "Telecommunications Sector Incidents Framework", which reveals that faulty hardware, end-of-system life, cell site congestion, power failure, microwave link failure, fibre failure, and Wi-Fi disconnection are among the incidents prevalent in the telecommunications sector. The framework also reveals that the incidents occur frequently, resulting in an average revenue loss of GH₵2 to 3 million ($182K to $273K) per month. Again, it reveals that employees become demoralized due to a lack of work-life balance, sleepless nights, frustrations, and undue pressure, which affects their productivity levels. With this framework, mobile network operators (MNOs) could get a better understanding of the incidents to keep their occurrences to a manageable level, create an exceptional customer experience by reducing churn, and increase revenues.

Keywords: Incidents, Telecommunications, Impacts, Revenue, Case Study

Introduction

The availability of telecommunication services is a vital concern for society today. People's lives are reliant on their availability, making these services indispensable (Bukhsh *et al.*, 2020). These services are among the key services of every country as they serve and promote other industries to thrive, such as banking, media, advertising, agriculture, health, education, and construction (Nguyen & Tran, 2023; GCT, 2019). When there is a disruption in these services, it in turn leads to decreased quality of life and the potential loss of life or property for

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citizens and subscribers (Bukhsh *et al.*, 2020). These service disruptions are termed incidents, and this is defined by the ISO 20000-1:2011 standard as "an unplanned interruption to a service, a reduction in the quality of a service, or an event that has not yet impacted the service to the customers" (ISO, 2005).

Incidents are considered to be the most difficult challenges in the telecommunications sector. In view of this, failure by mobile network operators (MNOs) to ensure infrastructure resilience and reach makes network reliability a pain point for subscribers (Maya, 2023). A study by Ernst & Young (EY) shows that households constituting 27% in Canada, 26% in France, 24% in Germany, 34% in Italy, 32% in Spain, 22% in Sweden, 27% in the UK, and 33% in the USA frequently experience unreliable broadband connections, resulting from outages, dropped signals, and buffering during streaming (EY, 2023). Bukhsh *et al.* (2020) added that the incidents occur because of system malfunctions, natural disasters, human errors, and attacks that can compromise their availability. Adel (2021) highlights the potential for software vulnerabilities, misconfigurations, outdated systems, and systemic deficiencies in telecommunication services to compromise enterprise assets and cause an initial network failure. Addressing subscribers' complaints effectively based on these incidents is a significant challenge to reducing churn and enhancing security in the telecommunications sector (EY, 2023).

The resulting effect of these incidents is that they can lead to decreased customer satisfaction and loyalty, potentially causing customers to switch providers or demand compensation, resulting in lower revenues and higher churn rates. Similarly, in employees' quest to troubleshoot and restore services, it can cause stress, affecting employees' evening and family time, leading to a decrease in responsible use of technology, negatively impacting organizational performance (Tams *et al.*, 2022; Asentria, 2020).

In the literature review, Bukhsh *et al.* (2020) concluded that there is lack of scientific reports on real-world telecommunication incidents and that this is likely due to confidentiality constraints. Most scientific interest is focused on incidents' method definition (Nawawi & Salin, 2018; Salah *et al.*, 2018; Hu *et al.*, 2017; Zee *et al.*, 2017; Fabian *et al.*, 2015; Carrillo & Chamorro, 2014; Hiran *et al.*, 2013; Luo *et al.*, 2013; Chen & Chou, 2012; Paolino *et al.*, 2011). For instance, a study by Nawawi & Salin (2018) found that employees' carelessness, poor knowledge, and clear intention to act dishonestly contribute to incidents in the telecommunications sector in Malaysia. Also, Carrillo & Chamorro (2014) proposed the adoption of the eSUPERTEL system to gather data on claims, complaints, suggestions, and failures in the provision of telecommunications services. However, as argued by Bukhsh *et al.* (2020), real-world telecommunication incidents and the amount of potential revenue lost by virtue of these incidents are scarcely discussed in the literature.

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As a result, this study sought to establish real-world incidents, their impacts on performance, and revenue, using data from the telecommunications sector in Ghana. The reason is that incidents are more profound and imminent in developing countries due to infrastructure challenges (EY, 2023). This is evidenced in the telecommunications sector in Ghana, as the sector faces various looming challenges in the form of fibre cuts by road contractors and cable theft, resulting in poor quality of service to subscribers. The severity of the incidents made the regulator, the National Communication Authority (NCA) in Ghana, impose a fine to the tune of $6.9 million on the MNOs, namely MTN, Vodafone, and AirtelTigo (Maseko, 2019). While these MNOs and their subscribers experience such incidents, little or no study has been done holistically to establish them and assess their impacts on revenues.

The study used a multiple case-study approach, as it provides great understanding about the differences and similarities between the cases, and its findings are considered strong and reliable (Creswell, 2014; Saunders *et al.*, 2012). The findings of this study could therefore be used as a reference point by policymakers to keep incident occurrences to a manageable level, create an exceptional subscriber experience by reducing churn, and increase revenues in the telecommunications sector. Additionally, the findings would add to the body of knowledge. In view of this, the study sought to answer the following research questions:

1. What are the incidents at the MNOs' workplaces?
2. How do the incidents affect performance?
3. Approximately how much revenue is potentially lost due to the occurrence of these incidents?

The remainder of the study begins with the literature review, followed by the presentation of the methodology, findings, and discussion, and, lastly, the conclusion and recommendation.

Literature Review

The literature review is divided into two sections: the concept of incidents in the telecommunications sector in general and the case of the Ghanaian telecommunications sector.

The concept of incidents in the telecommunication sector in general

An incident is explained as an unplanned and undesired interruption or event that may not result, or only minimally result, in a loss, damage, or injury due to favourable circumstances (Wienen *et al.*, 2017). Similarly, ENISA (European Union Agency for Network and Information Security, 2017) added that an incident is a series of events and failures, often triggered by multiple causes. For example, an incident could be caused by a storm or heavy

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winds, which may damage power supply infrastructure, resulting in a power cut and later outage as base stations are without power. To explicitly explain the incidents in the telecommunications sector, ISO (2005) said an incident is an unplanned and undesired interruption to a service, a reduction in the quality of service, or an event that has yet to impact the service to the customers.

The literature review on incidents in the telecommunication sector in general reveals that almost all the modern scholars have focused on incident detection and analysis methods (Diop *et al.*, 2023; Koutras *et al.*, 2023; Quek *et al.*, 2023; Tham *et al.*, 2023; Ducca & Margi, 2022; Gibilinda *et al.*, 2022; Adel *et al.*, 2021; Kuchar *et al.*, 2020; Puangnak & Chivapreecha, 2019; Salah *et al.*, 2018; Bloomfield *et al.*, 2017; Fagade *et al.*, 2017; Hu *et al.*, 2017; Nugraha & Legowo, 2017; Choi *et al.*, 2016; Gai *et al.*, 2016; Ordonez *et al.*, 2016; Zaman *et al.*, 2015; Carrillo & Chamorro, 2014; Hiran *et al.*, 2013). For instance, a study by Quek *et al.* (2023) about customer churn prediction proposes a customer churn prediction model using attribute selection analysis and support vector machines. The model improves prediction performance by identifying significant customer data attributes, enabling proactive actions to retain customers, especially with larger database samples.

Also, a study by Koutras *et al.* (2023) about an automated Wi-Fi incident detection attack tool on IEEE 802.11 networks presents a methodology for detecting intrusions from Wi-Fi networks using WiFi-NID. This tool is designed to automate the detection of illegal network scanning attacks at the Wi-Fi access layer. Similarly, a study by Carrillo and Chamorro (2014) about mobile systems for recording incidents in telecommunications in Ecuador proposes the use of eSUPERTEL (Superintendence of Telecommunications) mobile systems for recording incidents in telecommunications services, in order to provide an efficient online customer service channel, contributing to the dissemination of eParticipation and eDemocracy in Ecuador. The aforementioned studies provide valuable methods for incident detection and analysis suggesting that the incidents do occur in the telecommunication sector; however, they do not establish the actual incidents in the real-world telecommunication context and, to a large extent, do not discover the potential revenue loss due to these incidents.

Although a media report by Jacobs (2022) at techtarget.com outlines some common network issues that MNOs face, namely: VLAN and VPN problems; exhausted IP addresses; duplicate and static IP addresses; slow DNS lookups; excessive CPU usage; physical connectivity issues; weak Wi-Fi signals; and slow networks. For instance, he defines excessive CPU usage as whenever a great quantity of system resources, such as CPU, memory, or disk space, are utilized. But there is no scientific study found in the literature, to the best of the researcher's knowledge, validating these suggested incidents.

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Moreover, with respect to factors that bring about incidents in the telecommunications sector, Maya (2023) explains that MNOs face challenges in sustaining infrastructure to satisfy customer demand, intensified by soaring data usage, the digital divide, and the affordability of services, affecting calls and infrastructure. Additionally, ENISA (2017) classified factors that cause incidents into four main areas: system failures; human errors; malicious actions; and natural phenomena. However, within the context of this study, malicious actions are conceptualised as infrastructure incidents, as illustrated in Figure 1.

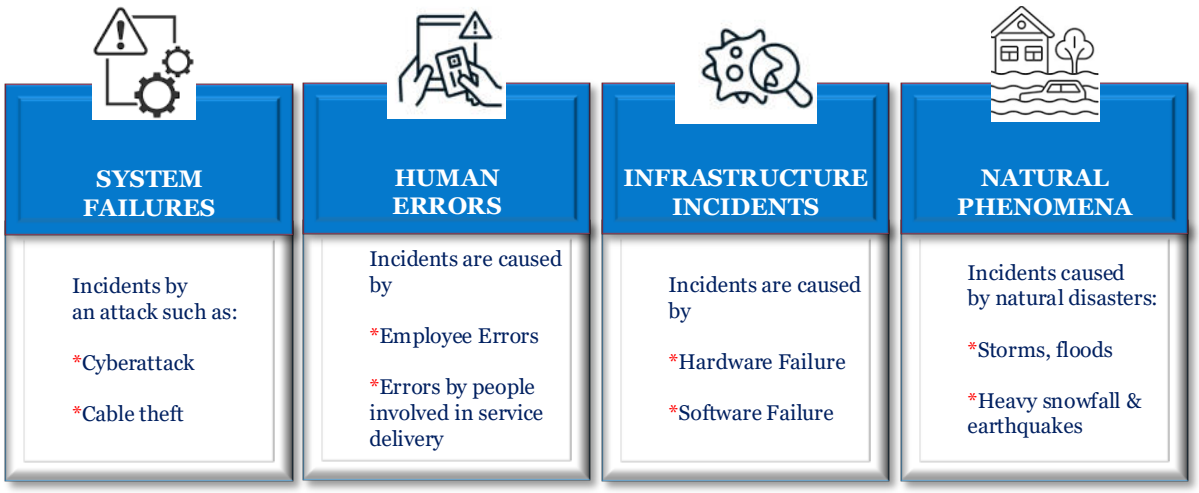

Figure 1: Incidents causal factors classifications (Source: Researcher's own construct based on ENISA classifications)

From the above discussion, it is evident that little has been done to establish the incidents in the real-world telecommunication context, their impact on MNO performance, and, to a large extent, to discover the potential revenue loss due to these incidents; hence, the relevance of this study.

The case of the Ghanaian telecommunications sector

The Ghanaian telecommunications sector is one of the strongest and most competitive in West Africa. This sector, as of January 2023, has 39,812,171 mobile voice subscriptions, constituting 125% of mobile voice penetration, and 22,756,215 total data subscriptions, constituting 72% of mobile data penetration. This sector contributed 22.8% to Ghanaian GDP in 2022 (Ghana Chamber of Telecommunications, 2023; GCB Strategic and Research Dept, 2023).

Unfortunately, after several iterations of searching through databases that contain publications for major journals and conference proceedings, namely Scopus, IEEE Explorer, Springer, and ScienceDirect, with a search string "Telecommunication AND Incident AND Ghana AND (Disruptions OR service downtimes)", all the incidents returned results did not relate to the Ghanaian telecommunications sector. This, therefore, suggests that there is a lack of scientific research on real telecommunications incidents and the corresponding revenues

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lost from the perspective of MNOs, which could have been realized to enhance the sector's contribution to economic development through taxes and infrastructure investments.

Table 1. Fines for MNOs by the Telecommunications Regulator in Ghana

Source	Title	Reasons	MNO	Amount Fined	Date
NCA.org.gh	NCA sanctions MTN for failing to comply with directives on the network challenges	Subscriber challenges with billing inaccuracies regarding the purchase of their telecommunications service bundles.	MTN	**GH₵**110,000 (**$**19,298)	2019
NCA.org.gh	Telcos sanctioned GH₵34M for failing quality of service tests.	MNOs were unable to meet their license key performance indicators (KPIs) in some district capitals with regards to QoS obligations for coverage, data, voice, and speech quality.	AirtelTigo	**GH₵**11,635,000 (**$**2.36million)	2018
			Glo	**GH₵**4,460,000 (**$**1.84 million)	
			MTN	**GH₵**9,080,000 (**$**1.79 million)	
			Vodafone	**GH₵**8,890,000 (**$**906,682)	
Venturesafrica.com	Ghana regulator fines mobile operators $461,000.	For defaulting on call congestion and call setup time obligations in three regions.	MTN	**GH₵**350,000 (**$**170,000)	2013
			Tigo	**GH₵**250,000 (**$**125,000)	
			Expresso	**GH₵**200,000 (**$**100,000)	
			Glo	**GH₵**200,000 (**$**100,000)	
			Airtel	**GH₵**50,000 (**$**25,000)	
Modernghana.com	The Chamber of Telecommunications reacts to NCA penalties.	Poor service.	MTN, Vodafone, Tigo, Airtel and Expresso	**GH₵**1.2million (**$**300,000)	2011

NB: **Expresso** has ceased trading**; Tigo, Glo** and **Airtel** have been merged and are now called **AirtelTigo.**

In the absence of scientific research, this study relies so much on some media and regulatory reports about some purported incidents in the sector. A report by the regulator, the National Communications Authority (NCA), in Ghana indicates that it performs telecommunications quality of services (QoS) tests on a quarterly basis, such as obligations for coverage, data, voice, and speech quality (NCA, 2023). When the incidents are beyond the measuring metrics, then it imposes a fine on the perpetrator MNO. For instance, as illustrated in Table 1, in 2019, NCA sanctioned MTN to the tune of GH₵110,000 ($19,298) for failing to comply with directives on subscribers' experience about billing inaccuracies regarding the purchase of their telecommunications service bundles (NCA, 2019). Additionally, NCA fined all the MNOs GH₵34 million ($6.8 million) in 2018; $461,000 in 2013; and GH₵1.2 million ($300,000) in 2011; for failing quality of service tests (NCA, 2018; venturesafrica.com, 2013;

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modernghana.com, 2011). However, neither the regulator nor the reporters indicated the factors that accounted for the service disruptions by the MNOs.

Conversely, there is a report by the Ghana Commercial Bank Strategy and Research Department (2023) about the telecommunications sector that suggests that factors such as the destruction of telecom equipment through construction, a lack of proper infrastructure, an increase in competition, and theft may pose a risk of incidents for consideration by the MNOs in Ghana. Similarly, a report by Maseko (2019) at itnews.com indicates that subscribers experienced various degrees of network disruptions from their mobile network operators in Ghana, which were purported to have come as a result of fibre cuts by road contractors and cable theft. But there is no scientific study based on the literature search results that validates such claims. Therefore, the study seeks to explore the network incidents in this sector and their impact on performance and revenues.

Methodology

This section presents the methodology for the empirical research conducted in this study, as illustrated in Figure 2.

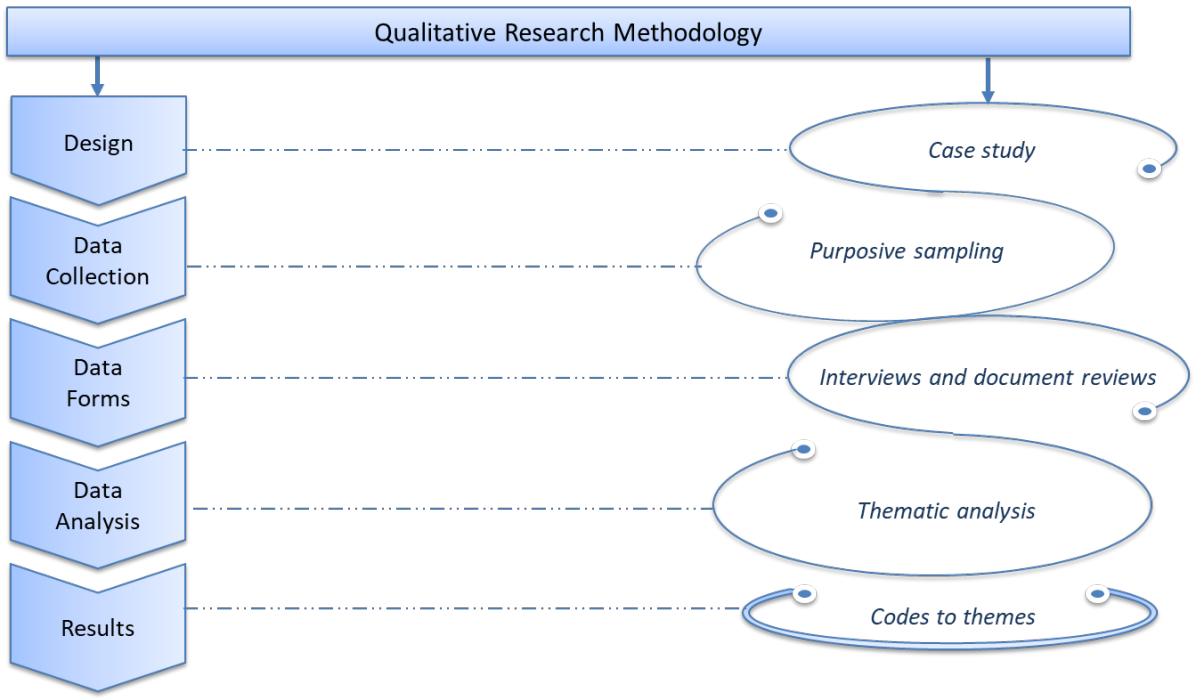

Figure 2. Qualitative research methodological model (Source: Researcher's own construct)

From Figure 2, the study adopted a case study, specifically a multiple-case study, approach, as it offers the opportunity to gain an in-depth understanding of the issues, by identifying common patterns, relationships, and differences between the cases, and the findings are considered strong and reliable (Creswell & Poth, 2018; Yin, 2018; Creswell, 2014; Baxter & Jack, 2008). Therefore, the study chose this research design with the aim of gaining a

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comprehensive understanding and providing new insights into the incidents, their impacts on performance, and revenues in the telecommunications sector using data from Ghana.

Sampling and data collection procedure

The study used all three MNOs in Ghana, namely, MTN, Vodafone, and AirtelTigo (AT). Each MNO constitutes a case, and all three consist of multiple cases within the bounded system, as explained by Creswell & Poth (2018). Within each operator, the study selected six employees through purposive sampling, as it is used to select respondents who are most likely to provide relevant and useful information (Robinson, 2014; Kelly, 2010).

Table 2. Demographic profile of participants

MNO Code	Participant's Code	Gender	Position	Years with MNO
#A	A1	Male	Product Manager (data)	2.8 years
	A2	Male	IT systems Engineer	4.4 years
	A3	Male	Revenue Performance Analyst	8 years
	A4	Male	Head, Performance and Planning	8 years
	A5	Female	Network Engineer (Service Quality)	3.5 years
	A6	Female	Business Intelligent Analyst	5 years
#B	B1	Female	Head, Usage and Retention	10 years
	B2	Male	Sales Incentive Manager	8 years
	B3	Female	Network Engineer	3 years
	B4	Female	Data Specialist	5 years
	B5	Male	IT systems Engineer	4 years
	B6	Female	Business Intelligent Analyst	5years
#C	C1	Male	Head, Direct Sales	3.4 years
	C2	Male	Revenue Assurance Manager	8 years
	C3	Female	Network Quality Engineer	3.6 year
	C4	Male	Head, Product & Innovation	8 years
	C5	Male	Sales Supervisor	5 years
	C6	Female	IT systems Engineer	6 years

Within each case, as presented in Table 2, the study selected three employees from the network and IT departments, whose functional roles are network quality engineer, IT systems engineer, and business intelligence analyst. These employees manage the network infrastructure, systems and platforms, and the intent was to understand the incidents from the technical point of view. Additionally, the study selected the other three within the commercial functions, namely, product management, sales, and revenue assurance, with the aim of obtaining information about the revenue impacts from these incidents. These selected employees were widely recommended within their respective operators based on their levels of experience in

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the subject matter, with a minimum of 2.8 to 10 years of experience in their roles, as shown in Table 2.

In the data collection phase, the study used open-ended interviews via a telephone interview method and document reviews, specifically MNO incidents posted on Facebook, as recommended by Yin (2018). The study used the telephone interview method because of its obvious benefits of cost effectiveness and time efficiency (Taylor, 2002; Gibson & Cohen, 2003). The intent of the open-ended interviews was to delve into the subject matter and probe it to greater depth while also allowing for free expression of thoughts by the participants (Chenail, 2011). The interviews were carried out between the hours of 12 p.m. and 2 p.m., as recommended by the participants as their most convenient times.

Data analysis

The study used thematic analysis to analyse the qualitative dataset. In view of this, the study used Atlas ti. to create quotations after data familiarization, assign codes, and develop themes, as using such software is a faster and more efficient way of storing and locating qualitative data (Creswell, 2014). The study upheld ethical considerations by providing the MNOs and the participants with pseudonymized codes **#A** to **#C** and **A1-A6** to **C1-C6,** respectively, to protect their identities, as presented in Table 2. The study used ideas from concept mapping and innovation concepts by Miles *et al.* (2014) and Novak & Cañas (2006), respectively, to develop figures and models for illustrating the findings.

Presentation of Findings

As a preamble to the interview findings, the study sought to establish the occurrence of incidents by reviewing the MNO communication posts on Facebook from September to August 2023. The complete findings of the reviews are presented in Appendix 1 and the summary is shown in Table 3. It was revealed that incidents with minor service quality impacts are communicated through short message service (SMS) to subscribers, and the major impacts are posted on social media in addition to SMS. The study established that incidents are inevitable in the telecommunications sector. From the review, it suggests that Vodafone experiences more incidents than its counterparts, MTN and AirtelTigo, in Ghana.

Table 3. MNO incident posts on Facebook

MNO	Incident Posts on Facebook, 2023		Total Posts
	September	August	
Vodafone	4	3	7
MTN	3	1	4
AirtelTigo (AT)	1	3	4

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The subsequent sections present the findings from the interviews. In view of this, the key elements found in the participant narratives were mapped to illustrate the differences and similarities across the cases, and the themes borne out of this exercise are discussed accordingly.

The Incidents in the Telecommunications Sector

Table 4. The incidents in the telecommunications sector

Sub-Codes	Categories	Themes	Aggregated Themes
Faulty hardware	Hardware Failure	**Network failure**	**Incidents in the Telecom Sector**
Hardware failure			
End of life systems			
Cell site (2G, 3G, LTE) outages			
Cell site congestion			
Power failure	Systems Connectivity Failure		
Microwave link failure			
Fibre failure			
Wi-Fi disconnections			
Loss of connectivity to OSS			
Fibre cuts by road construction	Human Errors		
Cell site outage due to stolen batteries			
Breaks in optical fibre			
Outages due to heavy wind & rainfall	Disaster		
Fibre destruction due to erosion			
Cell sites' downtimes by flooding			
Unable to make calls	Service unavailability	**Service failure**	
Inability to browse Internet			
No Internet availability			
Poor coverage			
Network reception in emergencies			
Inability to access shortcodes	Service inaccessibility		
USSD codes fluctuation			
Mobile money disruptions			
Unstable data connectivity	Poor service quality		
Slow data speeds			
Call drops			
Poor voice clarity			
Less severe	Severity	**Incident risk assessment**	**Incident risk and resolution assessment**
Severe			
Very severe			
Often	Frequency		
Sometimes			
Always			
Minute(s) (10 to 50)	Resolution time	**Incident resolution assessment**	
Hour(s) (1 to 4)			
Day(s) (1 to 5 days)			

This section presents incidents in the telecommunications sector using data from mobile network operators (MNOs) in Ghana. The codes created from the participants' narratives are

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mapped across to generate categories, themes, and aggregated themes as comprehensively presented in Appendix 2. Table 4 provides a summary of findings on the incidents in the telecommunications sector.

Network failure

This is the most prominent theme in the dataset, as the network is the architecture and lifeblood of telecommunication services, and its failure is of great concern to the survival of the MNOs. The network failure, as presented in Table 4, is characterized by:

- Hardware failure refers to the malfunction of hardware, end of system life, congestion at the cell site, and outages at the 2G, 3G, and LTE frequencies, as stated by A5, B3, B6, and C3, and C6 in cases **#A**, **#B**, and **#C,** respectively (see Table 4 and Appendix 2). For instance, A5 stated that:

  "Outages caused by microwave link failure, multiple fibre failures due to road construction, downtime due to faulty NPU 1C, and cell site outages caused by power or hardware failure" [**#A**, Network Engineer, Service Quality].

- System connectivity failure occurs due to power failure, microwave link failure, fibre failure, Wi-Fi disconnection, or loss of connectivity to OSS (Operations Support System), as found in all the cases and stated by A2, A3, B3, B6, C3, and C6. But this is strongly emphasised by C3:

  "Power failure, loss of connectivity to OSS, site is down due to faulty hardware, fibre cut and links failure, cell site outages due to stolen batteries, end of life systems causing service interruptions" [**#C**, Network Quality Engineer].

- Human errors, such as theft of batteries, road construction cutting of fibre, and optical fibre breaks, can cause cell-site outages, as shown in Table 4. These incidents are predominantly found in cases **#A** and **#B**, as alluded to by A2:

  "Fibre cuts are accidental breaks in an optical fibre, typically due to new construction in the area. Outages caused by power failure and microwave link failure" [**#A**, IT systems engineer].

- Disaster incidents can result in outages due to rain, fibre destruction due to erosion, and cell site downtimes due to flooding. This is explained by B4 as:

  "Challenges in accessing network services include outages across major cities due to heavy rain falls, fibre destruction due to erosion, and cell site flooding" [**#B**, IT systems engineer].

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Service failure

From Table 4 and Appendix 2, service failure is another important theme that emerged across the cases, and that reflects how the MNOs fail to fulfill their obligations to render services to their customers. The incidents are put into three main categories:

- Service unavailability includes the inability to make calls and browse the Internet, a lack of Internet availability, and poor coverage across all cases. For instance, B6 stated that "no Internet availability means that when Wi-Fi disconnects, dumps and cubes can't be accessed until the issue has been resolved" [**#B**, Business Intelligence Analyst].
- Service inaccessibility involves issues with shortcode access, fluctuating USSD codes, and disruptions in mobile money services, as alluded to by A4 and C4, respectively:

  "Call drops; unable to make calls to all networks" [**#A**, Head, Performance, and Planning].

  "USSD codes fluctuate, making it impossible to access network services. Slow data speeds" [**#C**, Head, Product and Innovation].
- Poor service quality consists of unstable data connectivity, slow data speeds, poor voice clarity, and call drops, as noted by A3, B1, B5, C1, C4, and C5. For example, B1 emphasized that:

  "Total network downtime and slowness in browsing; 2G site downtimes making calls difficult; poor voice and data coverage; intermittent drop in Internet bandwidth" [**#B**, Head Usage, and Retention].

Incident risk and resolution assessment

From the incidents in the telecommunications sector discussed above, the study assessed the risk associated with the incidents and their resolution time across the cases as shown in Table 4 and Appendix 2. The findings across the cases revealed that the impact of these incidents is *very severe,* and their frequency of occurrence is also *very high*. The study found across the cases that it takes, on average, *one to four hours* for the incidents to be resolved for service restoration.

The impacts of the incidents on employees and MNOs performance

This section discusses the impact of the incidents on employees and MNO performance in the telecommunications sector using data from Ghana. Appendix 3 displays key codes that were mapped across the cases to identify their differences, similarities, and themes produced from the analysis. Table 5 presents a summary of findings on the impact of the incidents on employees and MNO performance.

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Table 5. The incidents' impact on MNOs performance

Sub-Codes	Categories	Themes	Aggregated Themes
Employees have sleepless night	Employee personal life impact	**Employee morale impact**	**The incidents impact employees' performance**
Employees' family life impact			
Employee become frustrated	Employee work balance impact		
Employees become pressured & stressed			
Affect KPI achievement	Employee target achievement impact	**Employee performance impact**	
Miss targets			
Delay in performance reporting			
Slow down work rate	Employee productivity impact		
Employee become idle			
Customer churn	Customer base impact	**MNO performance impact**	**The incidents impact MNO's performance**
Difficult to acquire subscriber			
Loss of revenue	Financial impact		
Impact new sales revenue			
Affect company growth	Target achievement impact		
Impact company's monthly target			
Unrealised company's target			
Impact company performance reporting	Performance visibility impact		
Impact decision-making process			
Service unavailability	Service provision impact		
Service inaccessibility			
Customers become agitated and furious	Customer satisfaction impact	**MNO image impact**	
Customer dissatisfaction			
Regulatory sanctions (fines)	Brand image impact		
Media bashing			
Erode brand image			
Communication challenges			

The impacts of the incidents on employees' performance

In assessing the incident impacts on employees, the findings revealed that "employee morale impact" and "employee performance impact" are themes that emerged from the data analysis as presented in Table 5 and Appendix 3.

- The impact on employee morale is broadly categorized into two main areas: personal life impact and work balance impact. The former relates to employees' sleepless nights and poor family life, as explained by C6: "troubleshoot and restore services put a lot of pressure on us and become stressful, affecting our family life and also impacting our KPIs" [**#C**, IT Systems Engineer]. The latter is a combination of employee frustration,

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pressure, and stress, as stated by B4, B5, B6, C2, C3, and C6, respectively. For instance, B5 passionately emphasized that:

"Since all my work responsibilities are dependent on the Internet, such disruptions affect my KPIs, especially active data users and data revenues. Dealing with these interruptions can be frustrating and stressful. It can disrupt my workflow, cause annoyance, and impact my overall job satisfaction" [**#B**, Data Specialist].

- The impact of employee performance is seen in missing targets, resulting in an inability to achieve their KPIs, as well as a slowing work rate and becoming idle. These occur across the cases, as stated by A4 as "slows done work rate", B6 as "it becomes frustrating because you become idle and cannot do anything", and C1 as "it really affects my ability to meet my KPIs".

The impacts of the incidents on MNO's performance

From Table 5, the findings on the incident impact on MNO performance revealed two main themes, namely:

- MNO performance impact: this consists of, first, *customer base* and *financial impact*, where, across all the cases, it was found that, during the incidents, customers churn out of the network, and it also becomes difficult to acquire new subscribers, resulting in a huge revenue loss, as stated by A4 as "low acquisition of customers and revenue loss" [**#A**, Head, Performance and Planning], and B2 as "customer acquisition and new sales revenues are mostly impacted, affecting the company's monthly target" [**#B**, Sales Incentive Manager]. Second, *service provision* and *customer impact*, where it was revealed that the incidents make customers dissatisfied with the inaccessibility, unavailability, and poor quality of services, as alluded to by A2:

  "Service availability and accessibility by customers are hugely impacted; customers become dissatisfied, and it may attract fines from the regulator" [**#A**, IT systems engineer].

- MNO image impact relates to customer satisfaction and brand image impact. The findings revealed that the incidents make customers agitated and furious, resulting in customer dissatisfaction, as stated by A1 as "customers become agitated and furious" [**#A**, Product Manager]. Similarly, the MNOs receive public criticism and bashing from the media houses, making incident communication with customers a challenge, as stated by B4 as "the incidents generate public outcry that will affect the company's operations" [**#B**, IT systems engineer]. This, in large extent, brings about the regulatory sanctions, and that tarnishes and erodes the image of the MNOs, as affirmed by C6 as "the regulator will sanction the company with a huge fine, which will erode the company's image" [**#C**, IT systems engineer].

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The potential revenue loss and measures to minimise incident occurrence

This section presents the potential revenue loss due to occurrences of incidents and the measures required to minimise their occurrence in the telecommunications sector, using data from Ghana. Appendix 4 presents the complete findings regarding the key codes that were mapped across the cases to identify their differences, similarities, and themes produced from the analysis. Additionally, Table 6 displays a summary of findings on the potential revenue loss due to the occurrence of incidents and the measures required to minimise their occurrences.

Table 6. The revenue loss and measures to minimise incidents' occurrence

Sub-Codes	Categories	Themes	Aggregated Themes
Unable to disclose	Hesitation & lack of information	**Revenue Lost**	**The amount of revenue lost due to the incidents' occurrence**
It depends on the degree of occurrence			
Average GH₵ 100K loss of revenue daily	Loss of revenue disclosure		
An average of GH₵ 2 to 3 million, Month-on-Month (MoM)			
Approximately, GH₵ 1 to 2 million, MoM			
Adequate infrastructure investment	Network infrastructure investment	**Network Infrastructure Investment & System Optimization**	**Measures to minimise incidents' occurrence and impact on performance**
Investment for system upgrade and maintenance			
Leveraging aerial cabling instead of underground	Network infrastructure rollout strategy		
High-end radios as redundancy			
Utilise multiple carriers			
Well-maintained network infrastructure	System Optimization strategy		
Regular hardware system upgrades			
Contingency plans & stable platforms			
Urgent turnaround time for resolution	Effective incident resolution plan	**Effective Incident Management**	
Swift customer communication			
Employee training on disruptions			
Ensure backup equipment availability	System backup plan		
Ensure backup connectivity options			

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The potential revenue loss due to the incidents' occurrence

The findings revealed that the incidents have huge revenue impacts. Although some participants hesitated to reveal the amount of revenue lost amidst the incident, due to their sensitive nature and lack of information based on their roles, as stated by A4, B3, and C2, respectively:

> "I may not be able to disclose this information. Also, it is totally dependent on how long it takes for it to be resolved. It's not one size fits all" [**#A**, Head, Performance and Planning].
>
> "I can't really tell the amount except for the product and revenue assurance units" [**#B**, Network Engineer].
>
> "I cannot reveal that, but it is in millions" [**#C**, Revenue Assurance Manager].

However, the commercial-related employees indicated that such incidents cause MNOs to lose an average of GHc2 to 3 million, month-on-month (MoM). This is explained by C4, A1, and B2:

> "It is approximately GH₵ 2.5 million in revenue loss on a monthly basis" [**#C**, Head, Product & Innovation].
>
> "An average of GH₵ 2 to 3 million in revenue loss on a MoM basis" [**#A**, Product Manager].
>
> "It is about more than a million new sales revenue within the month of occurrence" [**#B**, Sales Incentive Manager].

The measures required to minimise incidents' occurrence

From Table 6, the findings revealed two main categories of measures required to minimize the occurrence of incidents and their impacts on performance. These measures are:

- Network infrastructure investment and system optimization: this measure is to ensure that MNOs adequately invest in the network infrastructure and systems upgrades, as indicated by A2 as "adequate investment in the company's infrastructure" [**#A**, IT systems engineer], and B4 as "capital injection for upgrades of systems and maintenance" [**#B**, IT systems engineer]. Also, MNOs should adopt a different network infrastructure rollout strategy where, instead of laying fibre underground to be destroyed by road construction, they leverage aerial cabling, ensure high-end radios as redundancy, and utilize multiple carriers, as clearly explained by A5:

  > "The use of high-end radios as redundancy instead of cables. Deploying a lot of redundancies in the network. Leveraging over-the-top cabling technology instead of underground" [**#A**, Network Engineer, Service Quality].

  Lastly, MNOs should implement a system optimization strategy, ensuring well-maintained network infrastructure, regular hardware upgrades, and platform stabilization with a contingency plan. This is explained by B2 as "having stable

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platforms" [**#B**, Sales Incentive Manager] and C6 as "I believe regular hardware and system upgrades can help curtail most of these incidents" [**#C**, IT systems engineer].

- Effective incident management: the findings revealed that employees should be well trained on disruptions, and, amidst incidents, MNOs should ensure swift communication with their customers and manage their expectations by ensuring an urgent turnaround time for resolution. These are explained by B5, A1, and C4, as follows:

  "Educating employees on how to maximize network connectivity and use alternative methods during interruptions" [**#B**, Data Specialist].

  "Swift communication of downtime and urgent turnaround time for resolution" [**A1**, Product Manager].

  "When they occur, a fast response rate to solve the issue and restore services can go a long way toward mitigating the negative effect on the company's performance" [**#C**, Head, Product and Innovation].

Discussion

The findings, as broadly presented above, have been summarised and illustrated in Figure 3, entitled "*Telecommunication Sector Incidents Framework",* using the innovation concept by Miles *et al.* (2014).

In answering question one of the study — What are the incidents in the telecommunications sector? — Bukhsh *et al.* (2020), after systematically reviewing the literature on incidents, concluded that there is a lack of scientific reports on real-world telecommunication incidents, which is likely due to confidentiality constraints. Therefore, the present findings would serve as real-world telecommunication incidents and validate the claims made in the media reports. In view of this, Figure 3 postulates that, broadly, incidents in the telecommunications sector are characterized by network failures and service failures, as briefly elucidated therein.

Network failure is of great concern to the survival of MNOs, as mobile networks are crucial for telecommunication services. The incidents constitute hardware failures where the network becomes congested due to heavy traffic, hardware becomes faulty, and systems are at the end of their lives. Again, system connectivity failures come from power failure, microwave link failure, and fibre failure; also, human errors, such as road construction resulting in fibre cuts, cell site outages due to stolen batteries, and poor management resulting in breaks in optical fibre. Lastly, there are natural disasters where outages result from heavy rainfalls, fibre is destroyed due to erosion, and cell sites experience downtime from flooding. These findings largely validate the assertions by the Ghana Commercial Bank Strategy and Research Department (2023); Jacobs (2022); Adel (2021); Bukhsh *et al.* (2020); Maseko (2019); and ENISA (European Union Agency for Network and Information Security, 2017).

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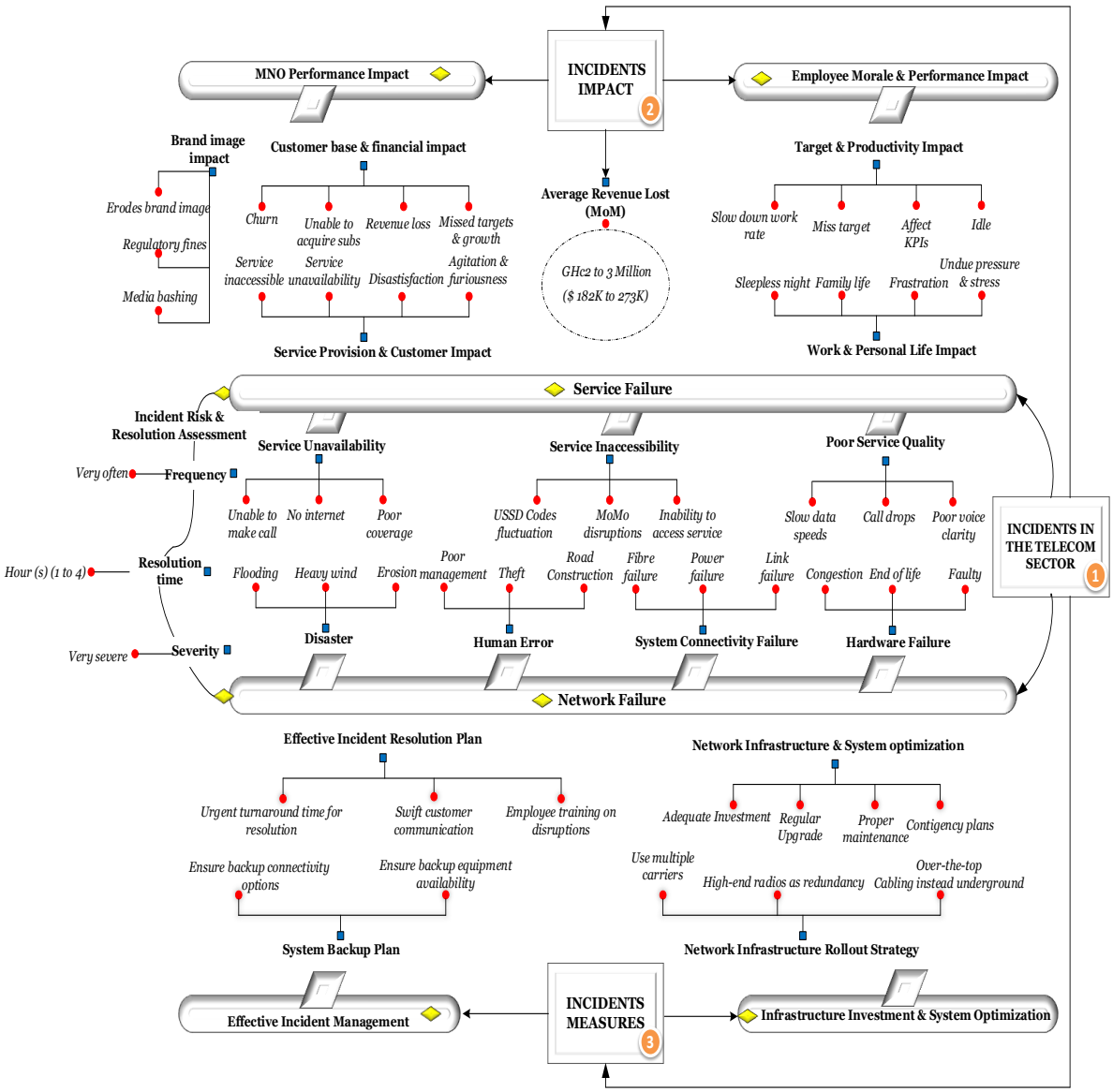

Figure 3: Telecommunications Sector Incidents Framework (Source: Researcher's own construct from the field data)

Service failure is a huge pain point for subscribers, as their entire lives are dependent on their telecommunication service availability. The incidents found in this category involve service unavailability where subscribers cannot make calls, there is no Internet, and network coverage is also poor, as asserted by Maya (2023); also, due to service inaccessibility, whereby USSD codes keep fluctuating, customers cannot use their mobile money wallets due to disruptions, and products and services cannot be accessed amidst the incidents. Finally, there is poor service quality, where subscribers experience slow data speeds, call drops, and poor voice clarity. These findings constitute a breach of quality of service (QoS) (NCA, 2023).

Figure 3 in relation to the incidents further indicates that the impact of these incidents is very severe, their frequency of occurrence is also very high, and it takes, on average, one to four

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hours for the incidents to be resolved for service restoration. These findings are a very important addition to the literature, as none has been found and validated scientifically.

Furthermore, in answering question two of the study — How do the incidents affect performance? — as shown in Figure 3, the study reveals that incidents in the telecommunications sector negatively impact employee and MNO performance. Employees become demoralized due to a lack of work-life balance, sleepless nights, frustrations, and undue pressure, which also affect productivity levels, hindering their ability to achieve performance targets. These findings validate assertions by Tams *et al.* (2022) and Asentria (2020). In relation to the MNO, the incidents impact their customer base and financials as subscribers begin to churn out and they are unable to acquire new subscribers, resulting in a huge revenue loss and affecting their growth, as observed by EY (2023). Also, MNOs' inability to provide service and satisfy customers amidst the incidents results in customer dissatisfaction as customers become agitated and furious. Lastly, MNOs' image is eroded due to public outcry, which to a large extent attracts regulator sanctions, validating assertions by NCA (2023) and Maseko (2019).

Finally, in answering question three — Approximately how much revenue is potentially lost due to the occurrence of these incidents? — the findings, as presented in Figure 3, revealed that the incidents result in an average revenue loss of GH₵ 2 to 3 million ($182K to $273K) per month. These findings are a very significant contribution to the literature owing to their sensitivity and confidentiality constraints.

Conclusion and Recommendation

The study adopted a multiple case-study approach to investigate incidents and their impacts on revenue in the telecommunications sector using data from mobile network operators (MNOs) in Ghana. Subsequent to the findings, as summarised in Figure 3, the study suggests measures to minimise incidents and impacts on MNOs' performance, including investing in network infrastructure, adopting a different rollout strategy, maintaining system optimization, having a contingency plan, well-trained employees, swift communication with customers, and urgent turnaround times for resolution.

In conclusion, the impact of these incidents is very severe, both on employees and operators' performance; their frequency of occurrence is also very high, and their restoration time is too long. This is a crucial issue that cannot be ignored; therefore, through the "*Telecommunication Sector Incidents Framework*", mobile network operators (MNOs) around the world could get a better understanding of the incidents in order to keep their occurrences to a manageable level, create an exceptional customer experience by reducing churn, and increase revenues.

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This study fills a gap in the literature on incidents and their revenue impacts in the telecommunications sector, providing a benchmark for future research in various countries. Nevertheless, this study focuses solely on mobile network operators' perspectives on the incidents within the context of the telecommunications industry in Ghana. Therefore, future studies can explore incidents from subscribers' points of view and how they affect their livelihood and business fortunes. Also, a study can quantitatively validate this proposed framework.

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Appendix 1: Incident posts on Facebook

Table A1. Incidents reported by Vodafone

Incidents' communication to customers	Date & Time	Areas Affected	Source
Dear Customer, we are currently experiencing challenges with our Mobile and Fixed services within Amasaman, Nsawam, Kotoku, Pobiman, Medie, Adieso, and its environs. Our engineers are on site working to resolve the challenges and restore services as soon as possible. We sincerely apologise for any inconvenience caused.	Sunday, September 24, 2023 at 3:45 pm	Some locations	https://web.facebook.com/vodafoneghana/posts/pfbid0zve072z3z2M4n1x79f6BytrssukG8n9TvFjAzT4AuUpxcmBmCC6gczEiLNaDU4Bsl?__tn__=%2CO*F
Dear Customer, we are currently experiencing challenges with our Mobile and Fixed services within Winneba and its environs. Our engineers are on site working to resolve the challenges and restore services as soon as possible. We sincerely apologise for any inconvenience caused.	Wednesday, September 13, 2023 at 7:40 am	A specific location	https://web.facebook.com/vodafoneghana/posts/pfbid02Lp28uQjtVrBzd1RaNHWugcbbMcHQb5JvbZ9rXNYgb8d5xjGAfXu5asVHpa9J7hXyl?__tn__=%2CO*F
Dear Customer, we sincerely apologise for the intermittent network challenges you may be experiencing using our mobile voice services at the moment. Our network engineers are on site working to resolve the as quickly as possible. Thank you.	Wednesday, September 13, 2023 at 7:28 am	Nationwide	https://web.facebook.com/vodafoneghana/posts/pfbid02WUpBc7JbgA6wQZ8rj43siNDdyp1GUN4ruxY7kVrFZCnKCh4d6vCwncgx8KifrQfhl?__tn__=%2CO*F
Dear Customer, we are currently experiencing challenges with our Mobile and Fixed services within Damanko, Kpandae,Bimbila, Bicheritanga, Kpassa, Wulensi, Tatale, Yendi and its environs. Our engineers are on site working to resolve the challenges and restore services as soon as possible. We sincerely apologise for any inconvenience caused.	Saturday, September 9, 2023 at 12:01 pm	Some locations	https://web.facebook.com/vodafoneghana/posts/pfbid019YHkAwcxtDQNPuhL8Du8YkAEJDgL3H7kEoS8JjQ4yj92AwVJzoyVfPjwN8dyuELl?__tn__=%2CO*F
Dear Customer, we are currently experiencing challenges with our Mobile and Fixed services within Sham, Ateiku, Gbedema and its environs. Our engineers are on site working to resolve the challenges and restore services as soon as possible. We sincerely apologise for any inconvenience caused.	Tuesday, August 15, 2023 at 10:34 am	Some locations	https://web.facebook.com/vodafoneghana/posts/pfbid0T95PyoJaBNwn8rKeje2rvZzaNWos5EVf1Snx2ZWV2Rd9EQ94TsRqXWpEnKAyyKi4l?__tn__=%2CO*F
Dear Customer, we are currently experiencing challenges with our Mobile and Fixed services within Gbawe, Manso Adubia, Barekese, New Adubiase, Apemenim,Takoradi Harbour, Patriensa, Kpembe, and its environs. Our engineers are on site working to resolve the challenges and restore services as soon as possible. We sincerely apologise for any inconvenience caused.	Friday, August 11, 2023 at 1:37 pm	Some locations	https://web.facebook.com/vodafoneghana/posts/pfbid0u2w8JtRF7fTr4nZ7iQinMS6wHpoLtSBiLN8CdyiEM6jWYoyC86nHwX7GhgHiucmcl?__tn__=%2CO*F
Dear Customer, we are currently experiencing challenges with our Mobile and Fixed services within Dominase, Tishigu, New Adubiase, Klagon,Larabanga,Kasoa,Gbewa,Oyibi, and its environs. Our engineers are on site working to resolve the challenges and restore services as soon as possible. We sincerely apologise for any inconvenience caused.	Sunday, August 6, 2023 at 6:06 pm	Some locations	https://web.facebook.com/vodafoneghana/posts/pfbid02hXmXHZqtH2oMjsSW47KBxRcRsFFw8RGnAvUtjhoESvq22Ee3Hc1eSRdKXEVwizvGl?__tn__=%2CO*F

Table A2: Incidents reported by MTN and AirtelTigo

Incidents' communication to customers	Date & Time	Areas Affected	Source

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Y'ello Valued Customer, We apologize for the intermittent challenges you are experiencing in accessing MoMo services. This is because of a technical challenge. Our engineers are working to resolve the issue. We'll update you when the issue is resolved We sincerely apologise for any inconvenience caused.	Friday, September 29, 2023 at 11:48 am	Nationwide	https://web.facebook.com/MTNGhana/posts/pfbid02GyTAVK9bqa258wrR6QqVCacWiYUfwFWp58YHSLvhEh3b4mf6wePfhNkjuHMnGKeBl?__tn__=%2CO*F
Y'ello Valued Customer, we apologize for the intermittent challenges a cross-section of customers are experiencing in accessing data, voice, and MoMo services. This is as a result of a technical challenge. Our engineers are working to resolve the issue. We will keep customers updated when the issues is resolved.	Tuesday, September 26, 2023 at 2:26 pm	Nationwide	https://web.facebook.com/MTNGhana/posts/pfbid0h6S9giCjgYkTkce6K1uG3yJrqKkmYTb7LmY21nFKJAef6jcZXNsxzc1AfEjoCmQFl?__tn__=%2CO*F
Dear Valued Customer, we apologize for the intermittent challenges a cross-section of customers are experiencing in accessing data services. This is as a result of a technical challenge. Our engineers are working to resolve the issue. We will keep customers updated when the issues is resolved. We deeply apologise for the inconvenience caused.	Friday, September 22, 2023 at 7: 47 pm	Nationwide	https://web.facebook.com/MTNGhana/posts/pfbid0310evadk9JJNpBLW9U79WGSijNFG1ukSRQTV1JaRsF648KgiM62rHWPsJpMKmYBCNl?__tn__=%2CO*F
Y'ello Valued Customer, We wish to apologise to customers across the country for the intermittent challenges being experienced with mobile and broadband data services. We sincerely apologise for any inconvenience caused.	Thursday, August 17, 2023 at 11: 30 am	Nationwide	https://web.facebook.com/MTNGhana/posts/pfbid0Vcacj3aqQzYk26T72ZTi2eQJ2Fs2cCcDwkgjKD6RM3VbQvNzibH4pjDoSMM1UVj2l?__tn__=%2CO*F
We sincerely apologise for the challenges with our short codes and mobile app. Our engineers are working to resolve it as soon as possible.	Sunday, September 24, 2023 at 3:45 pm	Some locations	https://web.facebook.com/theatghana/posts/pfbid02K9UpFC7XBEGCakUUqzQxGHDCxvydQ5DhyFHiuE5jLvCqCuoYRwyj3pgAwWDbHpN4l?__tn__=%2CO*F
We sincerely apologise for the challenges with our ATMoney services. Our team is working to resolve this as soon as possible. Thank you.	Thursday, August 17, 2023 at 12:29pm	Nationwide	https://web.facebook.com/theatghana/posts/pfbid02BbDkV813U3pLXnanCgmX3G8Q3NEJe3e7bYhukYWuHnV7tRXADS5mbRWPnVyvyMoEl?__tn__=%2CO*F
Kindly be informed that we're experiencing service disruptions. Our team is working to restore the service as soon as possible. Thank you.	Friday, August 4, 2023 at 9:15am	Nationwide	https://web.facebook.com/theatghana/posts/pfbid0U76w6i3MnqsUbeeSo82jeLnzBioJZC3jx4xgGw2B5xVpMv9JLE9PWYcB5egFPiSUl?__tn__=%2CO*F
Dear Customer, We are currently experiencing slow internet service. Our engineers are working diligently to resolve the problem as soon as possible. Thank you for your patience.	Thursday, August 1, 2023 at 10:00am	Nationwide	https://web.facebook.com/theatghana/posts/pfbid02knp86ZVGUxNWMZE5KsF8hHoyTr7L6f4Chp9mjZWPgsU8Z87Riv7YQM4hCLuBwtRdl?__tn__=%2CO*F

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Appendix 2: The Incidents in the Telecommunications Sector

RESEARCH QUESTION 1: What are the incidents in the Telecommunication Sector?

Participants Assigned Codes																		Sub-Codes	Categories	Themes	Aggregated Themes
A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	B5	B6	C1	C2	C3	C4	c5	c6	Total				
				*				*						*			*	4	*Faulty hardware*	Hardware Failure	Network Failure	Incidents in the Telecom Sector
*				*							*							3	*Hardware failure*			
						*								*				2	*End of life systems*			
		*		*			*				*		*	*			*	7	*Cell Sites (2G,3G, LTE) outages*			
								*									*	2	*Cell site congestion*			
*	*	*		*				*						*			*	7	*Power failure*	Systems Connectivity Failure		
	*							*			*			*			*	5	*Microwave link failure*			
													*	*			*	3	*Fibre failure*			
					*													1	*Wi-Fi disconnections*			
														*				1	*Loss of connectivity to OSS*			
	*			*									*					3	*Fibre cuts by road construction*	Human Errors		
														*				1	*Cell site outage due to stolen batteries*			
	*																	1	*Breaks in optical fibre*			
									*									1	*Outages due to heavy wind & rain falls*	Disaster		
									*									1	*Fibre destruction due to erosion*			
									*									1	*Cell sites downtimes by flooding*			
			*							*								2	*Unable to make calls*	Service Unavailability	Service Failure	
											*							1	*Inability to browse internet*			
					*													1	*No internet availability*			
						*							*					2	*Poor coverage*			
																*		1	*Network reception in emergencies*			
												*						1	*Inability to access shortcodes*	Service Inaccessibility		
															*			1	*USSD codes fluctuation*			
							*											1	*Mobile money disruptions*			
		*				*				*		*				*		5	*Unstable data connectivity*	Poor Service Quality		
						*	*								*			3	*Slow data speeds*			
		*	*															2	*Call drops*			
						*							*					2	*Poor voice clarity*			
				*					*									2	*Less severe*	Severity	Incident Risk Assessment	Incident risk and resolution assessment
*	*					*	*				*	*	*		*		*	9	*Severe*			
		*	*		*			*		*				*		*		7	*Very severe*			
*			*		*		*					*				*	*	7	*Often*	Frequency		
	*			*		*		*	*	*				*				7	*Sometimes*			
		*									*		*		*			4	*Always*			
									*									1	*Minute(s) (10 to 50)*	Resolution Time	Incident Resolution Assessment	
	*	*	*	*		*	*	*		*	*	*	*	*	*			13	*Hour(s) (1 to 4)*			
*					*											*	*	4	*Day(s) (1 to 5 days)*			

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Appendix 3: The incidents' impact on MNO performance

RESEARCH QUESTION 2: How do the incidents affect performance?

Participants Assigned Codes																		Sub-Codes	Categories	Themes	Aggregated Themes
A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	B5	B6	C1	C2	C3	C4	c5	c6	Total				
														*				1	*Employees have sleepless night*	Employee Personal Life Impact	Employee Morale Impact	Incidents Impact Employees' Performance
																	*	1	*Affect employees family life*			
								*		*	*							3	*Employee become frustrated*	Employee Work Balance Impact		
								*		*			*	*			*	5	*Employees become pressured & stressed*			
*					*			*		*		*			*	*		7	*Affect KPI achievement*	Employee Target achievement impact	Employee Performance Impact	
		*																1	*Miss targets*			
						*												1	*Delay in performance reporting*			
*	*		*	*			*		*					*	*			8	*Slow down work rate*	Employee Productivity impact		
										*	*							2	*Employee become idle*			
						*						*						2	*Customer churn*	Customer Base Impact	MNO Performance Impact	Incidents Impact MNO's Performance
			*				*					*						3	*Difficult to acquire subscriber*			
*		*	*			*						*	*			*		7	*loss of revenue*	Financial Impact		
							*											1	*Impact new sales revenue*			
										*		*		*		*		4	*Affect company growth*	Targets Achievement Impact		
							*					*						2	*Impact company's monthly target*			
		*												*		*		3	*Unrealised company's target*			
					*						*		*					3	*Impact company performance reporting*	Performance Visibility Impact		
				*							*							2	*impact decision making process*			
	*																	1	*Service unavailability*	Service Provision Impact		
	*																	1	*Service inaccessibility*			
*																		1	*customers become agitated and furious*	Customer Satisfaction Impact	MNO image Impact	
	*					*			*						*	*		5	*Customer dissatisfaction*			
	*							*									*	3	*Regulatory sanctions (fines)*	Brand Image Impact		
						*												1	*Media bashing*			
									*	*							*	3	*Erode brand image*			
																*		1	*Communication challenges*			

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Appendix 4: The revenue loss and measures to minimise incidents' occurrence

RESEARCH QUESTION 3: Approximately how much revenue is potentially lost due to the occurrence of these incidents?

Participants Assigned Codes																		Sub-Codes	Categories	Themes	Aggregated Themes
A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	B5	B6	C1	C2	C3	C4	c5	c6	Total				
	*		*	*	*	*		*	*		*	*		*		*	*	12	*Unable to disclose*	Hesitation & lack of information	Revenue Lost	The amount of revenue lost due to the incidents' occurrence
			*									*						2	*It depends on the degree of occurrence*			
		*																1	*Average GHc 100K loss of revenue daily*	Loss of revenue disclosure		
*													*		*			3	*An average of GHc2 to 3 million, Month-on-Month (MoM)*			
							*			*								2	*Approximately, GHc1 to 2 million, Month-on-Month (MoM)*			
	*																	1	*Adequate infrastructure investment*	Network infrastructure investment	Network Infrastructure Investment & System Optimization	Measures to minimise incidents' occurrence and impact on performance
								*	*									2	*Investment for system upgrade and maintenance*			
				*														1	*Leveraging over-the top cabling instead of underground*	Network infrastructure rollout strategy		
				*														1	*High-end radios as redundancy*			
														*				1	*Utilize multiple carriers*			
																*		1	*Well-maintained network infrastructure*	System Optimization strategy		
																	*	1	*Regular hardware system upgrades*			
							*	*				*						3	*Contingency plans & Stable platforms*			
*																		1	*Urgent turnaround time for resolution*	Effective incident resolution plan	Effective Incident Management	
*											*				*			3	*Swift customer communication*			
										*								1	*Employee training on disruptions*			
			*															1	*Ensure backup equipment availability*	System backup plan		
													*	*				2	*Ensure backup connectivity options*			

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