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# A Safety leading indicator approach: an exploratory study of the Nigeria construction sector

Isimemen Judith Ejohwomu<sup>1</sup>, David Oloke<sup>1</sup>, Lovelin Obi<sup>1</sup> and Olugbenga Oladinrin<sup>1</sup>

<sup>1</sup>*Faculty of Science and Engineering, University of Wolverhampton, WV1 1LY, UK*

## Abstract

The construction industry assembles the construction space needed for economic activities. However, the construction industry's reactive approach to safety has a negative impact on the image of the sector. The current study seeks to determine the extent to which proactive tools, such as safety leading indicators (SLIs), are utilized in the construction sector. The study adopted the use of qualitative research methods, and data was collected using interviewees and web scraping. The analysis of the collected data showed that the construction industry adopts the use of a reactive approach to safety management. In addition, the construction segment of the oil and gas industry utilizes a different approach to safety management when compared with other segments of the construction industry. The adoption of proactive measures, such as SLIs, could help to address the poor safety performance in the construction industry.

**Keywords:** Construction, Health and Safety, Nigeria, Safety Leading Indicators, Sentiment Analysis and Topic Modeling

## Introduction

The construction industry produces infrastructure that drives the economy. However, there are occupational health and safety (OH & S) risks, which are inherent in construction tasks. In particular, the sector accounts for at least 100,000 fatalities around the world, which is about 30% of all fatal injuries (ILO, 2015). According to Health and Safety Executive (2020), the number of work-related injuries in the UK's construction sector is almost 400% more than the average number in all sectors of the economy. This data suggests that the construction sector has a poor safety record that needs to be improved. Poor safety performance has an impact on outcomes of construction projects (Wanberg et al., 2013; You et al., 2019). Stakeholders need to develop and implement strategies to improve the safety record of the industry for its sustained growth.

Research into safety within the construction management domain has a long history. One of the first published studies that focused on safety in construction industry was reported in a paper by Andriessen (1978). Subsequently, studies based on the systematic review of literature have shown that the number

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• <sup>1</sup> I.J.Ejohwomu@wlv.ac.uk

of published studies on construction safety has grown (Antwi-Afari et al., 2019; Xu et al., 2021). This increase could be attributed to the importance of OH & S. To improve safety performance in the construction sector, studies have suggested that there is a need to move away from a reactive towards a more proactive approach to OH & S (Kjellén, 2012; Li et al., 2015). An understanding of Safety Leading Indicators (SLI) is one of the proactive measures used for improving safety in construction projects (Xu et al., 2021). However, little is still known about the theory of SLI as a core function of safety management systems in developing countries, such as Nigeria.

The purpose of this study is to explore to what extent SLI is being used as a driver for excellent OH&S practices in Nigeria's construction and sector. This goal is achieved by addressing two research questions: (i) What is the perceived role of the regulatory body in the attainment of an excellent OH & S practice in the sector? and (ii) What is the perception of industry actors and users regarding OH & S performance in the construction sector? The findings of the study make several contributions to the literature. First, the study provides insights into how self-regulation and firefighting influence OH & S practice in the construction sector. Second, it shed lights on the perception of stakeholders on state of OH & S in Nigeria's construction sector.

## **LITERATURE REVIEW**

### **Health and Safety Culture in Nigeria**

As shown previously, the safety performance of the construction sector in developed and developing countries is poor. In Nigeria, studies have attributed poor safety performance to lack of legislation (Ogbonna et al., 2016), poor safety culture, lack of management's commitment (Kukoyi and Smallwood, 2017) and "too much focus on cost rather than safety" (Windapo and Jegede, 2013), among others. Similarly, some studies have also shown that top management's commitment play a huge role in safety performance of construction projects. For instance, Jimoh et al. (2020) showed that positive attitude, setting OH & S as an important agenda for meetings and the use of safety considerations to modify business operations are a true reflection of management's commitment to safety. Also, it was revealed that stakeholders tend to prioritize personal safety rather than conducting inspections to enforce OH & S regulations (Tengan and Aigbavboa, 2017; Williams et al., 2018). Taken together, it seems that the practice of OH & S in the Nigerian construction sector is reactive. Due to weak enforcement of safety legislation in Nigeria, it is imperative for stakeholders to at the very least embed self-regulation in their business operations to improve safety performance of construction projects.

### **Self-Regulation in the Nigerian Construction Industry**

The concept of self-regulation is gaining traction in literature emanating from developing countries. In Nigeria, the proposed National Building Code of 2006 is yet to be passed into law (Omeife & Windapo, 2013). Thus, there is no industry specific legislation targeted at improving safety in the construction sector. Even when legislations exist its effectiveness is dependent on enforcement, motivation of supervisors and self-regulation among workers (Hon and Chan, 2014, Dolphin et al., 2021), among other factors. Research shows that contractors, especially foreign-owned companies, adopt the use of OH & S standards that were developed and implemented in their home countries (Idoro 2011; Tanko & Anigbogu 2012). The foregoing seems to suggest that safety performance of Nigerian construction

projects is influenced by worker's self-regulation and the nature of the ownership of a construction company.

Self-regulation is adaptable, engages the governed, and provides a sense of belonging. Self-regulation is also a person-centered approach to safety (Dawson et al., 1983; Cheah, 2007). More so, it is geared to business and customer concerns while it addresses different situations. Aside from being an essential regulatory tool, it addresses cost-related concerns and lowers the state's responsibility. Above all, it has the potential to reach a higher degree of compliance. As a result, it is regarded as more powerful than command and control regulation.

### **Lagging indicators and the Nigerian construction site**

Self-regulation has the potential to improve safety performance in the Nigerian construction industry. However, the effectiveness of self-regulation depends on two factors: technical and motivational (Dawson et al., 1983). Technical factors refer to the possession of knowledge (either gained through training or experience) and resources needed to identify and respond to safety risks (Dawson et al., 1983). Also, motivational factor can be viewed as commitment to embed technical factors into the operations and practice of an entity (personal or company). For instance, the pay for safety scheme, which is implemented in Hong Kong, has been linked to improved commitment to safety (Chan et al., 2010). Despite the evident benefits of self-regulation, previous research (such as, Kukoyi and Smallwood, 2017; Okorie and Adindu, 2020; Ijaola et al., 2021) seems to suggest that majority of activities in small-sized construction companies in Nigeria are carried out under unsafe conditions. Self-regulation may not be quite effective in these companies as the management focuses mainly on profit. In light of this peculiarity, there is a need to look beyond a solely lagging indicator (*reactive*) driven redress and consider a safety leading indicator (*proactive*) approach to behavioral based safety in Nigeria.

### **Leading indicators and the Nigerian construction site**

There are various definitions of the term "SLI". Alruqi and Hallowell (2019) assert that SLIs can be viewed as the "...measures of the safety management system that correlate with injury rate". SLIs are viewed as "...precursors to harm that provide early warning signs of potential failure". According to Xu et al., (2021), SLI are metrics for quantifying "the current performance of a safety management system of a project or firm". While a variety of definitions exists, the study adopted the use of definition put forward in Xu et al., (2021) who refers to the level of efficiency of a safety management system. In a systematic review of literature reported in Xu et al., (2021), SLI were classified into three categories: "firm level" (organizational commitment, safety auditing, training and orientation), "project level" (client engagement, designer engagement, contractor engagement, supply chain and workforce engagement, safety design, plan for safety, hazard identification and control, safety learning, recognition and reward and site communication) and "group and individual level" (safety climate, worker involvement and competence). The absence of any of these SLIs serves as an early warning indicator showing an increased probability of an accident (Cheung et al., 2020). Therefore, this information ensures that industry stakeholders embed proactive safety practices in the delivery of construction projects.

## **RESEARCH METHOD**

Several research methods have been used to investigate issues relating to safety in the construction sector. The methods used in the previous research include qualitative, quantitative and mixed (Wilkins, 2011; Mohammadi et al., 2018). Also, data collection methods utilized in these studies includes interviews, questionnaires and archival records, among others (Liang et al., 2021; Mohammadi et al., 2018). In this exploratory study, semi-structured interviews and text mining techniques (secondary data) were used to collect the data required for addressing the goal of the study. Qualitative research approach is considered suitable for the current study due to several reasons. First, the interviewees can freely express their views about the subject, which will be impossible to capture when structured research approaches, such as questionnaire survey, are adopted (Bryman, 2016). This approach provides deep insights and fresh perspective that have not been previously reported in previous research. Second, qualitative research methods are appropriate for addressing underexplored topics (Creswell, 2014). Very little is known about SLI in the context of developing countries, such as Nigeria. Finally, qualitative methods are useful for answering what questions, e.g., “what is Y?”.

As stated previously, data was collected using two methods to achieve data triangulation. This preliminary output reported in this paper is part of an on-going PhD study. The collection of primary data is delayed due to the outbreak of Covid-19. Semi-structured interviews were conducted with two experienced construction professionals. The criteria for selecting the interviewees are: (i) they are actively involved in the delivery of construction projects, (ii) years of experience and (iii) segment of the construction market. For instance, one of the interviewees is employed in the Nigerian construction sector, which is dominated by the international oil companies. The other interviewee works with a local main contractor. This selection is based on the assumption that foreign-owned firms would comply with OH & S standards through self-regulation when compared with local contractors. The interviews lasted for an average of 80 minutes. With the consent of the interviewees, the interviews were recorded. Subsequently, the recordings were transcribed. The transcripts were analysed using thematic analysis.

The internet has become a repository of vast amount of secondary data which is useful for research. Data from Twitter™ was scrapped using Rvest package within the R programming environment. To address research question 2, data (Tweets) which are archived on the internet were collected. Tweets, which are posted by people located in Nigeria, relating to building collapse covering the period between 2018 and 2021 were extracted from Twitter using application programming interface (API). These data contain Tweets by members of the general public (i.e., users) and professionals (industry actors). This data provides information on the perspective of industry actors and users on OH & S practices relating to response to building collapse. The scraped data was cleaned and analysed using text mining techniques, e.g., bag of words and sentiment analysis. Text mining is a method of choice when analysing large volumes of unstructured text data. This method has been used to uncover the impact of Tweets on stock market price (Karakatsanis et al., 2017; Oliveira et al., 2017). The findings emanating from the analysis of the interview transcripts and text mining are presented in the next section.

## **RESULTS AND DISCUSSION**

**The results are in twofold:**

### *1. Social Media Data*

Text analytics is an artificial intelligence (AI) tool that uses natural language processing (NLP) to transform free (unstructured) text into, normalized and structured information. The search period (2018 - 2021) is a snapshot into recent social media discourse relating to construction and OH & S regulations. This includes all Tweets within 250km radius in Nigeria. The result was then cleaned before analyzing. The file had 431 rows and 4 columns (date, time, username and tweets). The tweet column contained the discussions around OH & S, governance, regulations, construction and recent building incidents. The scrapped data was representative of three of the six geopolitical regions in Nigeria, namely North Central, South-South and South West. On the surface, the unstructured data seemed not to support the two research questions posed in the introduction. However, when structured using text analytics the following patterns emerged as captured in Figure 1 and Figure 2.

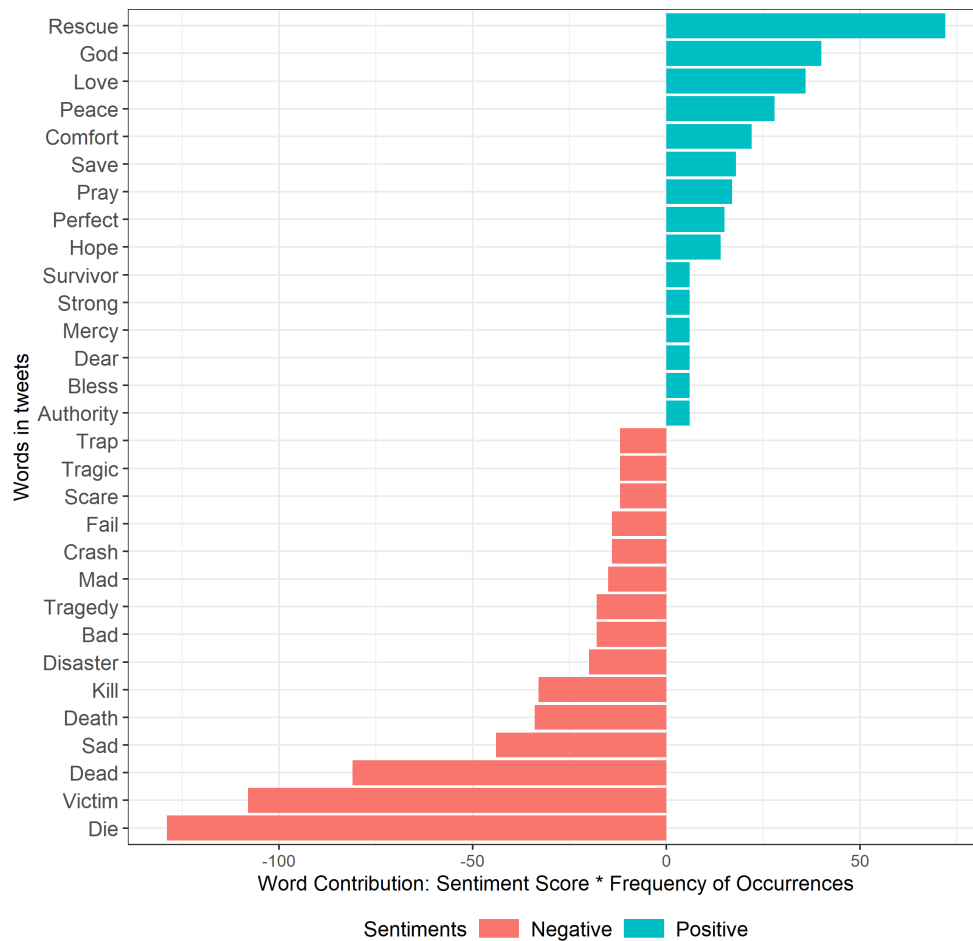


Figure 1: Polar sentiment of top 15 words in data scrapped from Twitter between 2018 - 2021

Figure 1 is a polar sentiment of the top 15 words present in the data. The word contributions are vividly skewed towards negative sentiments, which speak volume of stakeholders' perception of the construction industry and its OH & S standards. Words like "die", "victim" and "dead" which had very high frequency is an indication of the trauma and pain felt by some stakeholders drawn from tweets like "...woman commits suicide after losing two children in Lagos building collapse." [Tweet row 113] Notably, the context within which the positive sentiments like "rescue", "God" and "love" were used, is more a function of the emotional impact of the trauma endured by some Nigerians when it comes to

their perception of the performance of the construction sector and not how good safety regulation is. For example, this tweet read, “...every body is sad, government officials are commiserating with the families of victims”, and there is bewilderment towards the reoccurrence of building collapse “...every year buildings collapse with many casualties but that is it”. [Tweet row 130] This particular finding resonates with the argument of previous commentators that majority of activities in small sized construction companies in Nigeria are carried out under unsafe conditions (Okorie and Adindu, 2020; Ijaola et al., 2021).

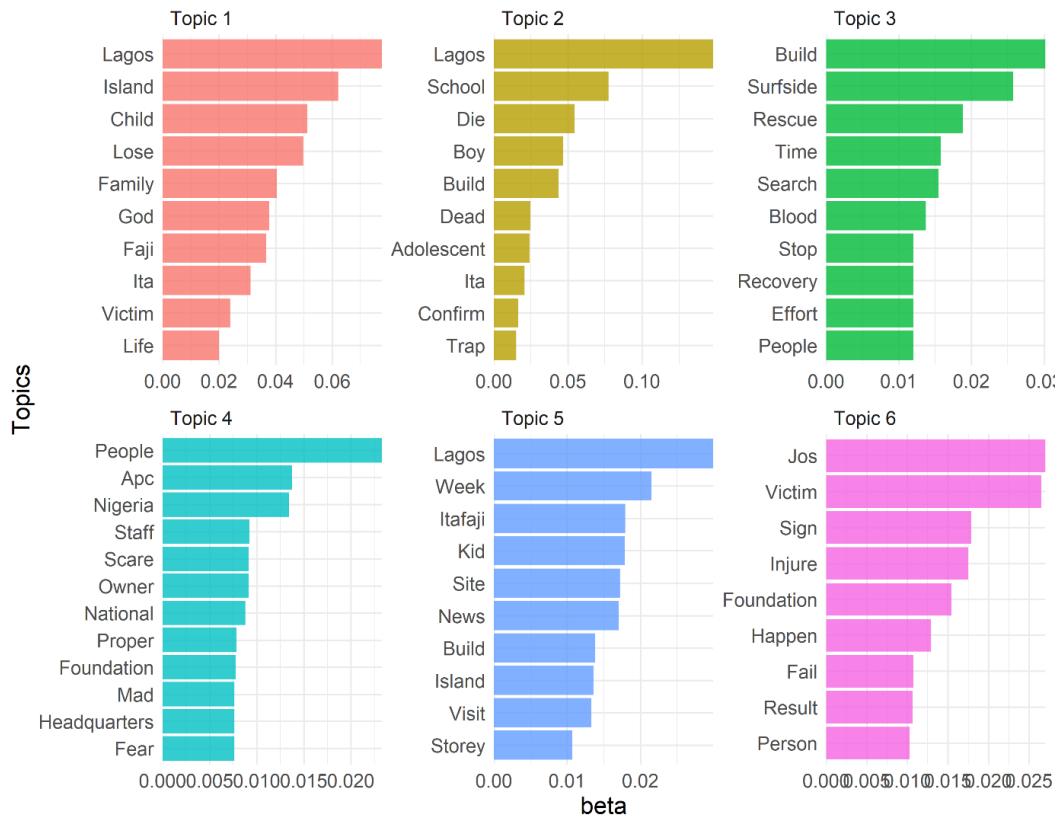


Figure 2: Emergent topic models and their respective beta values

The topic model captured in Figure 2 is an output of natural language processing. This allows for sense making and clustering of the unstructured texts. When combined, the six topics were transposed into three clusters:

1. Building collapses emerged as a cluster. This resonates with the literature as a major cause of injuries and fatalities. The propensity of occurrence is particularly high in poorly regulated sectors with misguided preference of self-regulation.
2. Lagos as a location emerged as a cluster. This city is home to approximately 17 million residents with a population density of around 6,871 residents per square mile. It is the 8<sup>th</sup> fastest growing city in Africa and generates 25% of Nigeria’s GDP (National Bureau of Statistics 2021). This may explain why it emerged as a cluster relative to the states in the three geopolitical regions.
3. The voices of affected and impacted stakeholders also emerged as a cluster. This cluster captures the perception (voices) of a sizeable construction and OH & S stakeholders in Nigeria.

The view of one other tweeter was, *“There is no review of building legislation, the owners of the building are usually persecuted so they pay damages to victims family.”* [Tweet row 150]. The regulator seemed to have been awakened by news of injuries and fatalities judging by this tweet from one of the leading regulators that read *“the council would begin to enforce the law as a measure towards ending the increasing rate of building collapse nationwide”* [Tweet row 4]. This gives the impression that the construction sector regulator needs to do more by way of being proactive. This finding is addressing question 2, which sort the perception of industry actors and users regarding OH & S performance in the Nigerian construction sector.

## 2. In-depth Interviews

In addressing question 1, the two participants in this scoping study were drawn from the construction and oil and gas industries, respectively. The former has a Building degree and works as a site manager for a local contractor with less than twenty employees. The latter has a Civil Engineering background and works as senior project engineer for a multinational. Their average year’s of experience is fifteen. The themes that emerged from the interrogation of the transcripts were general OH & S cultures, organisational policy and procedures, organisational goal and objectives, utilisation of lagging and leading indicators, design/regulatory safety and regulatory practices and management.

In particular, there were divergent views regarding issues involving general safety culture and implementation of organisational policy and procedures in comparing the construction sector with the oil and gas industry.

When compared to the construction industry, there was evidence that the oil and gas sector appeared to be better regulated and has functional organisational policies and procedures. Subtle policy cascading was commonplace in the oil sector. For example, *“it is standard practice to impress upon our vendors our own organisational culture and standards. This we achieve through training and meetings. No silo working allowed.”* [Participant 1]. The Department of Petroleum Resources (DPR) is the main regulatory body in Nigeria’s oil and gas sector. DPR as an agency of the federal government seem to have capacity to monitor and regulate the activities of the oil sector. There is nothing in the data scrapped from Twitter to suggest that the perception was any different. The leadership commitment in the oil sector appear strong and with collective responsibility for OH & S. This was echoed by the one of the interviewee who said, *“In my organisation, everyone has responsibility for safety. I have the right to stop you from continuing work if I notice breach of company safety policy and procedure.”* [Participant 1]

On the contrary, participant 2, though not an aggregate representation, participant 2, from the construction sector, suggested self-regulation was rife. With the perceived fault line being the existence of multiple regulatory agencies like the Council for the Regulation of Engineering (COREN) and the Council for the Regulation of Building in Nigeria (CORBON). Besides competing for influence and superiority, these regulatory bodies are both under resourced. They depend largely on annual membership subscriptions, which has adverse effect when it comes to proactive monitoring and regulating. For example, this interviewee said, *“On this 3 story building project, we are yet to receive visits from any of the regulators.”* [Participant 2] Similarly, there is often trade-offs between cost, quality and safety. Most times, safety is compromised for cost and/or quality because profit margins are tight. Another example being, *“I am not suppose to be the one directly in charge of H&S but because of the nature of the work we are doing, and the company having debt issues I have been asked to... I have not*



*been trained, and I have not being doing this work well because it is not suppose to be my job description, but I don't have a choice because if there is an accident on site it will still affect what we are doing."* [Participant 2] This is reflective of the findings of other commentators that there is too much focus on cost (Windapo and Jegede 2013), as well as the perception of data scrapped of social media that *"Government should be held responsible for building collapse in the country. contractors, builders and clients, always want to cut corners on their spending just to maximize profits, the endpoint is always what happened yesterday, I pray, may we never experience such again Ameen."* [Tweet row 166]. These findings suggest that the mechanism for the enforcement of the existing regulations is weak and unethical practices make self-regulation difficult. The outcome of the study highlights the need for the adoption of a more proactive approach (e.g., SLIs) to the management of safety in construction projects.

## **CONCLUSION**

The results emerging from the study, which aims to estimate the rate of adoption of SLI as a tool for improving the practice of OH & S practices in the Nigerian construction sector, suggests that the perception of stakeholders on the practice of OH & S practices is one of trauma and hopelessness when accidents occur. Comparatively, there is a significant difference in the maturity levels of the safety management systems in the construction, and oil and gas sectors. The latter seems to be better resourced and regulated while the former is poorly resourced and have competing regulatory bodies fashioned along professionalism. Although there was no clear evidence of an understanding of what SLI is and how it can be exploited, the maturity level of the oil and gas sector was found to be at a satisfactory level, which is an indication of the industries preparedness to implement SLI approaches. The public perception of regulators of the construction industry is particularly poor and reactive. Overall, the findings strengthen the idea that the construction sector needs to adopt the use of proactive methods to improve the practice of OH & S. This goal can be achieved through the use of SLI as a guiding principle.

The study contributes to the understanding of safety management practices in the Nigerian construction sector. The main limitation of the current study is that the number of participants is small which makes it difficult to generalize the findings to a larger population. Whilst these findings are not generalizable, it shows that the construction sector utilizes a reactive approach to safety management. Also, the public perception of the construction industry is seemingly poor. Future studies need to conduct a large-scale investigation to validate the findings emerging from the current study.

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