Solutions to the Engineering Education Research Activity Challenges in Sudan

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Abstract

Currently, the researcher has been engaging in engineering education research in Sudan. Needless to say, the researcher has encountered many challenges while gathering data using semi-structured interview. This paper discusses these challenges, and how the researcher was able to successfully overcome most of them, and to achieve complete interview. These challenges evolve around factors that affecting the quality of gathered data: experienced participants, well-developed interview protocol, interview environment and logistics, interviewer's experience and training, language of the interview, and transcription of recorded audio interviews to text. Researcher's network and his professional connections enabled the researcher to assemble and approach a group of experienced participants who were willing to share their expertise related to the research topics. Also, researcher knowledge of both Arabic and English languages was instrumental in conducting quality Arabic interviews, transcription of audio interviews, and accurate translation between the two languages. At the same time researcher's expertise and his upfront preparation helped in avoiding interview distraction and letting the participant to talk freely, while keep the participant focused on the research topics.

Keywords: Narrative Inquiry, Semi-Structured Interview, Interview Process Challenges, Interview Challenge Solutions.

1. Introduction

Sudan is located in North East Africa, and is considered one of the developing Sub Saharan African (SSA) countries. Since its independent in 1956, the country has been facing many political, social, and economic challenges. These challenges have crippled the country from investing its vast natural resources. Sudan is one of the low-income countries; its natural resources include: water, land, agriculture, forestry, livestock, crude oil, and minerals. With its above average Natural Capital (NC) score of 49.3%, Sudan ranked 78 out of 180 countries in NC. The NC indicator measures the country's ability to sustain the population and the economy, now and into the future (Minalla et al., 2021; Sudan GSCI, 2020).

The direct relationship between a country's economic development and its engineering capacity, which include enough well-trained engineers, is well known and documented (Zakaria, 2021; RAE, 2012; UNESCO, 2010, 2018 and 2019; World Bank, 2018). For instance, UNESCO (2010, p28) stated, 'The engineering profession plays a major role not only in the growth and development of a country's economy but also in improving the quality of life for its citizens. The engineering profession is also playing an ever-increasing role in enabling a country to participate in the global economy and in the protection of the environment'.

However, the engineering education systems in SSA countries, including Sudan, are very poor and the situation is worsening rather than getting any better (UNESCO, 2010; UNESCO, 2019; Mohamedbhai, 2014).

Other researchers were investigating challenges facing engineering education in Africa, such as insufficient funding, inappropriate facilities, lack of adequate human capacity, brain drain due to unattractive working environment in SSA, and missing of quality control and accreditation measures (Mohamedbhai, 2014; Falade, 2008). Moreover, The Royal Academy of Engineering (RAE) UK, has developed a single Engineering Index (EI), which consists of eight different engineering related indicators: i) Employment in engineering related industries, ii) human capital investment in engineering, iii) number of engineering businesses, iv) the quality of infrastructure, v) the gender balance of engineers, vi) the quality of digital infrastructure, vii) wages and salaries of engineers, and viii) exports of engineering-related goods. In 2016, about 99 countries were ranked based on the EI; none of SSA countries was included in this ranking either due to data availability or weak indicators' values (Ettridge, 2020).

Sudan has never been ranked based on the EI of RAE, and the country is very behind in the above-mentioned eight engineering indicators. Things are not getting any better due to poor situation of engineering education, and due to the accelerating rate of deterioration of engineering education in the country, compared to the most of SSA countries (Elhadary, 2010; Gasim, 2010; and El-Hassan, 1992). This fact is proved by the inability of engineering education system to accommodate the increasing number of desired students to study engineering, and to graduate

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competent engineers ready to meet the challenges of the 21st century (Osman, 2014).

The researcher has investigated issues related to engineering education in Sudan, and he summarized them as follow: Poor funding, outdated curricula, ineffective teaching and learning methods, inadequate human capacity, students' under preparedness for college, inadequate number and quality of facilities, issues of quality control and accreditation measures, absence of academic freedom, poor research and publishing conditions, inadequate educational technology and ICT environment, and weak university/industry relationship (Minalla et al., 2021).

These issues require the utmost attention of policymakers, academic administration, industry, and engineering educators, and resolving them would give Sudan the opportunity to achieve its full potential and become a prosperous country.

In addition, poor research and publishing condition in the country has resulted in a big gap in research activities, including engineering education research. Sudanese scholars are required to do more in this area to fill the research gap. The researcher himself believes that he has been doing his part, by engaging in engineering research in Sudan, since 2019. See section 4.

Moreover, the purpose of this paper is to discuss the seven challenges, see section 5, that have faced the researcher while conducting semi-structured interview, in Sudan, and how the researcher has been able to overcome those challenges. Hopefully, this effort helps other researchers while collecting data using similar instruments.

2. Literature Review

Semi-structured interview is considered as a method of choice in qualitative research. According to DeJonckheere (2019), a successful semi-structured interview depends on certain elements such as: (i) determining the purpose and scope of the study; (ii) identifying participants; (iii) considering ethical issues; (iv) planning logistical aspects; (v) developing the interview guide; (vi) establishing trust and rapport; (vii) conducting the interview; (viii) memoing and reflection; (ix) analyzing the data; (x) demonstrating the trustworthiness of the research; and (xi) presenting findings in a paper or report. In line with DeJonckheere, George (2022) identified 5 steps for successful semi-structured interview, namely, 'i) set your goals and objectives, ii) design your questions, iii) assemble your participants, iv) decide on your medium, and v) conduct your interviews.

The researcher encountered challenges, related to some of the above-mentioned elements, while performing semi-structured interview in Sudan: Engagement with experienced participants, semi-structured interview protocol, language barrier,

transcription of Arabic interviews, interview cancellation, avoiding interview distraction, and completeness of the interview. This section summarizes reviewed articles on these challenges.

2.1 Engagement with Experienced Participants

Many researchers connect the quality of data collection, to great extent, to the relationship between the researcher and experienced participants who are willing to share their lived experience on the research topic (Kakilla, 2021; Denzin, 2017; Nguyen, 2015; Santoso et al., 2011; and Guba and Lincoln, 1994). For instance: Finding enough participants may not be an easy task; Santoso et. al. (2011) reported that only 4 participants, out of 45 potential ones, agreed to participate in the interview. They added, 'Involving more participants in terms of quantity and variety would provide more conclusive results. Four students are not enough to capture a clear portrait of student's self-reports.' As well, in some cases, participants are unwilling to fully share their own experiences due to various reasons; of them are: the language barrier (Kakilla, 2021), limited understanding of the topic (Denzin, 2017; Nguyen, 2015), and/or distinct cultural values (Nguyen, 2015).

2.2 Semi-structured Interview Protocol

Preparing a semi-structured interview questions may be very challenging because semi-structured interviews require a balance between preparing fixed questions and conducting the interview (DeJonckheere et al., 2019; Kallio, 2016). The semi-structured interview allows the researcher to write fixed questions without following a certain number or order of questions; as well, the researcher has the flexibility to ask follow questions, when the need arises, to clarify, elaborate, and/or confirm participants' answers. However, it is not easy to develop a good set of questions for conducting a proper interview. George (2022) states, 'Semi-structured interviews can be difficult to conduct correctly due to their delicate balance of prior planning and spontaneous asides. Every participant is different in their willingness to share. It can be difficult to be both encouraging and unbiased.'

2.3 Language Barrier

Kakilla (2021) wrote a critical essay on the pros and cons of applying semi-structured interview in a qualitative research method. According to Kakilla, one of the weaknesses of the semi-structured interview is data loss due to language barrier. Kakilla suggests that employing translators might resolve the issue; however, the interviewer may lose the direct meaning through translation (Kakilla, 2021).

2.4 Transcription of Arabic Interviews

The first step in preparation of the interviews for analysis is transcription from verbal to written MS Word documents. Then written texts were edited and necessary corrections were made. This is a crucial step to prevent misinterpretation of any findings due to unnoticed /uncorrected errors. Santoso et al., 2011 states, 'Transcription of the interview proved to be very tasking because the interviews proved to be wordy and not specific to the questions asked.' They recommend that to pre-interview all participants and choose from them who demonstrate good communication skills. The researcher believes that this recommendation is not practical, and it is cumbersome to both interviewees and interviewers. Others utilize software, such as QSR NVIVO 10, for transcription of audio recording interviews.

2.5 Planning Logistics of Semi-structured Interview

Conducting a good semi-structured interview, requires a thoughtful planning which includes: identifying respondents, deciding on the number of interviews and preparing the interviews. DeJonckheere et al. (2019) wrote, 'Careful planning particularly around the technical aspects of interviews can be the difference between a great interview and a not so great interview.' In other words, good planning of a semi-structured interview would result in completion of the interview, without interview distraction and/or cancellation. Planning includes: contact potential interviewees, obtain informed consent, arrange interview times and locations convenient for both participant and researcher, and test recording equipment (Tomaszewski et al., 2020; DeJonckheere et al., 2019; and Creswell et al., 2018).

3. Method

Using the narrative inquiry, within the qualitative approach, this study will answer the research questions of challenges and solutions to conduct semi-structured interview in Sudan: What are the challenges that have faced the researcher while conducting semi-structured interview? And how the researcher was able to overcome them (solutions)?

Connelly and Clandinin (1990) define the narrative inquire as, 'the study of lived experience "in the field," within formal settings (e.g., schools, organizations, clubs)' (Clandinin and Connelly, 2000). As they introduced it, narrative inquire has many features; of them are: data is gathered through various qualitative data instruments, such as: interviews, observations, documents, pictures, etc; there are 4 types of narrative analysis: thematic, structural, dialogic/performance, and visual analysis; and narratives occur within context, specific places or situations.' (Riessman, 2008, as cited in Creswell, 2013 p. 71).

Narrative inquiry has been employed in many fields such as medical field, cognitive science, knowledge theory, organizational studies, linguistics, sociology, education, just to name a few (Riessman, 2005; Victor, 2009). Zakaria (2021) employed the narrative inquiry method, as introduced by Connelly and Clandinin (1990), because he believes that this method is suitable in the field of educational research; Zakaria (2021) states, 'In the context of educational research, this concept is developed into the perspective that education and educational researches are the construction and reconstruction of stories from one individual and a group of people socially. Learners, teachers, and researchers are storytellers and characters in their own stories or tell other people's stories'.

The researcher is using the narrative inquire, within a qualitative approach, to tell his own experience while performing engineering education research in Sudan; narrative data was collected through semi-structured interviews, researcher's observations, and recorded field notes. To answer the above-mentioned research questions, the researcher is using the Riessman's thematic analysis to analyze his own experience, as a semi-structured interview inquirer, and his own observations while gathering data, , about Sudanese engineering education system, using semi-structured interview method.

4. The Interest in Engineering Education Research

For many years, the researcher, who is a chemical engineering educator, has expanded his research interests to include engineering education research, in addition to his research in the areas of biotechnology, microfluidic technology, and nanotechnology.

4.1 Engineering Education Research- Sudan

Since 2019, the researcher's focus has shifted to cover engineering education research in SSA countries, focusing in Sudan. His research efforts have been covering various topics, such as: i) Overview of the situation of engineering education in Sudan. ii) Issues related to engineering education in Sudan (Minalla, 2021). iii) Engineering curriculum; for instance, the researcher has proposed flexible engineering curriculum for promoting engineering students' success (Minalla et al., 2022). iv) Teaching and learning methods required for graduating competent engineers.

While performing engineering education research in Sudan, the researcher has been using various instruments for data collection. As Figure 1 shows, his data collection process has been evolving through four distinctive stages.
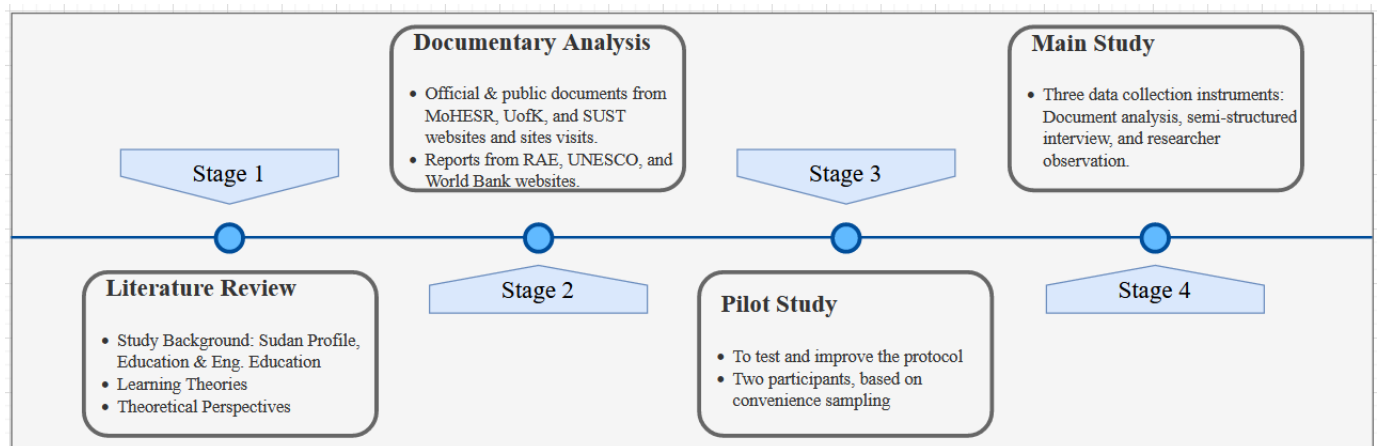
Figure 1. Four distinctive stages of data collection

Stage 1: The researcher performed literature review around three themes: the first theme was concerned with Sudan background, which included the country's profile, an overview of the general education sector, and engineering education as part of tertiary education; the second theme covered historical background of the learning theories; while the third theme dealt with theoretical perspectives and frameworks (Minalla et al. 2021).

Stage 2: Documentary analysis represented a source of secondary data; documents included: Official and public documents from Ministry of Higher Education and Scientific Research (MoHESR), University of Khartoum (UofK), Sudan University of Science and Technology (SUST), in addition to reports from RAE, UNESCO, and World Bank websites (Minalla etal. 2021).

These two stages have inspired me to advance my research into a new horizon. This led me to acquire primary data by interviewing engineering education stakeholders in the country, thereafter called the main study. While preparing for the main study I had to conduct a pilot study.

Stage 3: The pilot study allowed the researcher to test and improve the interview protocol and to prepare well prior to the commence of the main study. Based on convenience sampling, the researcher chose three participants, Int 1, Int 2, and Int 3, as shown in Table 1, for the pilot study. They were contacted and the interviews were completed in January of 2022.

Stage 4: The main data collection phase, which is in progress stage, consists of semi-structured interview, the main source of primary data, in addition to documentary analysis and the researcher's observations.

4.2 The Main Study- In Progress

Since July of 2022, the main study is ongoing data collection stage. As shown in Figure 1, this stage consists of semi-structured interview, the main source of primary data, in addition to documentary analysis and the researcher's observations. Data sources are Ministry of Higher Education and Scientific Research (MoHESR), University of Khartoum (UofK), Sudan University of Science and Technology (SUST), and relevant industries. Research activities have been split into field work, which included site visits, observations, documents collection, and interviews, and additional semi-structured interview through Zoom Conference Platform. The researcher has prepared a list of potential participants, semi-structured interview protocol, and other logistics for the interviews.

Table 1 shows the list of interviewees who participated on the study. They include: Academicians, education and engineering education administrators, policymakers, engineering professionals, and industry practitioners. Participants were contacted by email, phone calls, and/or direct personal contact. Upon their acceptance of participation on the interviews, participants were formally informed about the purpose of the study, and their consents were obtained prior to the data collection. So far, a total of 9 participants (part.) were selected and interviewed.

5. Challenges and Solutions

5.1 Engagement with Experienced Participants

A good quality interview requires experienced participants in the area of engineering education who are willing to share their own experience in their fields. As well, participants' availability to engage in the interview is very crucial for the study. It can be very challenging to prepare and approach a list of experienced participants. For instance: Finding enough participants may not be an easy task; Santoso et. al. (2011) reported that only 4 participants, out of 45 potential ones, agreed to participate in the interview. As well, in some cases, participants are unwilling to fully share their own experiences due to various reasons; of them are: the language barrier (Kakilla, 2021), limited understanding of the topic (Denzin, 2017; Nguyen, 2015), and/or distinct cultural values (Nguyen, 2015).

Solution: Being a Sudanese who have connections with many Sudanese academicians and professionals, in addition to the Sudanese culture that allows at ease connections and networking, enabled me to assemble a list of purposeful participants, and easily approach them and access their institutions. Table 1 shows the list of participants who have already got involved in the interviews.

It is worth noting that, the researcher, who born and raised in Sudan, has studied, worked and travelled extensively in Europe, USA, Africa, Middle East, and Asia. The researcher earned his first chemical engineering degree from Romania, and a master degree in chemical engineering from USA. Since 2015 the researcher has moved to United Arab Emirates (UAE), and he has been working as a chemical engineering lecturer at Higher Colleges of Technology, UAE. Throughout his career as a professional engineer, and as engineering educators, the researcher has been able to establish his professional network that includes Sudanese scholars inside the country and diaspora.

According to Guba and Lincoln (1994), the qualitative interpretative research requires strong link between the researcher and the participants while creating meanings, which means certain researcher's biases may influence the study. Nevertheless, the researcher believes that his bias, values, beliefs, and background have positive addition to this study rather than negative impact.

Table 1.　Semi-structured Interview Participants (Part.)

Part.	Gender	Affiliation	Experience	Note
Int 1	Male	UofK	Academia 25+ yrs	Pilot
Int 2	Female	MoHESR	Administration & Academia 10+ yrs	
Int 3	Male	MoHESR	Administration & Academia 10+ yrs	Study
Int 4	Female	UofK	Academia 5+ yrs	
Int 5	Male	Industry	Industry & Academia 30+ yrs	Main
Int 6	Male	Industry	Industry 30+ yrs	
Int 7	Female	UofK/ MoHESR	Administration & Academia 10+ yrs	Study
Int 8	Female	MoHESR	Administration & Academia 10+ yrs	
Int 9	Male	UofK	Academia 25+ yrs	

5.2 Semi-structured Interview Protocol

A well-developed semi-structured interview protocol is crucial for generating a quality data in terms of objectivity and trustworthiness, which means plausible results.

Like structured interview, the semi-structured interview allows the researcher to write fixed questions without following a certain number or order of questions; as well, the researcher has the flexibility to ask follow questions, when the need arises, to clarify, elaborate, and/or confirm participants' answers. However, it is not easy to develop a good set of questions for conducting a proper interview (DeJonckheere, 2019; Kallio, 2016). George (2022) states, 'Semi-structured interviews can be difficult to conduct correctly due to their delicate balance of prior planning and spontaneous asides. Every participant is different in their willingness to share. It can be difficult to be both encouraging and unbiased.'

Solution: Starting with research objectives and research questions, the researcher developed a bilingual (English/Arabic) semi-structured interview protocol draft, see next section about the language barrier. This draft has been tested, revised, and finalized during the pilot study. Then, this predetermined semi-structured interview protocol has been used to collect the data for the main study.

After completion of the first few semi-structured interviews, the researcher was able to determine that their quality was unsatisfactory, in terms of the amount of gathered information, missing information about certain topics, and unreliable information. Unsatisfactory data might be caused by biased and leading questions. Therefore, another semi-structured interview protocol revision had been completed, and a well-developed, bilingual semi-structured interview protocol was produced. Then, the main data collection has been resumed.

5.3 Language Barrier

Although English is the official teaching language in most of the Sudanese universities, the researcher decided to prepare a bilingual (Arabic/ English) semi-structured interview protocol because Arabic is the country's official language, and it is the mother tongue of most of Sudanese. As well, to ensure that participants thought and opinions precisely captured, the researcher decided that interviews to be performed in Arabic, unless participants choose otherwise; then, the following step is translation of transcribed interviews to English.

The challenge was to accurately translate back and forth between Arabic and English languages.

Solution: At the beginning, the semi-structured interview protocol was prepared in English, then translated into Arabic language through two-step translation process: The first step was translation using google translator. Although google translator has done a reasonable job producing the Arabic version of the protocol, still a second step was performed to revise and correct any mistranslation. A proper bilingual protocol was obtained.

On top of that a rigour understanding and translating of Arabic interviews is crucial to capture, without distortion, all gathered information. Google translator, followed by rigours editing step resulted in a neat translation of transcribed interviews. This is a very time-consuming task, but it is critical, though. The

researcher's knowledge of both Arabic and English languages guaranteed the translation accuracy.

5.4 Transcription of Arabic Interviews

As above-mentioned, the researcher decided to conduct all interviews in Arabic language, which resulted in the burden of transcribing Arabic audio to text. This has become one of the main challenges because of one or more of the following reasons: Zoom Conference Platform does not support transcription of audio in Arabic language; free transcription software could not support lengthy audio interviews; Commercial transcription software is too expensive, at a rate between $90-$180 per one-hour audio. The researcher was very reluctant to utilize expensive commercial Arabic transcription software, with no guarantee that these types of software would complete the transcription accurately; bear in mind, interviewees, most of the time, were talking using Sudanese dialect rather than standard Arabic language.

Solution: Manual intelligent verbatim transcription was the option, knowing that it is very time-consuming task; however, the researcher took the opportunity to complete simultaneously multiple tasks, namely: transcription, translation, and coding; in addition, verbatim transcription allowed the researcher, who knows both Arabic and English languages, to identify and address any inconsistency within the interview or questions that come up as he listens to the recorded interviews.

5.5 Interview Cancellation

Some of scheduled interviews have been cancelled due to one or more of the following reasons: i) unplanned work-related commitments of participants; ii) unexpected social events happened to them; and/or iii) a wave of political unrest during the period of data collection. In addition, some of Face-to-Face interviews were cut very short for the same reasons.

Solution: Interview cancellation forced the researcher either to reschedule missing interviews (Int 3 and Int 7), or in few cases to omit the interview completely and replace it with another participant. Incomplete Face-to-Face interviews were continued using Zoom Conference Platform (Int 5, Int 6 and Int 9). At the same time, the researcher has to capitalize on few opportunities and to conduct informal meetings/discussions. These meetings, in some instances, turned out to be very fruitful, where participants willingly provided meaningful insights about the research topic. One example was the meeting with the chair of the chemical engineering program (Int 4), which has become a complete interview.

5.6 Avoiding Interview Distraction

Avoiding distraction, during the interview, is key for gathering high quality Information. Distraction may occur due to various reasons, for instance: lack of interviewing experience, inaccurate preparation for the interview, interview surroundings, etc.

Focusing on a research topic during the interview has represented another challenge since conducting a successful semi-structured interview requires that the interviewer remains an active listener and non-judgmental who is able to let the participant to guide the interview, while keep him focus on the research topics (Adams, 2010).

Solution: However, to overcome these challenges: the researcher prepared well for the interview (participants and logistics), used a well-developed, bilingual semi-structured interview protocol; during the interview, he avoided leading questions and closed-ended questions, and he had become a good listener rather than a participant in the discussion (Santoso et al., 2011).

5.7 Completeness of the Interview

Incomplete interviews and/or loss of data represents a real challenge. Potential loss of data might be caused by: language barrier, limited understanding of the research topic, uncooperative participant who fails to share his own experience, and incomplete interview (Kakilla, 2021).

Solution: Performing data analysis immediately after the data was collected helped me to improve and correct any errors. For instance, I found out that the first few interviews were very poorly conducted due to the semi-structured interview protocol. Accordingly, the interview protocol was reviewed and improved, see section 5.2. Then, I continued interviewing, a total of 9 participants. To ensure the integrity and completion of the interview, the researcher allowed himself sometime, at the end of each interview, to review it, write his own remarks, record the gap, and evaluate the quality of the information. Although the quality of the interviews was much better than the first few, I noticed reasonable gaps within collected data. I have been filling the gaps using Zoom Conference Platform with the same participants. Zoom meetings have been working very well, and I am planning to do more interviews through Zoom Conference Platform.

6. Ethical Considerations

Sochacka et al. (2018) claim that the research quality is connected to its ethics in two ways; they report, 'First, we found that the quality of our work improved when we critically explored the intersections between our motivations and intentions for investigating particular research topics and broader cultural agendas and assumptions. Second, we found that when we actively sought to do justice to the participants, co-investigators, and readers of our research, we were afforded with opportunities to increase the quality of our work, in sometimes quite unexpected ways.' On the other hand, qualitative

researchers have to consider the ethical issues of their work.

Therefore, all participants were informed about the research, and its academic nature, and their consents were obtained. As well, participants were informed that their participation is voluntary with no obligation to complete the research. On the other hand, the researcher has an obligation towards all participants and their wellbeing; the researcher should ensure participants' anonymities and the confidentiality of the information.

Conclusion

In conclusion, the researcher has encountered many challenges while performing semi-structured interview in the context of Sudan. These challenges were: Engagement with experienced participants, semi-structured interview protocol, language barrier, transcription of Arabic interviews, interview cancellation, avoiding interview distraction, and completeness of the interview.

Moreover, the paper discussed how the researcher has been able to overcome most of these challenges, to conduct complete interviews, and to gather high quality data.

The significance of this study is to illustrate explicitly both challenges, faced the researcher while conducting semi-structured interview, and proposed solutions, by the researcher, to overcome these challenges.

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