Developing healthcare Artificial Intelligence for developing countries

Author: Ainura Aidarova
University of Twente
P.O. Box 217, 7500AE Enschede
The Netherlands

ABSTRACT,
Artificial Intelligence (AI) is increasingly integrated into various industries, including healthcare. The growing application of AI systems requires the designers and developers of AI to consider the expectations and needs of the stakeholder involved, especially healthcare professionals (HCPs). This study intends to identify the role of HCPs in the development process and aims to determine factors that designers should consider to align with their expectations. Although AI has the potential to positively impact healthcare globally, only a few studies were conducted in developing countries. This research addresses this gap by investigating the perspective of healthcare professionals in developing countries.
This study discovered that HCPs in developing countries currently have limited involvement in the design process, as the countries experience scarcity of AI developers. To provide insights for AI designers, this study identified four overarching factors that should be considered: job-related, ethical, socioeconomic, and psychological factors. Job autonomy, doctor-patient communication, data protection, and level of education emerged as key considerations for designers. By incorporating these factors, designers can create human-centered AI that can lead to smoother adoption of technology in the healthcare industry. This research emphasizes the significance of collaboration between developers and users and the co-creating of AI systems. It accentuates the importance of involving HCPs as key stakeholders to ensure a seamless fit into their work environment. The findings provide practical guidance for designers and policymakers to create AI systems that optimize healthcare delivery in developing countries.

Graduation Committee members:
1st examiner: Dr. Maarten Renkema,
2nd examiner: Dr. Jacqueline Drost

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1. INTRODUCTION

Artificial Intelligence and similar technologies are increasingly becoming part of people's daily lives and are going to have a positive trend in the future (Haenlein & Kaplan, 2019). The term "artificial intelligence" (AI) refers to a branch of computer science that focuses on developing machines that can do tasks that typically require human intelligence (Nilsson, 1982, as cited in Waardenburg & Huysman, 2022). AI is increasingly being incorporated into businesses and organizations.

The healthcare industry is one of the industries that is adopting those technologies. Reddy et al. (2018) suggest that AI will have the highest impact on healthcare administration, clinical decision support, patient monitoring, and healthcare interventions. Additionally, Davenport and Kalakota (2019) mentioned that Artificial Intelligence is not a single technology but a wide collection of different technologies. Those technologies are able to cover the broad spectrum of work in healthcare and have the potential to expand the scope further. Nonetheless, the healthcare industry is remarkable for having high adoption failure rate for digital innovations (Greenhalgh et al., 2017, as cited in Procter et al., 2023).

It was claimed that AI could be seen as a new era of industrial transformation, resulting in numerous people losing their jobs (Kaplan, 2015; Lanier, 2014; Schwab, 2016; as cited in Bailey & Barley, 2020). Therefore, Bailey and Barley (2020) suggest that it is highly significant to use a unified approach to understand workplace technology better in order to have an opportunity to influence the design of AI by the time the technology is adopted and implemented. This is highly important for further social outcomes that AI and digitalization can result. Thus, the users and developers of the technology should collaborate in designing AI systems.

This statement is also related to the healthcare industry as the job of healthcare workers requires a high level of expertise due to the complexity of medical knowledge. Waardenburg and Huysman (2022) suggest that co-creating should be the priority instead of co-existing with technology. The co-creating perspective accentuates the collaborative work of developers and users by sharing technical and work-related knowledge with each other in order to create the technology that fits perfectly into the environment where it is used.

It is vital to integrate the different stakeholders involved, who might influence and be influenced by the design of AI. The expectations of the various stakeholders might be taken into account in the stage of designing technology to get the perfect fit into the work environment.

1.1 Research scope

Various factors and stakeholders are involved in designing AI in healthcare. Hogg et al. (2023) identified five main stakeholder groups influencing clinical AI implementation: developers, healthcare professionals, healthcare managers and leaders, patients and the public, regulators, and policymakers. This research is focused on healthcare professionals since they are the main users of the technology.

The current research will look specifically into healthcare professionals in developing countries. The study by Hogg et al. (2023) indicates that eligible studies about clinical AI represented 23 nations, with the United States, the United Kingdom, Canada, and Australia being dominant. Moreover, 88.2% of studies (90/102) regarding clinical Artificial Intelligence were conducted in countries that are classified to "very high human development" with human development index higher than 0.8 by the United Nations Development Programme.

As can be seen, there are few studies conducted in developing countries. Currently, as those countries have limited resources, mostly implementation and adoption of AI are at a very early stage. However, developing countries are a large stakeholder group in designing and implementing Clinical Artificial Intelligence. Adoption and effect of the digital technologies is different across different countries (Aly, 2020). Additionally, inequity in healthcare is endured within and across countries, and AI can potentially worsen it if it is not adequately designed and implemented (Okolo, 2022). It becomes possible to discover and address any biases and ethical considerations of AI by involving HCPs from different regions, socioeconomic backgrounds, and healthcare settings.

Moreover, digital transformation positively contributes to the countries' economy by increasing productivity, Gross National Income (GNI) per capita, and employment rate (Aly, 2020). It is reported that a country's GDP per capita grows by 0.75% for every ten percent improvement in its digitalization score (Sabbagh et al., 2013, as cited in Aly, 2020). The example of high-income countries, e.g., the USA, depicts that technology positively influences public health services and AI, saving up to 150 billion USD in healthcare costs. Technology has the potential to increase economic growth and decrease poverty in developing countries (Joshi et al., 2022).

The adoption of AI in developing countries has great potential, as it can positively influence the quality of healthcare provided and provide broader access to healthcare. However, currently experiencing fundamental issues such as a lack of public health infrastructure, a lack of qualified professionals, and psychological fear of unemployment (Joshi et al., 2022). Fear of unemployment causes distrust of AI and related technologies in professionals leading to challenges in implementation technologies (de Abreu et al., 2021, as cited in Joshi et al., 2022). These are the main barriers for developing countries to implement AI. Nonetheless, the better alignment of the expectations of the professionals and technology, as well as collaborative co-creation of the design of AI, might contribute to smoother implementation and adoption of technology. As Hogg et al. (2023) highlighted in the systematic literature review on the topic of AI and healthcare, there is a lack of research done in developing countries.

This research aims at looking at how healthcare providers, as important stakeholders, try to influence and co-create the design of AI systems. The involvement of HCPs in the design process enables development of technological solutions that are contextually relevant and aligned with the challenges and opportunities in the work environment as well as conform with ethical principle and mitigate biases. The research will focus on healthcare professionals (HCP) in developing countries. The research aims to identify the main expectations of HCP in the design of Artificial Intelligence and suggest to the developers of AI how those could be implemented to optimize the systems.

The research question is as follows: *"What is the role of healthcare professionals in the design of AI, and what factors should designers of AI consider to align with the expectations of healthcare professionals in developing countries?"*.

2. LITERATURE REVIEW

The following section is going to discuss the relevance of the research and form the foundation for the study in addition to the primary empirical research. The section is divided into four main topics central to the research questions: *Integration of AI in healthcare systems, Design of AI, Role of Stakeholders and Stakeholders in developing countries*.

2.1 Integration of AI in healthcare systems

Artificial Intelligence and innovations are providing healthcare organizations with new opportunities. The research looks at different types of Artificial Intelligence used for different purposes in the healthcare industry. There are five main applications of AI systems in the healthcare industry: diagnosis and treatment, patient engagement and adherence, administrative application, implications for the healthcare workforce, and ethical implications (Davenport & Kalakota, 2019).

The software systems designed to automate intelligent behavior in a healthcare setting for diagnosis or treatment are called Clinical Artificial Intelligence (Young et al., 2021). Clinical AI has the potential to replace the routine job of radiologists and pathologists with image recognition and Machine Learning (ML) systems. ML is a statistical method for "learning" through "teaching" models with data and fitting models to data. Additionally, it is the most prevalent type of AI. Moreover, it can support clinicians in the limited human resource environment (Hosny et al., 2018). AI in healthcare decision-making is based on clinical knowledge and data. Therefore, it has the capability to improve the decision-making process through smart diagnosis and treatment recommendations (Suha & Sanam, 2023). The study by Fowler et al. (2023) concluded that the performance of Clinical AI was either superior or comparable to radiologists. This research refers to several similar studies with similar outcomes.

Different AI technologies can be applied in healthcare. For instance, machine learning can be used in precision medicine by forecasting which treatment protocol has the highest chance to succeed based on the patient's characteristics and context. Moreover, the neural network, or deep learning, can recognize possible cancerous lesions in radiological images. There are many other applications of the AI technologies, such as Natural Language Processing (NLP), Rule-based expert systems, and robots (Davenport & Kalakota, 2019).

Even though AI systems can cover a wide range of services, thus far, no jobs have been eliminated by AI (Davenport & Kalakota, 2019).

The future predictions are that most jobs that involve digital information, radiology, and pathology have the potential to be automated. The main reason for the lack of job impact is that the nature of the healthcare industry has more challenges in implementing AI into daily working schedules.

The abilities of technologies are constantly widening; however, the healthcare industry has unique contexts and challenges in the adoption of AI in comparison to other industries (Jain et al., 2020).

2.2 Design of AI

To effectively design AI systems for healthcare, a Human-Centered Design (HCD) can be adopted. According to Zhan and Dong (2008), HCD is a design centered on the users' needs and created precisely for the end-user. Frontline healthcare professionals, doctors, and nurses are going to use the technology. Thus, it should be understandable and perceivable by them. Healthcare workers can provide valuable input in the design of AI, which can ensure the aligned needs of patients and healthcare workers. Early recognition of needs and communication with technology users provides the possibility for the designers to bridge the knowledge gap and create the technology in a highly specialized context.

Designers of AI can achieve successful human-machine teaming performance by enforcing user trust (Chen et al., 2022). User trust can be created by presenting its working mechanisms and providing a suitable user interface. Additionally, Chen et al. (2022) highlighted through a systematic literature review in the healthcare industry that currently, the advancing human factor goals (understandability, trust, reliability) of Machine Learning systems rely on developer's intuitions and assumptions instead of users' experience with technology and usability of ML outputs. The study stresses that it is essential for developers to conduct user research as well as empirical user testing as part of HCD. This will ensure that designers of technology comprehend the needs of end-users and designed algorithm actually accomplishes the predefined objectives. The systematic review summarizes the previous works that adopted the Human-Centered Design approach and had successful cases in implementing AI systems into clinicians' workflow.

Moreover, as healthcare workers are expected to operate with AI-enabled tools, it is essential for them to be able to independently use technologies and understand the decisions they generate (Okolo, 2022). This would be the key for successful human-machine collaboration; therefore, it is highly important to investigate the role of stakeholders in the design of AI.

2.3 Role of Stakeholders

Human-Centered Design is directly linked with collaboration with the stakeholders because the complications of the decision-making process in the healthcare industry require close collaboration among the stakeholders (Suha & Sanam, 2023).

Moreover, Bailey and Barley (2020) emphasize the importance for the designers of AI to closely explore stakeholders who are interested in technology under development. It is necessary to research stakeholders in real-time rather than relying upon past research (MacKenzie, 2001, as cited in Bailey & Barley, 2020).

Additionally, the main factor for its users' acceptance and adoption of technology is a positive experience with using it. This includes ease of use, security for care, safety, a perceived need to use, and social influence (Tsertsidis et al., 2019, as cited in Zhao et al., 2022). To ensure the successful adoption of technology, it is significant to address stakeholders' issues during the design stage.

The different stakeholder groups are affected in different ways. For the current research, one of the five main stakeholder groups identified by Hogg et al. (2023) is examined: healthcare professionals. The HCPs are the major stakeholders as the users of AI technologies; thus, they are key to the successful implementation and adoption of technology. The adoption of the technology is highly correlated with the design of the innovation. Furthermore, different groups of HCPs differ by age, gender, and cultural background; thus, expectations or the perception of AI technologies might differ. It is important to differentiate and segment stakeholder groups in order to understand and study them better.

2.4 Stakeholders in developing countries

This research is focused on a specific subgroup of HCPs: healthcare professionals in developing countries. Following the study by Joshi et al. (2022), the term developing countries refer to low-income, resource-limited, and emerging economies. The distinction of stakeholders is significant as the environment surrounding stakeholder groups play a huge role in the personalities of society.

The humans at the center of the development of AI systems, specifically in the medical field, are highly significant as, at the moment, AI practices worsen existing imbalances in low-resource areas, particularly those involving biases (Okolo, 2022).

Additionally, Hogg et al. (2023), in the systematic literature review on clinical AI, mentioned the lack of research in resource-limited nations. Additionally, Suha and Sanam (2023) also

highlighted the rareness of studies of AI in the context of developing countries. Their research explored fifteen key factors for sustainable AI decision-making in the case of Bangladesh. The study concluded that the individual competency of associate healthcare personnel to handle the system and healthcare professionals' satisfaction with the system are highly significant in integrating AI systems in healthcare in Bangladesh.

On the other hand, the research conducted by Swed et al. (2022) focused on exploring knowledge, attitude, and practice among HCPs and medical students in Syria. The results of the study depict that 70% of participants of the survey had prior knowledge about AI; however, only 23.7% of participants knew about its application in the healthcare industry. Moreover, the study concludes that training and raising awareness of AI technologies is obligatory in implementing AI into work. AI technology is able to enhance diagnosis and treatment, specifically in the context of the lack of qualified professionals.

According to the previous studies conducted, it is essential to research more in the context of developing countries as well as pay attention to human factors while implementing AI systems in healthcare.

3. METHODS

3.1 Research design

The current research follows the explorative qualitative research approach to determine healthcare professionals' expectations in the design of AI in developing countries. Qualitative research refers to the method of studying phenomena without an analysis of numerical data. The explorative research design of the study allows to look into subjects that are novel to the area (Babbie, 2015). Considering that the topic of AI in healthcare in developing countries did not receive significant attention in the prior studies, the explorative approach enables the gathering of new insights about the role of HCPs in the design and development process of AI in developing countries and their expectations.

Furthermore, this qualitative research follows an abductive approach. Abductive research is the so-called combination of inductive and deductive approaches. Abductive research is a technique used in qualitative research that requires the reflection on the data in relation to various theories so that data can further develop and/or contribute to the research question (Ahrens & Chapman, 2006, as cited in Conaty, 2021). It refers to the new theory creation or the development of existing theory with the support of primary data collection.

The advantages of abductive research over deductive include that it does not require a pre-selection of a theory to be supported by the creation and testing of hypotheses. On the other hand, the advantage over the inductive approach is that the abductive approach does not obligate to build and justify theory by analyzing empirical data (Haig, 2005, as cited in Conaty, 2021). Considering that AI in Healthcare is just gaining popularity, the abductive approach will provide flexibility for analysis.

The current research aims to identify the expectations of healthcare professionals in the design of AI and suggest how those could be implemented to optimize the systems. Therefore, doctors and nurses in Kyrgyzstan can be interviewed in semi-structured interviews to attain qualitative data, which are used to explore new themes and insights about their expectations and preferences for AI design in healthcare.

On the other hand, existing theories are used to support current beliefs or hypotheses about how AI is designed for healthcare. It can be investigated whether certain features that have been found during the interviews with HCPs whether those are found in previous studies.

The abductive approach enables a comprehensive understanding of the expectations of healthcare professionals in the design of AI in developing countries while also validating or building on pre-existing theories, possibly from different countries, related to the design of AI in healthcare.

3.2 Data collection

As an example of developing countries, the data is collected from the healthcare professionals in Kyrgyzstan. United Nations (WESP, 2022) classified the countries into developed and developing economies according to their basic economic condition and level of development. The research also classifies the developing landlocked countries and economies in transition as well as economies by income. Kyrgyzstan classifies into the groups of landlocked developing countries, economies in transition, and low-income countries. Additionally, Kyrgyzstan, with a GDP per capita in 2021 = 1,276.70 USD (World Bank, n.d.), can be considered a developing county. Moreover, being a post-Soviet Union country can be representative to the Central Asian countries, such as Kazakhstan, Uzbekistan, Tajikistan, and Turkmenistan, as those had experienced similar historical events.

The data is collected from 8 healthcare professionals having different fields of expertise, genders, and various age groups (see Table 1). This is done to reduce any biases during the study as well as to research diversified opinions and expectations from Artificial Intelligence. Moreover, the data is collected both from governmental and private hospitals and clinics to reduce biases caused by education and training levels.

	Specialization	**Age group**	**Interview duration**
HCP1	Physician	25-35	45 mins 30 sec
HCP2	Neurologist	25-35	25 mins 55 sec
HCP3	Surgeon	25-35	40 mins 20 sec
HCP4	ENT	35-45	35 mins 15 sec
HCP5	Physician /Nephrologist	45-55	29 mins 49 sec
HCP6	Gynecologist	65+	47 mins 30 sec
HCP7	Gynecologist	35-45	16 mins 30 sec
HCP8	Physician	25-35	21 mins 50 sec

Table 1: Interviewees' demographics

The data is collected in a semi-structured interview context. The interviews are conducted in the Russian language. In Kyrgyzstan both Kyrgyz and Russian languages are widely spoken as a result of being part of the Union of Soviet Socialist Republics (USSR). Moreover, the Russian language in Kyrgyzstan is an official language in the country (Act about the official language of the Kyrgyz Republic, 2000), and around 90% of the literature in National Library is in Russian language (Orusbaev et al., 2008). The interviews are recorded after participants give consent and later transcribed through the transcribing platform, Amberscript, which is later revised by the interviewer.

3.3 Research instruments

Semi-structured interviews are employed as the primary data collection method for this study. This suggests that the questions and subjects to be discussed will follow a predetermined pattern

but with open-ended questions to promote further discussion and change substantially between participants (Fylan, 2005). The discussion can create more opportunities for participants to express their opinions on their terms. Since semi-structured interviews are an adaptable method of collecting data, they can contribute to the development of a much deeper exploration of a research topic.

The interview protocol is constructed in English, as the language for this study is English; however, it is translated into Russian by a native speaker (see Appendix 2). This is done to communicate easily with the healthcare professionals in Kyrgyzstan and allow them to express their opinions easily in a more comfortable setting.

The interviews are conducted in a one-to-one setting. The study will not reveal the interviewee's personal data to protect their privacy. The interviews are recorded with the consent of healthcare professionals, transcribed, and later, the transcriptions are revised by the interviewer and translated from Russian to the English language. Lastly, data is analyzed using ATLAS.ti platform.

3.3.1. Interview protocol

The semi-structured interview is designed in a way that allows to assess and collect data on the expectations of healthcare professionals in developing countries from AI in healthcare (see Appendix 1). However, considering that there is a lack of research on the level of awareness and perception of AI systems in developing countries, the interview questions address those topics as well.

The structure of the interview is composed so that the interviewee is ascendingly involved in the topic of "AI and healthcare" and their expectations. The interview includes an introduction with the doctors to get to know the interviewees and create a comfortable setting for them. Next, HCPs are asked about the current challenges in their work and the industry in general. The acknowledgment of the current needs might support interviewees in the following stages of the interview to potentially build a picture of the expectations of Artificial Intelligence. The next block of questions refers to the background knowledge of AI and its applications. Later, the topic of AI in Healthcare is questioned. The questions include prior knowledge, applications, and personal experience with AI at work.

Finally, healthcare professionals are asked about their vision and expectations from AI in the healthcare industry, specifically in the context of developing countries.

The interviews are semi-structured, meaning that they will follow the current pattern. However, questions might be adjusted according to the responses of the interviewees.

3.4 Data analysis

In order to analyze conducted interviews, thematic analysis is employed. Thematic analysis is a method for determining, analyzing, and reporting patterns (themes) within data (Braun & Clarke, 2006). Thematic analysis can support both developing and understanding the experiences and views of the participants and identifying key concepts and themes in the data that are related to the research questions.

One of the advantages of thematic analysis is its flexibility. Exploratory research can make use of thematic analysis as it enables the researcher to identify themes that might not have been predetermined due to its flexibility. Moreover, thematic analysis allows for social and psychological data interpretations as well as identifying similarities and differences in the dataset. Therefore, thematic analysis allows to compare and contrast various experiences and perspectives of healthcare professionals in Kyrgyzstan.

The analysis follows the guide through six phases of analysis suggested by Braun and Clarke (2006).

First, the interviews recorded are transcribed to become acquainted with the data gathered (responses of healthcare professionals). The transcriptions are read through several times to get the initial ideas and recognitions of possible patterns. Then, the Russian transcriptions are translated into English. The time spent on interpreting verbal data is an early stage of the analysis as it develops a thorough understanding of the data. Next, initial codes for interesting aspects are generated through ATLAS.ti platform. The inductive coding approach is applied. Inductive coding is a method of data analysis in which the researcher analyzes and interprets unprocessed textual data to create ideas, themes based on interpretations of the data (Thomas 2006; Boyatzis 1998; Corbin and Strauss 1990, as cited in Chandra & Shang, 2019). All of the interview results are carefully coded by paying equal attention to each data item. Then, the codes are collated into potential themes, which are later reviewed and checked on the relation to the datasets. The first theme groups from the data were grouped into "The challenges in practice" as well as "Country level problems" as those appeared frequently and highly related to each other (see Appendix 5). Those are the external factors that were mentioned regarding the barriers of adoption of AI. Next, the codes regarding the aspects that are important and valued by healthcare professionals are grouped together (see Appendix 6). The results of the interviews depict that healthcare professionals relate all of these factors and create a vision and expectations regarding the design of AI based on the current problems and/ or opportunities.

In order to answer the research question, the codes are grouped as the factors that designers should consider while developing an AI system for healthcare in developing countries. The codes and code groups are collated into 4 overarching themes. Later, the themes are named and clearly defined. The four themes are job-related, ethical, socioeconomic, and psychological factors that designers should consider. Finally, the report is produced.

This guideline allows the structured analysis of the results of the interviews with HCPs and draw conclusions for the study.

4. RESULTS

The semi-structured interviews covered the topics beyond the healthcare professionals' role and AI design requirements as it was essential to dive into the current situation as only a few studies were conducted in developing countries, specifically Kyrgyzstan.

From the data collected in this study, it can be claimed that Artificial Intelligence usage in the country is at a very early stage. Healthcare professionals reported that they neither used any AI systems in their work nor heard of any applications in the medical field in Kyrgyzstan. All of the interviewees had an idea of what AI is; however, not all of them were familiar with the application methods in healthcare. Additionally, because of the lack of information and applications of AI, it was challenging for doctors to identify their role in the design and development process of AI systems. Most of the interviewees are just getting to know the AI, primarily, through chatGPT, for personal use.

The results of this study are structured into the overarching themes that correspond to the initial research question (see Appendix 4). As the data is collected from healthcare professionals, their perspective is prevalent in the current

research. Therefore, the expectations and the requirements from AI in healthcare are formulated as "factors that designers of AI systems should consider" to align with the expectations of the HCPs.

During the study, four overarching factors are identified, namely, *job-related, ethical, socioeconomic, and psychological factors.* Each of these factors includes the subthemes, which are codes that visibly appear frequently among the data collected. Each of the themes is discussed in detail separately below.

4.1 Job-related

The discussions about the design of AI systems in the workplace setting are mostly around the job design of healthcare professionals. All interviewees highlighted that the most important features, such as doctor-patient communication and control over medical decisions, should remain on the doctors. On the other hand, it was highlighted that AI could be designed in a way that can resolve current difficulties. Healthcare professionals highlighted that post-visit patient care and monitoring are currently challenging to accomplish due to the workload. Doctors claim that monitoring the patients can reduce the number of returning patients, potentially lowering the workload. Below each aspect of the job-related factors that should be considered by the designers of AI will be described.

4.1.1 Control/Autonomy

All of the interviewees stressed the importance of control over medical decisions. The decision-making should remain on humans; it is said by healthcare professionals: *"… the final decision should be left to individuals…", "the last word must remain on humans," "if AI does not choose the execution tactics to facilitate operation, then I do not mind it in my work".*

Doctors mentioned the very specific nature of the medicine. It is said that regardless of the data included in the AI systems, *"surely, 100% of patients AI will not be able to cure"*. The interviewees claim that the systems operated with the data, regardless of the complexity and its amount, are not able to diagnose all patients correctly. The HCPs bring up the concepts such as *"nuances"* and *"not standard cases"*. Each person is an individual, and his/her individuality is always present. It includes different features, such as age, gender, nationality, ethnicity, living conditions, and many other factors influencing the patients' health. The HCP5 claims that any computer/ data-based system is a sort of unification. Currently, it is impossible to take into account all *"small nuances"* about the patient. Additionally, HCP4 mentioned that there are always *"exception cases"* among patients where the predetermined treatment options are not applicable.

Furthermore, the concept of *"interpretation"* is raised by 3 out of 8 doctors. HCPs claim that two identical numbers can be interpreted in different ways depending on the capabilities of the person who interprets it, *"… this is called clinical thinking in medicine"*. Currently, AI is limited in interpreting beyond its capabilities. Therefore, humans should make final decisions.

Therefore, taking into account these aspects, healthcare professionals propose that AI systems should be designed as an *"assistant"* or *"tool"* that can provide options for diagnosis and/ or medical treatments from which the doctors can choose and make final decisions. Additionally, doctors proposed that AI could be utilized as support of their medical decisions by including the past data, for instance, comparisons of the treatment options and the success rate. Moreover, the HCPs indicated that AI could assist doctors in taking over routine tasks, such as paperwork, filling up medical records, and quickly suggesting necessary treatment options taking into account the patient's needs. HCP4 said, *"that would be great if AI, for example, could look at some diseases, look at the instructions of the pills and check suitability with the patient"*.

In addition to that, healthcare professionals expressed that they want to build a good relationship with Artificial Intelligence. HCP1 suggests that it is important to *"become friends"* with AI as it will develop further and become an integral part of our lives. HCP1 reports: *"I see it as a friendship, as a partner who will help me do the work that I now do all by myself."*

All of the healthcare professionals interviewed envision the AI system to be designed as an assistant which will leave complete control over the decision-making process to humans and doctors.

4.1.2 Doctor-patient Communication

Doctor-patient communication highlighted as the most important aspect of the work by 5 out of 8 interviewees. They also mentioned that this part of their work they are not willing to be performed by AI systems. HCP2 indicated that the reason is *"sympathy for patients"* and *"building a trustful relationship"* between doctor and patient is crucial. Moreover, HCP3 highlighted that patients are not very familiar with medical innovations, so each patient needs extensive explanations and needs to be approached individually.

On top of that, the healthcare professionals emphasized the need to feel the patient. HCP2 said: *"I still need to touch and feel the patient since, in my profession, there is no way without it"*. HCP6 also claims that a sensitive feel of the patient is necessary in some cases.

Furthermore, doctor-patient communication is sometimes the most efficient treatment. As reported by HCP5, *"… in practice, it happens that a patient visits me, I talk to him, and it turns out that he came with one problem, but tells me completely different"*. The doctor also assumed that due to the lack of attention to mental health in Kyrgyzstan, some people feel sick; however, simple communication can be effective in helping the patient.

Additionally, it is suggested by one of the interviewees that AI systems can enable more effective doctor-patient communication. The regular visits are about 15-30 minutes, where the majority of the time goes for paperwork, such as filling up the medical records. Therefore, not much time is left for personal contact with patients, and HCP says: *"I would better spend more time talking and convincing the patient, for instance, to adjust his/her regime"*.

Therefore, as suggested by HCPs, the AI systems should be designed in a way that will not interfere with the communication between doctor and patient. Possibly AI system can be a look of *"…something like smart application, or software, where a doctor can fill in data or request and visually get the results"*. HCP2 stressed that she is not willing to have any voice communication with the AI as the attention of the doctor should purely focus on the patient.

4.1.3 Patient care / Patient monitoring

The interviewees indicated that AI systems could be helpful for patient care and post-visit monitoring. It is claimed by HCP that *"people in Kyrgyzstan do not really value their health"*; therefore, those can neglect the doctor's recommendations and even the treatment protocols. As a result, patients return to the doctor with more severe complaints. Thus, the workload consistently remains high.

Furthermore, HCP2 mentioned that it is almost impossible in neurology to help the patient in one visit. She emphasizes the importance of receiving feedback from the patient; however,

currently, it is unattainable to check up on each patient. It is suggested that AI systems can support doctors in monitoring the state of patients through some kind of applications and/or feedback chatbots. For instance, patients can consult in regard to the prescribed pills' side effects. Also, AI can give advice and recommendations after the treatments.

In addition to that, patient health monitoring systems can be utilized in preventative measures. The HCP1 imagines a future where AI-based systems can assess overall health and stimulate people to undergo examinations.

4.2 Ethical factor

The main skepticism regarding the adoption of AI systems by healthcare professionals are ethical considerations. Thus, the designers and developers of AI systems should address those concerns for the better acceptance by HCPs. The main ethical factors that doctor highlight are *data protection* and *safety.*

4.2.1 Data protection

It is emphasized by HCP4 that the concept of *"medical secrecy"* is essential in the profession of doctors. Even the digitalization of medical records is a "violation of medical secrecy" since hackers can break the digital system, access data, and the person's health can be manipulated. The importance of the patients' data protection is accentuated by other interviewees as well. The leak of information data can be traumatic for some people. The HCP5 mentioned that doctors themselves cannot keep the information about all patients; therefore, patients can feel safe that the information "will not go beyond this room".

On the other hand, one of the healthcare professionals expressed that for him personally, the confidentiality of the medical records is not that important, and he does not fully understand the concept of medical secrecy. It is said: *"Even if it is shown that I have something somewhere (disease), for me, it would change nothing"*.

Overall, the majority of healthcare professionals pointed out that AI systems for healthcare should be developed taking into account the personal and medical data protection of the patients.

4.2.1 Safety

Safety is another essential aspect of AI systems. Repeatedly, safety in healthcare is highly important as the industry works directly with human lives. The HCP5 mentioned that the main rule for healthcare workers is *"do not harm".* Therefore, he mentions that it should be the same main requirement for Artificial Intelligence since it works directly with the health of people.

4.3 Socioeconomic factors

Socioeconomic factors cover the external factors that inevitably influence healthcare professionals' perceptions and attitudes toward AI. Therefore, AI can be designed considering those factors and address them to provide the best fit for the work environment. The main factors that are retracted from the interviews are *level of education, level of income, limited access to resources, and cultural diversity*. The main aspect that developers of AI can address is the level of education. Indeed, all of the external factors cannot be resolved by designers; however, it is still valuable to consider all factors that might influence the adoption of technology by healthcare professionals.

4.3.1 Level of education

The level of education is the most repetitive answer to the question about the barriers to potentially adopting Artificial Intelligence in Kyrgyzstan. In total, 7 out of 8 interviewees stressed the low level of education in the population. The level of education and technological literacy of healthcare professionals is limited due to the limited resources for development. It is reported by one of the interviewees: *"Lack of finances in state hospitals greatly limits professional development. Since money is a resource that allows you to travel, visit courses/seminars, buy modern equipment and develop in general"*.

Additionally, it is indicated that healthcare professionals are just getting to know the technological/digital innovations. Another interviewee responded as *"The main obstacle is the human factor. Our people are extremely little educated in terms of communication with computers even"*. It is reported by another doctor of the age group of 25 to 35 years old, who had been working in the governmental hospital recently: *"We had old computers that barely supported one single application, and there was not always access to the internet"*.

Moreover, the concept of the education level refers to the general country's population. One of the interviewees stressed that communication with the patients might be challenging due to their limited education level. It was said: *"…only survey takes about 15-20 minutes because it turns out the level of education in the country is low. Schools do not teach any basics"*.

It can be observed from these interviews that the overall level of education in Kyrgyzstan is relatively low. Thus, there are currently difficulties in adopting any kind of technology. From the interviews, it can be retracted that only some medical institutions have adopted digitalization in the workplace. This is due to computer literacy as well as access to the internet and resources. Therefore, the AI systems are expected to be easy to use for the population with the lower technological literacy.

4.3.2 Level of income

The level of income is a factor that only government is able to influence. However, the level of income influences different aspects of life. The HCP6, who works in a public hospital, shared that her monthly salary, which is 17,000 soms; in equivalent, it is equal to 177,40 €. As a retired doctor, she receives a pension; thus, combining the pays it is enough for her personal living expenses; however, she also says: *"For a young family, where doctors need to take care of their family/children, this is a small amount"*.

The low level of income forces healthcare professionals to find alternative income streams. HCP1 reported that corruption at the level of doctors and patients is present. *"In Kyrgyzstan, the paperwork brings some kind of profit to doctors; by signing a false document or writing a certificate, doctors get paid"*. Digitalization in some medical institutions is rejected because of the medical records, *"part of the income is lost"*.

Moreover, it is highlighted by HCP4 that level of income and lack of finances limit the development of healthcare professionals. The government rarely organizes advanced training for HCPs. Therefore, professional development is *"from own pocket"*. The HCP4 also noted that currently, working in a private clinic and increasing his level of income, he is able to attend international conferences and various pieces of training and spends around *"5000-7000 $ annually"*, whereas three years ago, working in a public hospital couldn't allow it for himself. It is emphasized that without constant education, doctors stop developing. *"Money is a resource"* that allows one to grow professionally.

4.3.3 Cultural differences

In addition to the factors above, healthcare professionals highlighted other culture-specific aspects. There are different *"may be specific to the Central Asian culture"* mentality of

people. First, it is indicated that people really value personalized communication. It is also reported by HCPs that patients require a lot of attention from doctors. For instance, HCP4 shared the experience from the training in South Korea: *"There are people who do not want to communicate with doctors; the doctor's appointment lasted three minutes…"*. He also assumed that, most probably, regardless of efficiency in South Korea, this method will not work in the Central Asian countries, which people need to trust.

Trust is an essential aspect of adopting any innovations. This aspect highly correlates with resistance to change. However, the HCPs emphasized the population's lack of trust as culture-specific. One example of it is that the general population usually prefers to see doctors that *"had no less than 10-15 years of experience"*. The HCP3 mentioned: *"We are young professionals; no one listens to us"*. Thus, the trust in the general population is relatively low, especially for anything novel.

4.4 Psychological factors

The acknowledgment of the psychological barriers that healthcare professionals experience towards AI can help the designers of AI to develop a system to minimize those skepticisms.

4.4.1. Fear of Replacement

The fear of replacement frequently appeared during the discussions with interviewees. During the interview, 3 out of 8 interviewees expressed that they have a fear of replacement. However, they believe that it is not going to happen in the near future. HCP5 claims: *"…there will come the moment when AI will replace the healthcare professionals, then a whole layer in healthcare will fall out, … why support ~ 10 doctors when you can spend money once and install an AI system…"*. From this point of view HCPs reported that this also could be barrier not only for adoption of AI systems but also their contribution to the design and development process. It is said: *"…why should I myself produce the one who will then leave me without work"*. The lack of information causes misconceptions regarding AI.

Other doctors indicated that they have no fear of replacement. On the contrary, they report a positive attitude towards AI. However, 3 of them also indicate that there is a misconception regarding AI and fear of replacement in the industry: *"…I know that some are afraid of the AI, but I think those are no longer confident in themselves… even now, iPhones are smarter than some users…"*. HCP3 also indicated that with the developments of surgical robots, *"some surgeons think that they will lose their jobs"*.

Reportedly, AI systems have not yet been introduced to the interviewees. Some interpretations are made according to the fantasy movies where machines take over control over humans, therefore can cause confusion among the general public. Healthcare professionals who participated in the study claim that it is crucial to provide doctors with more information about AI as well as it *is "necessary to explain that this (AI system) is only to help doctors and make the work easier"*. Additionally, it is suggested that AI can possibly be designed in a way that it will introduce itself better. Lastly, it can have a look of a tool/assistant that will depend on humans to ensure HCPs do not experience fear of replacement.

4.4.2. Resistance to change

Another concept that arises during the discussions with healthcare professionals is the population's resistance to change. This is the current challenge while implementing digital healthcare systems. In addition to that, some healthcare professionals, usually at public hospitals, still use old-fashioned treatment approaches. For instance, in Kyrgyzstan, the *"old Soviet medicine approach"* is still very popular. Reportedly, the aging population is mostly highly resistant to change.

It is suggested that the introduction of AI in healthcare should be incremental. Therefore, AI can be designed so that the changes in HCPs' work settings are not radical.

The factors that designers of Artificial Intelligent technologies should consider in development process (design factors) and exact design requirements that are derived from the empirical research are depicted below (Table 2).

Design Factors	Design requirements
Job-related 1. Control 2.Doctor-patient communication 3. Patient monitoring	AI system should serve as an assistant to healthcare professionals and foster a good relationship, leave complete control over the decision-making process to humans, should not disrupt the communication between doctors and patients and can be utilized for preventative measures by monitoring patients.
Ethical 1.Data protection 2. Safety	AI systems for healthcare should prioritize the protection of personal and medical data of patients and be safe to use
Socioeconomic 1.Level of education 2. Level of income 3. Culture	AI systems should be designed to be easy to use, considering individuals with lower technological literacy and design should prioritize building trust among the general population
Psychological 1. Fear of replacement 2. Resistance to change	AI systems should be designed to introduce themselves effectively and have a look and function as a tool/ assistant, emphasizing its supportive role and dependence on humans

Table 2: The design factors and design requirements

5. DISCUSSION AND IMPLICATIONS

As technological innovations are notable by the high failure rate of adoption in healthcare (Greenhalgh et al., 2017, as cited in Procter et al., 2023), it is essential to align the design of technological advancement with the different needs and requirements of end-users. Therefore, the acknowledgment of the expectations of healthcare professionals regarding the design of AI can give valuable insights and support the development of technologies.

The importance of the user-centered approach is highlighted by the potential users during this study. The healthcare professionals mentioned the significance of involvement of healthcare workers into the whole design process, including the initial development process as well as the testing of the technologies. In order to comply with the "human-centered design" approach it is necessary to identify the needs and expectations of the end-users and design the product specifically addressing those needs. It is noted that engineers associate the "user-centered design" with acceptance, thus this approach is dominant to achieve acceptance of their products (Breuer et al., 2023).

The current study classified the factors to consider while designing AI for healthcare professionals in developing countries as job-related, ethical, socioeconomic, and

psychological factors. Those categories are retracted from the most frequent topics (codes) raised, and the patterns are identified and grouped. Additionally, the healthcare professionals expressed the AI design requirements coming from these aspects. Overall, the majority of factors that healthcare professionals want to see in AI systems are similar to the prior studies conducted in developed countries (Morisson 2021; Jacobs et al.,2021; Tucci et al., 2022; Khanijahani et al.,2022). However, it is discovered that the main differences are coming from external factors, such as issues at the national level and cultural differences. Thus, it influences the attitude, and perception towards technological innovations and accessibility of AI systems. Therefore, these aspects can influence the adoption of technologies in developing countries.

The previous studies regarding design of AI and medical decisions revealed the main aspects for the design of novel technological innovations. Those include patient preferences, recommending clinical processes, understanding system constraints, and engaging with domain knowledge (Jacobs et al., 2021). The factor such as "patient preferences" is similar to the "patient care" in the current study as both include treatment recommendations and the patient monitoring. Additionally, another qualitative study on the basis of the innovation theory regarding the barriers and facilitators that influence AI adoption retracted 3 main themes: System, People, Technology (Morrison, 2021). Moreover, the study by Khanijahani et al. (2022) through systematic literature review identified three characteristics associated with adoption of artificial intelligence in healthcare. Those are organizational, professional and patient aspects.

5.1 Job-related

Job-related factors are dominant factors in designing AI for healthcare. Healthcare professionals who participated in this study emphasized the importance of job design for them, specifically job autonomy and control. Job autonomy is directly associated with increased employee motivation and lower turnover (Parker et al., 2017). The interviewees expressed their strong opinion on maintaining their job autonomy and control over medical decisions if/when AI systems are implemented. Numerous studies discovered that the adoption of AI is significantly influenced by how healthcare professionals see threats to their professional autonomy (Khanijahani et al.,2022). The prior studies confirm that AI is to support humans, improve their performance, offer guidance or alternative assessments, and not to replace people. Taken these discussion points the following proposition point can be utilized for this research.

Proposition 1: *AI systems for healthcare should be designed as an assistant for medical staff where the doctors are in charge of the decision-making process to align with the expectations of healthcare providers in developing countries*

5.2 Ethical factor

Ethical factors are universally important in the design and development of AI regardless of the industry or country where it is adopted. The healthcare professionals emphasized the importance of medical data protection. The AI systems for diagnosis require a large amount of input in the form of the personal data of a patient. The information of the patients can be used for manipulative purposes. Moreover, the usage of AI in healthcare should be disclosed as it may cause problems with privacy, data collection, and transfer (Dai & Tayur, 2022).

Furthermore, it is important for AI systems to be ethically integrated into the work environment (Hameed et al., 2023). The participants of this study are also touching the subject of the ethical usage of AI systems. Reportedly, the main objective for medical professionals is "not harm the patient"; thus, it should be applied to the AI system in healthcare. Therefore, the following proposition from the ethical perspectives can be derived.

Proposition 2: *AI system for healthcare should be developed in a way that is safe for doctors, patients, and other stakeholders to meet the expectations of healthcare providers in developing countries.*

5.3 Socioeconomic factors

The direct link between socioeconomic factors with the design of AI is not obvious. However, external factors are influencing the population. Thus, the perception of AI systems differs. Arguably, the country-level problems are causing challenges in the practice of healthcare professionals (see Appendix 5). The challenges in practice usually are the main needs of healthcare professionals. Thus, healthcare professionals expect technological innovations, including AI systems, to support them in that. AI deployment can unite healthcare solutions for various societal groups, regardless of socioeconomic condition (Panch et al. 2019, cited in Joshi et al. 2022).

Starting with the level of income, the average monthly salary in Kyrgyzstan in 2020 was 18,940 soms (National Statistical Committee of the Kyrgyz Republic, n.d.) which is equal to 197.28 € [1], for doctors it was 12,897.9 soms = 134.34 €.

As the interviewee indicated, the salaries are usually not enough for those individuals who are looking after their families. Therefore, illegal income streams for healthcare workers might appear like corruption. The Corruption Perception Index (CPI) in Kyrgyzstan is 27 out of 100 (Transparency International, 2022), where 100 is being very clean and 0 is highly corrupted. Additionally, corruption at the higher levels of the government causes limited resources for healthcare, namely, developing public hospitals, providing the necessary equipment, and educating employees and medical students. One of the side effects of corruption is slowing development, making it inefficient in the country (Olken & Pande, 2012). There is a lack of various resources: financial, human, intellectual, and physical. The lack of resources for development causes a lower level of education. Thus, in developing countries, human expertise is limited and untested (Joshi et al., 2022). Healthcare professionals do not have the ability to develop and improve their qualifications.

Moreover, during this study, another aspect is highlighted by HCPs, such as access to healthcare. Reportedly, there is a drastic regional disparity in Kyrgyzstan. Therefore, the access and affordability to healthcare are different in capital and rural areas. The same is confirmed by Peters et al. (2008). Even though access to healthcare improved in developing countries lately, there is still a lack of adequate access; this includes geographic accessibility, availability, and financial accessibility. The HCPs are hopeful that AI systems possibly will enable equal access to healthcare, possibly, through remote healthcare. In developing countries, the cost of maintaining public health is quite high and increases during emergency times (Javaid et al., 2022, cited in Joshi et al., 2022). Moreover, the technology has the potential to stimulate economic development, reduce poverty as well as positively influence the achievement of an economic, equitable, and sustainable health system (Joshi et al., 2022). These socioeconomic factors can be utilized for the design of AI as follows.

[1] to the date:15.06.2023

Proposition 3: *AI systems for healthcare should be designed as accessible as possible, including financial accessibility and perceived ease of use process to align with the expectations of healthcare providers in developing countries*

Furthermore, healthcare professionals point out cultural differences that might influence the perception of AI systems in developing countries. Technological developments are shaped and driven by culture-specific characteristics. Currently, technological advancement is driven by the "West" cultural values. Moreover, the culture is at the level of perception (cognition) at the stage of the creation of the knowledge systems (Amershi, 2019).

According to Hofstede (2004), there are six cultural dimensions that influence personalities. For the current research, trust is raised as the culture-specific aspect; it can be explainable as the uncertainty avoidance index is 88 (Hofstede Insights, n.d.). This high score indicates people are very risk averse. There is an emotional desire for strict rules, regulations, and protocols to reduce the level of uncertainty. Moreover, cultures with high uncertainty avoidance are highly resistant to change. Therefore, the strong belief in old-fashioned treatment approaches and more older doctors are preferred by the population. Moreover, the power distance score is 88, meaning that power holders are very distant from society. The hierarchy leads to inequalities as the power holders have more benefits. The regional disparities are explainable by this factor.

The cultural specificities differ widely, so it is quite complex to design AI systems, as those could fit in any culture. However, those need to be considered if developers want to ensure the adoption of systems in the industry. Thus, the proposition regarding the design of AI systems in regards to cultural differences as follows.

Proposition 4: *AI systems for healthcare should be designed as it enforces the user trust and brings incremental changes in the workplace of healthcare providers.*

5.4 Psychological factors

Psychological factors can potentially be an obstacle for doctors to use AI in healthcare settings. The psychological factors are highlighted as part of the professional characteristics that influence the adoption of technologies by Khanijahani et al. (2022). Interviewees in current research highlighted the fear of replacement and resistance to change. Those are the results of the lack of knowledge about AI systems. In another prior research about the engineers' perspective in the design of AI and user engagement, it is featured that the healthcare workers' fears associate with two main issues: the safety of using the systems and the threat of losing their jobs (Breuer et al., 2023). Thus, the assumption from the engineer's perspective coincides with the responses of HCPs. Moreover, the paper by Breuer et al. (2023) claims that the potential fears appear as a result of unfamiliarity with technology.

Furthermore, the attitude and perception toward AI contribute to the adoption of the technology (Khanijahani et al.,2022). It is known from the current research that the general population has a lot of misconceptions and misinformation regarding AI technologies and their application. Thus, some people can have negative prejudgments regarding AI.

Therefore, the developers of the AI systems can design the technologies to address these issues and minimize them. The expectation for the design of AI to overcome the fear of replacement and resistance to change are according to the Propositions 1 and 4.

5.5 Implications

5.5.1 Academical implications

Throughout this study, several academical implications are discovered. First and foremost, the current study builds up on the research by Bailey and Barley (2020), which calls the attention of researchers to the unified approach in the design and development of AI. Bailey and Barley (2020) mentioned the concerns that are skipped over in existing conceptions of intelligent technology, where one of them is power. This research reveals that healthcare professionals in developing countries have lack of power to influence the design of AI systems. The design and adoption of technologies are tailored for the authorities with purchasing power; thus, digital transformation is driven by politics (Markus, 1983; Noble, 1984; Winner, 1980, as cited in Bailey & Barley, 2020). The developing countries are limited in resources and economic development. Thus, stakeholders from these countries have lack of power.

Additionally, this research also builds upon the existing literature regarding the factors influencing the adoption of AI systems by confirming several and adding new aspects.

Moreover, this study fills the gap in the literature, as limited researches were conducted in developing countries. Evidently, the results from the developing country have similarities to the developed country cases. Similar research in a developed country, the United Kingdom, regarding the factors influencing the adoption of AI in healthcare also covers psychological factors. However, the case from the developed country highlighted the lack of resistance from doctors. Moreover, doctors in that study do not believe that AI will replace them (Morisson, 2021). In contrast, healthcare professionals in developing countries emphasized the fear of replacement by AI systems as well as resistance to change, even in digitalization.

On the other hand, ethical considerations such as data protection and safety are the same in both developed and developing countries cases; however, as the technology is more accessible in the developed country, the design requirements of HCPs are more advanced.

The differences in perception of AI in populations from developing and developed countries should be researched further. This study builds up the existing literature with novel aspects that are valued in the design of AI. In developing countries, socioeconomic factors, such as level of education and culture, is highly valued by HCPs and frames their perception, expectations, and requirement of the technology. These aspects need more attention in future research. Moreover, this paper stimulates further research in developing countries. Furthermore, the propositions can be utilized for further theory development in the topic of design of AI in healthcare in developing countries.

Lastly, the results of the study confirm that "human-centered design"/ "user-centered design" approaches are the ones desirable by healthcare professionals in adopting AI systems in their work.

5.5.2 Practical implications

The findings of this research have several practical implications. Firstly, the results of this study can be used directly by designers and developers of AI systems for healthcare. The propositions of the research can be utilized as the design requirements from the healthcare professionals in developing countries. This can provide them a picture of what HCPs value in their work and directly provide suggestions for AI design that doctors are willing to see.

Moreover, this research can bring the attention of designers of AI to specific stakeholder groups as those have different requirements rather than classifying all healthcare professionals as a whole. As currently developers hardly differentiate the groups of healthcare workers difficulties in work and homogenous experiences (Breuer et al., 2023). Potential disparities in the duties, working environment, and specializations of various healthcare professions are overlooked and it is assumed that all of the HCPs have the same difficulties in work and homogenous experiences (Breuer et al., 2023).

Lastly, it can be practical for other stakeholder parties, for instance, governmental institutions in developing countries. The findings of this research are able to assist in evaluating the meaningful aspects of implementing technological innovations for healthcare professionals and support them legislatively.

6. LIMITATIONS AND FURTHER RESEARCH

6.1 Limitations

There are several restrictions that come with the current study that apply to this research. As an example of a developing country, Kyrgyzstan was chosen as the representative for the study. Nevertheless, it is vital to recognize that while Kyrgyzstan could offer insights into surrounding areas, it cannot completely represent all developing nations equally.

Second, due to scheduling constraints, the sample size was limited to 8 interviewees. The limited number of participants might have had an impact on the findings' depth. Additionally, the most of interviewees are working in the capital city of Kyrgyzstan, Bishkek. Only one of the interviewees is working in different region, Osh. Therefore, the healthcare professional might still be more technologically advanced compared to those in rural areas.

Thirdly, there may be some bias in this study because those who accepted to be interviewed fit can be characterized as being more innovative and open to new technologies. As a result, the general perception of AI in this study is often positive. Additionally, a few medical professionals, especially those from older generations, declined to participate in the interviews, especially after learning about the topic of the study.

Last but not least, information was gathered initially in Russian and then translated into English. This procedure raises the chance that some subtleties or elements might be unintentionally changed or overlooked during the translation.

6.2 Further research

Further research in the field of the design of AI and healthcare is necessary, specifically in developing countries, as this topic is just gaining popularity. There are different fields that might be researched in this field. First, the study regarding the needs and expectations of healthcare professionals can be conducted with a larger sample size and/or in another representative of developing countries. Second, further research can look at the factors influencing the acceptance and implementation of technologies in developing countries. As it was discovered, there are still existing fears and skepticism toward AI. Therefore, it is meaningful to study if and how the systems designed are implemented.

On the other hand, this research discovered a variety of country-level problems influencing the perception of AI in healthcare. Therefore, future research can study the technology implementation from the governmental perspective and assess to what extent the governmental institution tries to bring up technological innovation in healthcare.

Moreover, the cultural influence in the design and development of AI can be researched.

Lastly, the perception and/or acceptance of AI by patients can be a research scope. During the research, it is known that the level of education of the general public in developing countries is on the lower side. Therefore, it is interesting to research it from the patient's perspective.

7. CONCLUSION

This study is conducted to analyze the role of healthcare professionals in the design and development process and their expectations from the Artificial Intelligence systems in developing countries. The expectations of healthcare workers can be converted to suggestions for developers of AI systems to design the technology specifically for users. The following research question is developed:

What is the role of healthcare professionals in the design of AI, and what factors should designers of AI consider to align with the expectations of healthcare professionals in developing countries?

The qualitative research in one of the representative developing countries depicts that healthcare professionals in developing countries do not yet play a role in the design and development process. This is due to a lack of information and non/ or exceptionally rare AI-developing companies or engineers. However, this research uncovered that this exclusion is an important omission: healthcare professionals emphasize the importance of the medical specialists involved in the design and development specialists are involved in the design and development process. It is essential since the frontline healthcare workers are those who works with technology and it should be developed in a way that HCPs are able and willing to use it. Also, healthcare professionals can share their knowledges and experiences to ensure the high-quality AI system. Moreover, doctors highlight the importance of performing technology testing specifically by practicing doctors. The healthcare sector projects are highly specialized as those once implemented influence human life.

Therefore, this research analyzed and identified the factors that should be considered while designing AI systems for healthcare from the perspective of healthcare professionals in developing countries. There are four overarching factors that should be taken into account. Those are job-related factors, ethical factors, socioeconomic factors, and psychological factors. Each of these topics has sub-topics with a more specific aspect. The main factors that should be taken into account by designers of AI systems are job autonomy, control over medical decisions, maintaining doctor-patient communication, safety, data protection, and level of education. Taking into account these factors will enable better alignment and developing human-centered designed AI systems. This can enable the smoother adoption and implementation of the technology by healthcare workers and contribute to the development and progress of the healthcare industry in developing countries.

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10. APPENDICES

10.1 Appendix 1: Semi-Structured Interview outline in English:

Semi-structured Interview outline

Technical information:

As it is semi-structured interview, the questions are still differed per interviewee, depending on their answers. The questions in grey, are "secondary", may be not asked from interviewees.

Prior to the interview:

1. Introduce myself and explain the purpose of this interview
2. Inform about how the data will be used
3. Ask for consent for recording and data collection
4. Ask if everything is clear and if there are any questions

Questions/ or topics:

Topic	**Questions**
Introduction	-Name, age group and gender (if comfortable to reply) -Doctor in which field are you (job position)? -How long have you been a practicing doctor? -Do you work in Private or public hospitals/clinics?
Main complication/needs in their work	- What are the main challenges you face with in your work? -What do you think is needed to resolve these challenges? -What are the challenges/difficulties you find in healthcare industry in Kyrgyzstan? - What in your opinion would improve (is needed) the Healthcare industry in Kyrgyzstan?
Background knowledge of AI	-Have you ever heard of AI? Can you explain in your words what do you think it is? - What aspects of AI are you familiar with? - Are you familiar with machine learning, neural network, deep learning? -What examples of applications of AI you heard/faced with?
AI in healthcare	-Did you have an experience with AI in your work personally? What was it? How was it? - What are the (other) applications of AI in healthcare are you familiar with? - What are the possibilities and opportunities with AI in your work? For industry?
Expectations of AI (design)	-What would you like to see in AI in your work? - What you don't want AI to do? And why? -What features or characteristics do you think an AI system should have to be useful for doctors/ nurses? -In your opinion, what are the biggest barriers for healthcare professionals in Kyrgyzstan to adopt AI in their practice? -How do you think AI can be designed (can look like) to address those barriers? -What ethical considerations should be taken into account when designing AI for healthcare? -How do you think the implementation of AI in healthcare will affect your job and your profession/ industry as a whole? -Can you describe a situation where you think AI could have been used to improve patient care in your experience? -What other insights or suggestions do you have regarding the design and implementation of AI in healthcare in developing countries?
Design of AI	-In your opinion, what role should healthcare professionals play in the design and development of artificial intelligence systems for healthcare? - How can you share your experience effectively? - How can medical professionals/try to influence AI design? - How do you ideally see healthcare in Kyrgyzstan in 10-20 years?

10.2 Appendix 2: Semi-Structured Interview outline in Russian:

План интервью

До интервью:

1. Представьтесь и объясните цель этого интервью:
2. Запросите согласие на запись и сбор данных
3. Сообщите, как будут использоваться данны
4. Спросите, все ли понятно и есть ли вопросы

Вопросы/или темы:

Тема	Вопросы
Введение	- Имя, возраст - Какова ваша должность? Врач (какой области) или медсестра? - Как давно вы являетесь практикующим врачом? - Частная или государственная?
Основные сложности/потребности в работе	-С какими основными трудностями вы сталкиваетесь? - Что, по вашему мнению, помогло бы минимизировать эти трудности? - Какие сложности вы находите в сфере здравоохранения в Кыргызстане (в вашей специализации или в целом)? - Что, на ваш взгляд, улучшит (необходимо для) здравоохранения Кыргызстана?
Базовые знания об ИИ	- Можете ли вы объяснить своими словами, что такое искусственный интеллект для вас? - С какими аспектами ИИ вы знакомы? -Знакомы ли вы с машинным обучением, нейросетью, глубоким обучением? -С какими примерами использования ИИ вы сталкивались или наслышаны?
ИИ в здравоохранении	- Был ли у вас личный опыт использования ИИ в вашей работе? Что это было? Как это было? - С какими (другими) методами использования ИИ в медицине вы знакомы? - Какие есть перспективы и возможности в использовании ИИ в вашей работе? Или в индустрии в целом?
Ожидания от ИИ	- Что бы вы хотели видеть в ИИ в своей работе? - Чего вы не хотите, чтобы ИИ делал? И почему? -Какими характеристиками, по вашему мнению, должна обладать ИИ, чтобы быть полезной для врачей/медсестер? - По вашему мнению, что является самым большим препятствием для медицинских работников Кыргызстана при внедрении ИИ в свою практику? - Как, по вашему мнению, можно спроектировать ИИ (как он может выглядеть) для преодоления этих барьеров? - Какие этические соображения следует учитывать при разработке ИИ для здравоохранения? - Как, по вашему мнению, внедрение ИИ в здравоохранение повлияет на вашу работу и вашу профессию/отрасль в целом? - Можете ли вы описать ситуацию, в которой, по вашему мнению, можно было бы использовать ИИ для улучшения ухода за пациентами? - Какие еще идеи или предложения у вас есть относительно разработки и внедрения ИИ в здравоохранении в развивающихся странах?

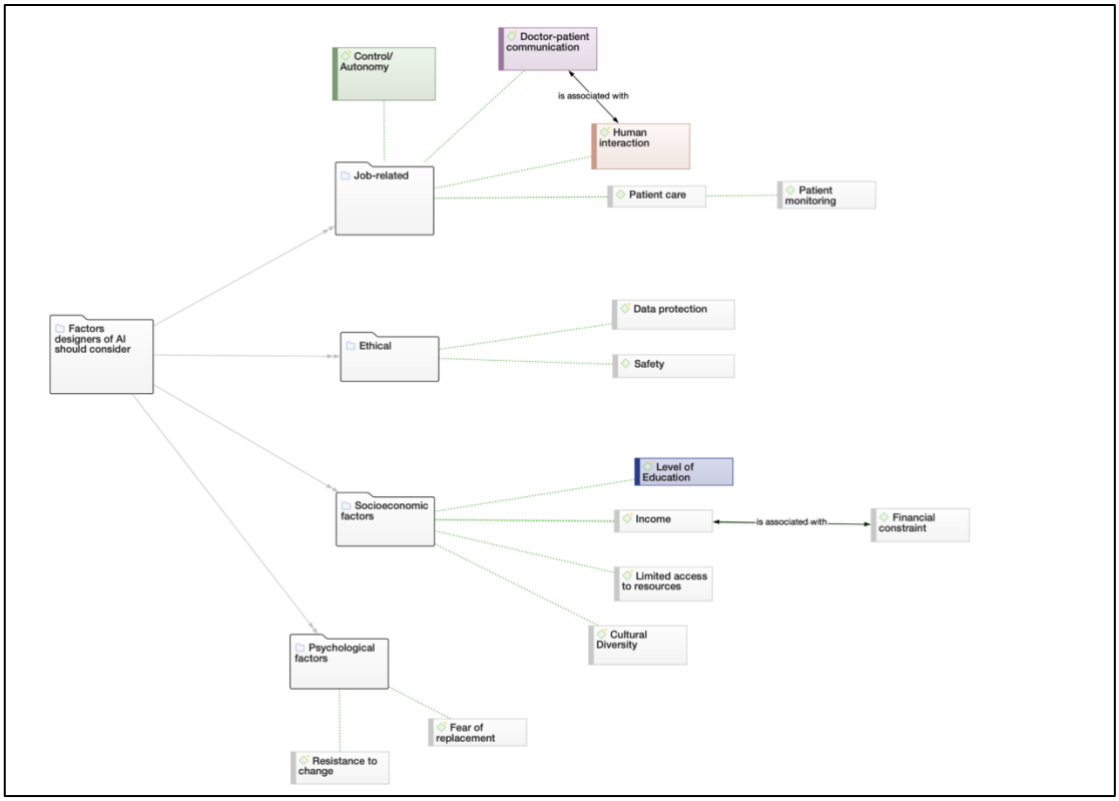
Дизайн ИИ	-«По вашему мнению, какую роль должны играть медицинские работники в разработке систем искусственного интеллекта для здравоохранения? - Как вы можете эффективно поделиться своим опытом?».

	- Как медицинские работники могут / пытаются влиять на дизайн ИИ? - Каким в идеале вы видите здравоохранение Кыргызстана через 10-20 лет?

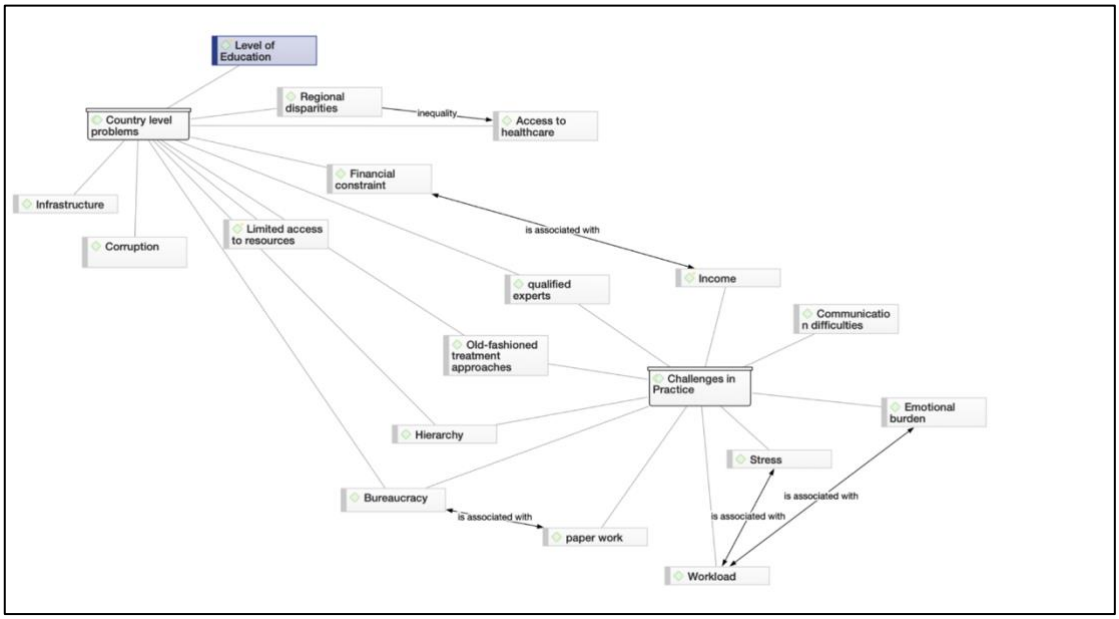
10.3 Appendix 3: Interviewee's demographics

	Gender	Specialisation/medical field	Age group	Work institution	Duration
HCP1	M	Physician	25-35	Private (prior: Public)	45 mins 30 sec
HCP2	F	Neurologist	25-35	Private (prior: Public)	25 mins 55 sec
HCP3	M	Surgeon	25-35	Private (prior: Public)	40 mins 20 sec
HCP4	M	ENT (Otolaryngologist)	35-45	Public and Private	35 mins 15 sec
HCP5	M	Physician	45-55	Private	29 mins 49 sec
HCP6	F	Gynecologist/ family doctor	65+	Public	47 mins 30 sec
HCP7	F	Gynecologist/Endocrinologist	35-45	Private (prior: Public)	16 mins 30 sec
HCP8	F	Physician	25-35	Private (prior: Public)	21 mins 50 sec

10.4 Appendix 4: Thematic analysis



10.5 Appendix 5: Country-level problems and challenges in practice relationship network



10.6 Appendix 6: Relationship between important factors at work and those that should be taken into consideration while designing AI systems