

Bachelor Thesis

**UNIVERSITY
OF TWENTE.**

The Impact of Digitalization on Humanitarian Aid:

A Systematic Review

about the Use of GIS Mapping in Refugee Camp Management in Africa

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Abstract

Digital tools are more frequently used in refugee camp management. For instance, geographic information systems (GIS) can be used to track refugee flows, to plan refugee settlements, or to identify difficulties and needs. However, to date, there is limited research examining *how the use of GIS mapping has influenced refugee management processes in Africa*. To further explore the potential and threats of digitalization in this area, eight case studies about the use of GIS mapping in Africa were systematically reviewed. The *Digital Governance Theory* and theory of *Responsible Innovation* served to investigate the impact and challenges of the tool. The review showed that GIS could strengthen the collaboration among actors and improve the assessment of humanitarian aid but is not yet implemented in an advanced stage, especially looking at the government level. The design of GIS lacks sociotechnical perspectives, which leads to a variety of challenges when applied in a camp settlement. The limitations not only relate to the effectiveness of geospatial technology but also touch on ethical dimensions. Acknowledging the identified potential and challenges of the tool by public administration can serve to adapt and optimize the implementation of GIS within refugee management.

Table of Content

1. Introduction	1
2. Theoretical Framework	5
2.1. Digital Government Theory	5
2.2. GIS in Digital Migration Management	6
2.3. Responsible Innovation	10
3. Methods	11
3.1. Systematic Literature Review	11
3.2. Literature Collection	12
3.3. Data Analysis	13
4. Findings	14
4.1. Descriptive Statistics & Co-Authorship Analysis	14
4.2. Pillar 1: Coordination and Collaboration	18
4.3. Pillar 2: Provision of Humanitarian Aid	20
4.4. Pillar 3: GIS Digitalization within Migration Management	23
4.5. Challenges and Limitations	25
4.6. Responsible Innovation	28
5. Discussion	29
6. Conclusion	34
7. References	36
8. Appendix	39
8.1. List of Documents for Systematic Review	39
8.2. Coding Table	40

List of Tables and Figures

Tables

Table 1	<i>Descriptive Statistics</i>	15
Table 2	<i>List of Documents for Systematic Review</i>	39
Table 3	<i>Coding Table</i>	40

Figures

Figure 1	<i>GIS Mapping of a Refugee Camp in Eastern Chad</i>	2
Figure 2	<i>Visualization of co-authorship network</i>	16
Figure 3	Frequency of GIS usage for the improvement of collaboration	18
Figure 4	<i>Different fields of GIS application</i>	20
Figure 5	<i>Density Map in Khartoum, Sudan</i>	21
Figure 6	<i>Camp Suitability Evaluation in Kenya</i>	22
Figure 7	<i>Presentation of the GIS digitalization in the reviewed studies</i>	23
Figure 8	<i>Types and frequency of faced challenges while applying GIS</i>	25

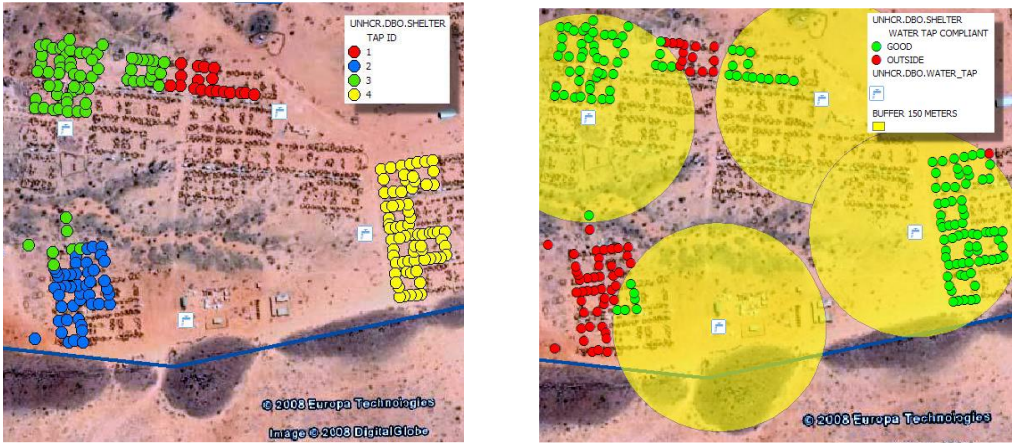
1. Introduction

Flight and migration are two of the most important topics on today's policy agenda. An estimated 103 million people were forcibly displaced from their homes as of June 2022 for a variety of reasons, including conflict, violence, or human rights abuses (UNHCR, 2022). This development is rather increasing, which also results in an increased number of internally displaced people (IDPs) in non-permanent camp settlements. Until the causes of flight are addressed, and long-term solutions are found, IDP camps must be properly managed and provide a minimum standard of living (Younes et al., 2022). However, camp management is accompanied by many obstacles like complexity, the need for multi-level cooperation, and the difficult estimation of necessities (Larrison & Raadschelders, 2020). To address the issue of migration, many actors need to be involved. On the one hand, this is facilitated by public administration bodies, but also by civil society, and private actors such as NGOs. During times of displacement, they carry out tasks like providing shelter, creating access to healthcare, or helping to transform policies and services that affect forced migrants (UNHCR, 2023).

Since we are living in an era of digital transformation, the increased use of digital tools can also be seen within public administration and, more specifically, in the management of refugee populations. Digital tools cannot solely be used to gain profit but also in areas for humanitarian aid and development. Therefore, this can positively affect socio-economic and humanitarian development (Bonina et al., 2021). Digital tools within refugee management concern a wide range of areas, including the implementation of digital biometric systems, the use of drones, increased digital data or digital mapping (Jacobsen & Fast, 2019). The latter, the Geographic Information System (GIS), is a visualization tool for geographic data based on Global Positioning Systems (GPS) and satellite imagery which is stored on a geospatial database. It is widely used in various sectors, for instance, land use management, Smart City governance, infrastructure, risk management, forestry, and even medicine (Hognogi et al., 2021). Within refugee management, GIS is applied to improve the camp's infrastructure, data collection, or decision-making processes. It also helps to research refugee camp situations, refugees' vulnerability, or migration flows (Meehl, 2008). Participatory mechanisms involving the public (PPGIS) have also adopted GIS to empower marginalized groups and communities. Below is an example of a mapped refugee settlement showing shelters and their

assigned water taps (Figure 1, left) as well as the intended maximum distance between shelters and taps (Figure 1, right).

Figure 1
GIS Mapping of a Refugee Camp in Eastern Chad



Note. From Meehl, J. S. (2008). Using GIS and other Location Based Tools for the Registration, Design, Maintenance, and Mapping of Refugee Camps. *Papers in Resource Analysis*, 10. <http://www.gis.smumn.edu>

Even though the tool can potentially have many benefits and its use in the non-profit sector is increasing, its practical implications are still facing challenges, such as data issues, technological access, and human resources (Meehl, 2008). Accordingly, its use in local governments and the implementations within governmental processes and decision-making remain low, but this is rather traced back to institutional barriers and less to technological ones. On top of that, the use of data and digital technologies might pose social challenges due to the reproduction and exacerbation of existing social and political inequalities, which especially have negative impacts on marginalized groups (Ganapati, 2011).

However, to date, it is not yet scientifically assessed how GIS tool implementation has impacted migration management and to what extent it is efficient and effective. One way to evaluate this is to draw on studies of Public Administration and, in doing so, to apply the *Digital Governance Theory* by Margetts and Dunleavy to present implementations of Geographic Information Systems within refugee management. Margetts and Dunleavy (2013)

argue that there has been a shift to “digital era governance” (DEG), which focuses on (1) *reintegration*, (2) *needs-based holism*, and (3) *digitalization within governance*. Given this, they argue first that public administration needs to focus on the cooperation of different actors to avoid double processes and thereby reduce costs and efforts. Secondly, they highlight the needs-oriented approach to create holistic and user-based structures and service provisions that are simultaneously flexible and resilient. Lastly, they emphasize the capability of the public sector to adapt and implement digital services and automatization into their administrative processes.

In addition to that, the theoretical framework consists of the theory of *Responsible Innovation (RI)*. This states that the development of digital tools lacks social and political perspectives during the design process (Hess et al., 2021). Since technology always involves power, disregarding potential societal risks can have far-reaching consequences (Bonina et al., 2021). For example, compromising data justice or security can lead to the use of digital tools disadvantaging certain groups. In order to not only achieve economic targets but rather benefit various societal demands and values, it is necessary to go beyond the technical dimension and include multidisciplinary approaches. This sociotechnical acknowledgement can create digital tools with a broader scope of application and lower barriers to implementation.

However, the impact of geospatial technology within refugee camp management remains poorly understood. Especially research within Africa is still quite limited since the majority of Public Administration research focuses on the Global North. Therefore, this study aims to further investigate the intersection of GIS, Public Administration, and Migration in this context. To observe common impacts or challenges and identify consistencies or discrepancies, a systematic literature review of recent case studies within this research field will be conducted. The findings can establish a scientific base, which will be used to examine the following main question:

How has the use of GIS mapping influenced management processes in refugee camps in Africa?

In order to answer this research question, a content analysis of the reviewed articles is conducted, guided by the three pillars of the *Digital Governance Theory*. To transfer the *Digital Governance Theory* to migration management, the three pillars will focus on three factors: (1) *coordination and collaboration between humanitarian actors*, (2) *provision of humanitarian aid*, and (3) *extent of GIS implementation within refugee management*. In

addition, attention will be paid to any emerging barriers and indicators for *Responsible Innovation*. Combined, these serve to create the characteristics for the analysis. Subsequently, the findings of the published case studies will be examined and interpreted to answer the following sub-questions:

1. *How is GIS mapping used to facilitate the coordination and collaboration among different stakeholders to improve multi-level governance?*
2. *How do actors use GIS to support the provision of humanitarian services to refugees?*
3. *To what extent are geographic information system tools properly implemented within refugee camp management in Africa?*
4. *What are the challenges and limitations of using GIS mapping for refugee management?*

Scientifically speaking, this study can extend the scope of the *Digital Governance Theory* into a new field by looking at refugee governance and narrowing the pillars down to multilevel collaborations, the optimized assessment of humanitarian aid to refugees, and, lastly, the digitalization within the management of refugee populations. The effectiveness of GIS within refugee management has only scarcely been researched, and more research needs to address GIS implementation in Africa since the living conditions of refugees in Africa are associated with higher vulnerabilities. On top of that, the power of digital tools, particularly concerning the user's rights or how they potentially influence policy decisions by highlighting or hiding features, requires further research. The dominant Western perspective on public administration may not be applicable worldwide, hence inclusive approaches are needed to center the perspectives and experiences of actors in the Global South (Haque, 2019). The current study can improve public management research by identifying existing limitations, challenges, and possible implementation changes. Extensive and broad-based research not only contributes to scientific relevance but also sets the foundation for further social and political implications.

Subsequently, these findings are also societally relevant since they can be used to practically advance digitalization and optimize the use of GIS in migration management. The core of migration issues lies in the questions of public administration, especially looking at the local level (Hognogi et al., 2021; Yeo & Huang, 2020). A focus on digital improvements and policy adaptations can optimize public processes to save costs and optimize workflows and create more effective administration. This could have far-reaching and long-term positive effects for

the involved actors and the civil society as well as for the affected migrants (Larrison & Raadschelders, 2020). In particular, recognizing RI and improving client-centered service delivery could establish more appropriate governance processes that are less neglectful of societal needs. This could ultimately benefit not only economic factors but also have an impact on the political, social, and ethical dimensions.

2. Theoretical Framework

2.1. Digital Government Theory

To answer the research question of “*how the use of GIS mapping has influenced management processes in refugee camps in Africa*”, first, the *Digital Governance Theory* is applied to assess whether refugee camp management is indeed digitalized in terms of GIS.

The Digital Governance Theory was established by Margetts and Dunleavy and focuses on the effective and responsible governing of digitalizing public processes. They developed the term Digital Era Governance (DEG), which refers to the use of digital technologies in the public sector to enhance governance and public service delivery (Dunleavy et al., 2006). DEG is an umbrella term for all recent initiatives to modernize governance in public administration (Ravšelj et al., 2022). Margetts and Dunleavy (2013) argue that there has been a shift to a “digital era governance” (DEG), which focuses on the (1) *reintegration*, (2) the *needs-based holism*, and (3) *digitalization within governance*. Within each of these three pillars, there are two streams identified to achieve an adequate digital transformation: 1) to establish a centralized, network-based government that enhances communication, or (2) to develop a decentralized, databased government which increases information processing.

The DEG involves changes in IT and information management and has multiple dimensions, including information dissemination, communication with citizens, service delivery, socioeconomic monitoring, advanced social analytics, and regulation of social life (Dunleavy et al., 2006). Many of the changes originate from the advancements of technology in private companies, for instance, digital process automation, but implementation within the government sector has not yet reached the same extent. Research studying the use of ICTs (Information and Communication Technologies) in the public sector suggests that an

increased implementation could lead to economic benefits like the reduction of costs and increased productivity. But also, on the political dimension, DEG could potentially combat corruption, increase accountability, and institutionalize transparency in public sector practices. Furthermore, the increased transparency and flexibility potentially make it more attractive to public engagement (Hognogi et al., 2021).

This theory was used by several scholars to test the extent of digital transformation within the public sphere and observe the impacts, use, and results of a specific digital tool. Hognogi (2021) for instance used this theory to review drones and GIS and their different areas of use worldwide. The main findings were related to image processing, landslide, and heritage. However, the tool's potential is limited due to the lack of connection between academia and public administration, as well as the lack of innovation capacity within economics. Hence, the digital tool as such, was not sufficient to establish proper digital transformation within governments. Ravšelj (2022) also investigated DEG research and encountered bureaucratic obstacles and a lack of innovation within public governance. Moreover, an emphasis was placed on the need for modernization and digitalization in public governance to create value for citizens and achieve more sustainability. Zhou's (2013) application of the *Digital Governance Theory* resulted in the finding that governments need new organizational structures to avoid an implementation gap. Here, GIS is used in spatial planning practices but encounters challenges within the implementation. Due to that, either the external conditions or the internal design of the tool requires adaptation to improve urban planning and decision-making. The previous studies gave examples of why the *Digital Governance Theory* is suitable to identify assets and drawbacks of digital technologies, as well as to advise optimizations of the tool and evaluate different areas of use. However, the previous outcomes revealed the lack of suitability and interdisciplinarity of digital tools, which is why the theory of *Responsible Innovation* will be applied additionally to complement the theoretical perspective.

2.2. GIS in Digital Migration Management

Given the potential benefits of digitalization, within migration management, it can therefore be analyzed whether or how the implementation of geoinformation systems can optimize refugee management on several levels. GIS can specifically be situated in the context of

migration management, providing a technological tool to depict spatial information visually and conduct spatial analysis. Mapping can be used in different ways regarding camp assessment, camp planning, and camp management. To investigate “*how the use of GIS mapping has influenced management processes in refugee camps in Africa*”, the original three pillars of the *Digital Governance Theory* are adapted into the exact context of refugee management: (1) *reintegration* becomes coordination and collaboration between humanitarian actors, (2) *needs-based holism* will be adapted to the provision of humanitarian aid, and (3) *digitalization* will be adjusted to the extent of GIS implementation in refugee management. The distinguishment into the three areas will be investigated with the first three stated sub-questions.

Firstly, it is asked, “*how GIS mapping is used to facilitate the coordination and collaboration among different stakeholders to improve multi-level governance?*”. The process of reintegration is therefore characterized by the restructuring of government processes and cooperation mechanisms to reduce costs and efforts. Here again, the transition can run in two possible separated streams: A centralized network-based government can be achieved through the recentralization of control and process optimization by reducing double service delivery chains. Central management centrally employs specialists that relieve work from local decision-makers and create faster and more effective responses. Looking at the other possible stream, a digitalized government can be characterized through a decentralized database. Here, data is collected from different settings to create a big, universally accessible database and enables data pooling between different parties. This way, processes, and decisions are based on accurate information and can limit costs and time by reducing unnecessary workflow steps and connect processes.

Now looking into refugee camp management, it needs to be stated that it is a complex multi-level process involving regional organizations, national policy-making, and local implementation. To address the challenges of migration management, there is a need for a transnational perspective, collaborative governance, diversity in migrant integration in public bureaucracies, and a focus on government-in-society (Larrison & Raadschelders, 2020). Geographic Information Systems could improve this collaboration by collecting information and creating databases. The universal availability and accessibility of digital data can increase transparency and combat corruption. Furthermore, it can provide necessary details for profound decision-making (Ravšelj et al., 2022). Another advantage of GIS is the creation of

insights and reliable information, which can facilitate the coordination of tasks to assess the necessity of humanitarian organizations and personnel. This shows that digital tools can simplify different organizational and governmental workflows within the public administration. On top of that, digital tools can also improve cooperation at and within the citizen level. GIS becomes more and more accessible to the general public and is not exclusively used by experts. In this context, some areas have adopted participatory GIS, e.g., in traffic and transit, information provision, volunteered geographic information, customer relationship management, and local government decision-making (Ganapati, 2011). This can improve bottom-up approaches within migration management. Based on potential impacts on organizational workflows, decision-making, and participatory uses, the following first hypothesis is made:

H1: The use of GIS mapping is increasing the multi-level cooperation between actors.

Secondly, it will be investigated ***how actors use GIS to support the provision of humanitarian services to refugees.*** According to the second pillar of the theory, public management should create holistic and user-based structures and service provisions. More specifically, government services must be structured around clients' needs. Hence public administration should distribute and weigh public services around the actual necessity and importance, to primarily meet the citizens' needs and not waste the budget on services that are not needed. This can then serve to create efficiency. Herbert Simon defines efficiency in public administration as the absence of limits to output and quality, in detail, the absence of limits on the ability to perform and on the ability to make correct decisions (Simon, 1946).

Furthermore, processes need to be flexible on the one hand and resilient on the other. This means that programs and processes should be user-friendly, understandable, and easy to access, for instance, through widely developed online services. Another way to achieve needs-based-holism is the preventive risk assessment and monitoring of developments carried out on various levels. Thus, it is possible to detect difficulties, risks, and upcoming needs at an early stage to avoid issues to grow or escalate in the first place. In general, this governmental transformation follows the device of "invest to save" and assesses needs precociously and client-based.

With regard to refugee camp management, the ability to collect data and information provision can act in the creation of a needs-based government. Humanitarian response is

accompanied by several barriers: e.g., complexity due to multi-level governance, limited resources, security issues, and uncertainty. GIS mapping from humanitarian organizations could combat this by providing reliable information, especially data about the camps' conditions and the refugees involved. It can be used to research the living conditions of camp residents, for example, housing conditions, access to water, or health facilities. It can also be used to map migration flows and trace areas of origin (Meehl, 2008). This mapping can be used to assess whether standards are being met in camps or whether adjustments are needed. In addition, it may be possible to highlight hotspots or particularly vulnerable areas. In this way, risks can be mitigated, and holistic information about needs and necessities can be obtained, which can be used to provide humanitarian assistance appropriately and make necessary adjustments within a camp. Geospatial technology could substantially enhance multi-level monitoring, prior needs assessment, and client-based service provision within the humanitarian response. This leads to the following hypothesis:

H2: GIS mapping tools can improve the provision of humanitarian aid to refugees.

Lastly, it will be investigated *to what extent geographic information system tools are properly implemented within refugee camp management in Africa*. The last pillar of the theory is concerned with the actual process of digitalization within governance. The public sector should be capable of adapting and implementing digital services and automation into their administrative processes. Within the centralized transformation stream, this means cutting out the middleman within processes and developing and channeling all kinds of online services. Furthermore, it focuses on customer segmentation and the establishment of universal digital access for clients. The decentralized digital transformation, on the other hand, focuses on the implementation of e-governance in terms of digital process automatization and open data initiatives. If governments can resolve the privacy and security issues involved, this digital transition can reduce the need for staff and save costs. In this way, digital tools can eventually lead to an increase in efficiency within governance processes.

However, looking at migration management, it is observed that digital transformation here is lacking due to several reasons: Digitalization at first might create a higher workload during the transformation, which is why there is resistance within institutions regarding automatization. On top of that, technical problems like digital literacy and technological access might arise, which slow down the process. Moreover, digital tools are handled with caution due to the risk of bias and errors, which could lead to ethical impairments (European

Migration Network, 2022). Barriers were also identified in the context of participatory GIS, but these were largely due to institutional reasons rather than technical ones (Ganapati, 2011). In other studies, difficulties regarding the practical implementation of GIS have also been encountered due to data issues and human resources. Generally, there are several barriers when it comes to the integration of digital tools within public administration. The tools are not designed and adapted to the governmental structures and requirements, which leads to an implementation gap (Kai Zhou, 2013). These previous insights regarding the presence and emergence of barriers lead to the following hypothesis.

H3: *GIS is not yet adequately implemented within public administration processes to increase the effectiveness of migration management.*

2.3. Responsible Innovation

As we hypothesize that the full realization of digital transformation will be hindered, it is important to find out which factors exactly are the reason for that. Therefore, in addition to the theoretical framework of *Digital Government Theory*, the theory of *Responsible Innovation* is also taken into account.

Technical innovation can appear in various dimensions, like the economic, social, or political one. The theory of *Responsible Innovation* addresses the design of technology, which should not only have advantages in terms of economy and technological efficiency but also take into account societal values and practical implications (Hess et al., 2021). To achieve this end, the process of research and development needs to incorporate experts from different scientific areas, as well as people from the field, to create “responsible research” (Owen et al., 2021). There has been a recent increase of diverse and multilevel cooperation in research, especially in Europe, where it even became a policy perspective, but there is still a need to enhance the partnership between humanists and technical scientists to establish stronger cooperation to identify problems and solutions, especially for science or policy development (Hess et al., 2021). With regard to the political dimension, it is important to embed, for instance, stakeholder dialogue, moral imagination, multiple-perspectives approaches, or systemstinking into the decision-making process. By doing that, governance structures can incorporate the four dimensions of RI: anticipatory, reflective, deliberative, and responsive (Nathan, 2015). Therefore, the incorporation of sociotechnical perspectives is strongly

connected to the *Digital Governance Theory*. Designing technology in order to effectively centralize or decentralize processes could serve collaboration among actors and, therefore, the *reintegration* dimension of digital governance. Adaptation of technology to the needs of the consumer goes hand in hand with *needs-based holism*. And lastly, if institutional and practical barriers are acknowledged, the implementation and digitalization process can be adjusted. Only when technology is designed and implemented with a variety of perspectives in mind is it possible to adequately shape the digital transformation?

This perspective regarding challenges and RI creates another angle of vision and operates as the fourth sub-question: 4. **What are the challenges and limitations of using GIS mapping for refugee management?**

3. Methods

3.1. Systematic Literature Review

Geographic Information Systems are mainly studied within the research areas of Geography, Urban Planning, or Public Land Management but rarely within the field of Migration. However, there is a recent increasing trend of using GIS within migration management. To investigate GIS in the emerging literature, a systematic approach serves to structurally investigate a complex and multifaceted topic like refugee management. The review will create an overview of the current literature and scientific assumptions within the field, which is needed, to create a basis for future research. Therefore, a Systematic Literature Review of published case studies within this topic will be conducted to answer the proposed research question “*How has the use of GIS mapping influenced migration management processes in refugee camps in Africa?*”

A Systematic Literature Review represents a profound method to transparently summarize and analyze the current state of the art within a specific research topic. Systematic Literature Reviews are a method of qualitative analysis that is widely used among scientific researchers. They serve to create a certain basis before further research is conducted. The structural and systematic review organizes and analyses these already existing scientific articles in one specific area to show which findings have already been made and which scientific puzzles

still need to be solved. It helps to understand the variety, depths, and scope of the research interest. Furthermore, it can reveal existing limitations but also show consistencies or inconsistencies among the literature. This knowledge based on prior work enables an extensive assessment to further create hypotheses and theories (Fink, 2019; Page et al., 2021; Xiao & Watson, 2019)

There are several types of systematic reviews with different depths of analysis. This qualitative analysis will be based on the structure of *Qualitative Content Analysis* by Philipp Mayring. This consists of the following six steps: (1) Determination of the evaluation unit/text passage, (2) Lexical-grammatical definition of the text passage, (3) Determination of the permissible explicative metadata, (4) collection of material (with open or closed code), (5) Formulation of explicative paraphrases, (6) Verification if explication is sufficient (Mayring & Fenzl, 2019).

3.2. Literature Collection

The chosen database for the keyword search will be the Web of Science. Even though it is argued to contain less research about humanities and social science, the given data will be sufficient for the type of research. A preliminary search with different keyword combinations was performed to get a general insight into the number of case studies available. These were, for instance, “GIS” and “Public Administration” or “GIS” AND “Humanitarian Aid”. However, these keywords proved to be either too narrow or too broad. For instance, the keyword “Humanitarian aid” yielded research about humanitarian aid in general, some of it not related to migration. The keywords “GIS” AND “Refugee” proved to include the most relevant research regarding my research question. The preliminary research did not show any existing reviews on this research topic, which advocated the choice of the methodology even more.

The output from the keywords “GIS” AND “Refugee” gave 106 results and was screened for the keyword “Camp” to filter for results specific to GIS in camp management or camp site assessment. Using this approach prevents the inclusion of wrongly identified articles that refer to governmental institutions or green infrastructure (“GI”/ “GIs”). In total, using the keywords “GIS” AND “Refugee” and screening the results for the keyword “Camp” revealed 28 hits

with several studies in Bangladesh, Jordan, Cameroon, and Sudan and single studies in other countries, e.g., Greece, Turkey, or Kenya. To increase the comparability of studies, the date of publication was limited to the past five years (2017 – 2022), and a geographical focus was put on studies conducted in Africa. This approach resulted in a final selection of 8 articles (see *List of Documents for Systematic Review* in the appendix).

3.3. Data Analysis

These eight articles provide information about different implementations of geographic information systems and their challenges and limitations in single cases. Summarizing the findings of individual studies allows an all-encompassing view into the current state of research. To give a first overview, the descriptive statistics of the analyzed articles, including the authors, years, title, journal, topic, and geographic scope, will be displayed in an APA table. Furthermore, the co-authorship network will be investigated and visualized in a bibliometric analysis.

The analytical approach of the review will be a qualitative content analysis of the articles, with codes derived through deductive coding. In this top-down approach, a codebook will be created with an initial set of 5 codes which are based on the existing theoretical framework. The operationalization concretizes rather broad concepts from the theory into exact variables. The first part of the coding categories will be based on the *Digital Governance Theory*, which is divided into the three pillars (1) *reintegration*, (2) *needs-based holism*, and (3) *digitalization within governance*. The three pillars will be adapted to codes that correspond to GIS within refugee management: (1) *coordination and collaboration between humanitarian actors*, (2) *provision of humanitarian aid*, and (3) *the extent of GIS implementation in humanitarian management*. For instance, the content analysis of the first pillar will search for content that shows signs of networks, workflows, partnerships, shared tools, or reduction of cooperation barriers. As each of the three pillars is further subdivided, attention will be paid during the screening process to the indicators relating to these two streams. Thus, it will be reviewed whether the codes can rather be characterized under a *centralized network-based communication-gaining process* or a *decentralized data-based information-gaining process*. Additionally, it will be examined if any obstacles are occurring within the digital transition. This perspective will be coded under *Challenges and Limitations*. Finally, the articles are

searched for mentions and indicators about sociotechnical perspectives or integrative approaches, which creates the last code *Responsible Innovation*. The corresponding coding table will be presented in the appendix. In order to make the analysis more accurate, the method of color coding was undertaken. To minimize the subjectivity of the qualitative coding, peer coding was carried out with a fellow student from the same program. A comparison of the coding was then used to test the coding procedure.

After creating a comprehensive scientific base about the use of GIS within refugee management, the codes within one typology are then compiled and summarized for hotspots, overlaps, commonalities, and discrepancies. Subsequently, it will be analyzed to what extent digitalization, according to the *Digital Governance Theory*, can be confirmed. In addition, in determining the challenges experienced and the absence or presence of socio-technical perspectives, further policy adaptation and implementation recommendations will be discussed. Moreover, it will be observed if there are any differences or surprising outcomes among the case studies that can be attributed to specific conditions or approaches. Inferences about these characteristics can also serve implementation improvements. Finally, the results will be discussed regarding their accordance with the initial GIS policy goals and guidelines formulated by the United Nations to see if these reflect the actual circumstances or require adaptations. Through these findings, it will be possible to draw general conclusions about the extent to which GIS has changed refugee management in refugee camps. This may serve to highlight necessary research within Public Administration and Migration and to give future recommendations to optimize the process and use within refugee management in Africa.

4. Findings

4.1. Descriptive Statistics & Co-Authorship Analysis

To give a first overview of the reviewed scientific field and research areas, a descriptive statistic about the systematic review will be provided hereafter. This includes information about the publication date, author, journal, research unit, and GIS application. The reviewed articles research the potential GIS use in different African settings like Cameroon, Kenya, or Sudan and test different technical integrative approaches. The research interests can be

categorized into different fields within refugee management (1) Camp Site Selection, (2) Camp Mapping, and (3) Risk Monitoring.

Table 1
Descriptive Statistics

Year	Author	Journal	Geographic Scope	GIS Usage
2017	Tiede et al.	Remote Sensing	East Africa	Camp Mapping
2020	Lang et al.	European Journal of Remote Sensing	Africa	Camp Mapping, Camp Site Selection, Risk Monitoring
2021	Ghorbanzadeh et al.	European Journal of Remote Sensing	Cameroon	Camp Mapping
2021	Tiede et al.	Transactions in GIS	Sudan	Camp Mapping
2022	Younes et al.	International Journal of Disaster Risk Reduction	Kenya	Camp Site Selection
2022	Ghorbanzadeh et al.	Remote Sensing	Cameroon	Camp Mapping
2022	Gella et al.	Remote Sensing	Cameroon	Camp Mapping
2022	Curtis et al.	Tropical Medicine and Infectious Disease	DRC	Risk Monitoring

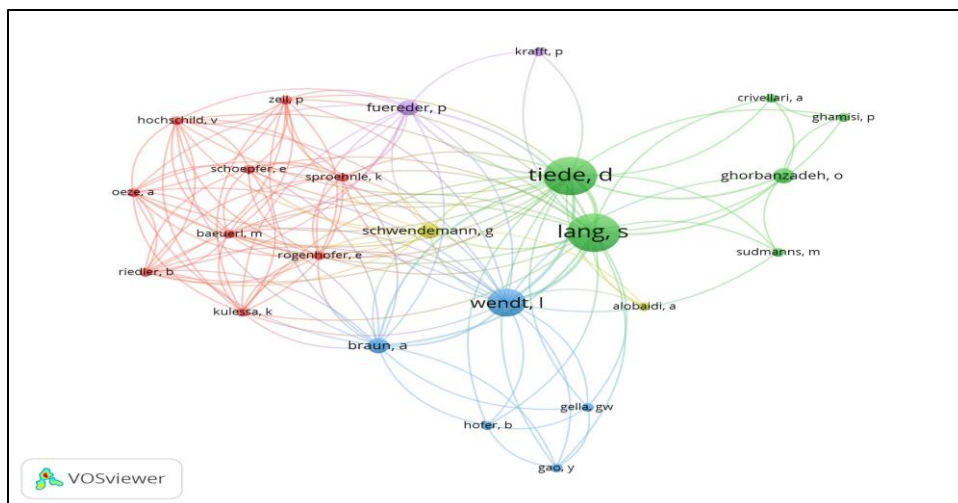
While the second article by Stefan Lang (2020) covers all of the fields and tries to give more general findings about the effectiveness within humanitarian assistance, the other articles focus on one particular setting. Ali Younes (2022) examined conditions in Kenya based on 19 geographic, social, environmental, and infrastructural criteria and used these to assess suitability and risks for camp settlements. Andrew J. Curtis (2022), on the other hand, identifies health risks in a settlement in the Democratic Republic of Congo by mapping outbreaks of Cholera and the presence of water, sanitation, and healthcare facilities. However, most research has focused on advancing or integrating geospatial information technologies to map camps for population estimates, map infrastructure, or characterize dwellings.

The research topics can also be identified by the publishing scientific journals. While the case studies about cholera and camp site selections were published in journals in the fields of

Medicine and Disaster Risk Reduction, all the other authors published in journals with a more technical nature, focussing on Remote Sensing Technology and Spatial Science. The proximity of the journal directions as well as the repeated names in the authorship, indicate many connections within this scientific field. Based on this assumption, the descriptive statistics were followed by an author network analysis bases on bibliometric data about authorships and co-authorships to identify the intensity of the connections and interrelationships.

Figure 2

Visualization of (co-)authorship network



Note. Based on bibliographic data from the Web of Science; larger nodes indicate a high frequency of authorship, and the lines show the different connections to the other (co-) authors.

In recent years, research has been less and less carried out individually, hence the collaboration among authors is increasing. This trend was initially seen in natural sciences but is more and more visible in social sciences as well. Since scientific publications are a major factor in the development of scientific fields, it is interesting to observe co-authorships and cooperation in research (Acedo et al., 2006). Recent elaborating research fields, which also include only a limited number of researchers, tend to show strong collaborating ties (Mourao & Martinho, 2020).

As visualized in the figure above, it can be seen that reviewed publications show two networks. One smaller network consisting of four authors. But more importantly, one big

network consisting of all the author authors and co-authors. Read from the size of the nodes and the number of ties, the authors Dirk Tiede and Stefan Lang indicate the strongest interrelations among this field. Both of them research and teach at the faculty of geoinformatics at the Paris-Lodron University in Salzburg, Austria (PLUS, 2023). This finding can be traced back to the systematic reduction of the research field for the systematic literature review. It displays the small interconnection of the field of geoinformatics, which is concerned with refugee camp management and simultaneously geographically limited to the continent of Africa. This excludes other researchers who, for instance, investigated GIS in camps in Greece, Jordan, or Bangladesh, which were found before adding the geographic filter to the literature selection. Taking a step back and looking into the authorship of a previous article selection, a greater distribution of networks was presented, which would indicate weaker collaborations. However, the literature collection was also reduced according to the date of publication. This step removed many more publications from Tiede and Lang since their research project consisted of around 30 studies carried out in refugee camps in Africa.

In general, it can be said that the intersection of geoinformatics and humanities is still very limited. The authorship is highly homogeneous since it solely consists of a small number of scientists, which almost all seem to collaborate since they are tied to one big research project by the University of Salzburg. Thus, it can be questioned if coherences and similarities can really be traced back to the actual finding or rather to bias and connections within the network. This finding represents a limitation that is taken up again in the upcoming discussion.

After now giving a general insight into the scientific network and the nature of the publications, the analysis hereafter will evaluate the following:

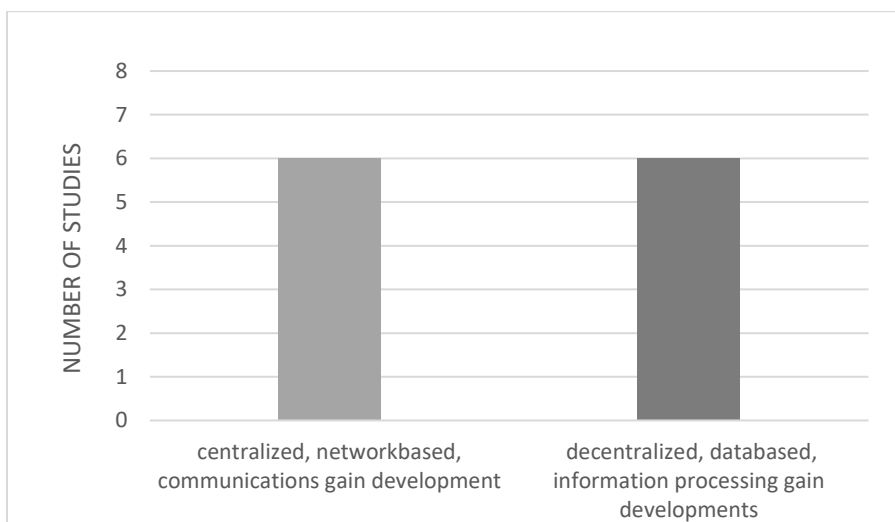
The articles were reviewed first for indicators that play into the *Digital Governance Theory*. The content analysis revealed indicators for all three areas within refugee camp management: (1) collaboration between humanitarian actors, (2) assessment of humanitarian aid, and (3) the level of digitalization. However, the total fulfillment of a digital transformation was impaired by a variety of challenges, which will be displayed afterward. Subsequently, the articles were screened for marks regarding the second theory: *Responsible Innovation*, which might serve as a solution to improve the digital transformation.

4.2. Pillar 1: Coordination and Collaboration

Digital Transformation can best be achieved through the reintegration of processes, acknowledging needs-based holism, and pursue digitalization. As mentioned in the theory section, the first pillar of the *Digital Governance Theory* refers to the collaboration and cooperation among actors of humanitarian aid. This can either be achieved through a centralized, network-based government or through a decentralized, data-based, information-processing government. This could be, for instance, a government where all bodies are tied to one central control mechanism or contrary government processes which consist of decentralized delivery chains that use shared devices and databases. The eight research articles were searched for work steps that included GIS and could be assigned to one of the trends. While the theory originally refers to processes in public management, the reviewed studies only stated steps that either were executed by scientists or NGOs or which were not allocated to a specific actor. Therefore, statements about the public and private sector are limited and the following findings exclusively relate to the third sector concerning non-profit and scientific activities.

Figure 3

Frequency of GIS usage for the improvement of collaboration



The first direction was detected in six out of eight articles through statements about the influence on workflows and work chains. Mapping through geographic information systems

allowed the enhancement of operational workflows and improved management procedures within humanitarian organizations. During the camp site selection, for instance, GIS helped to assess an adequate settlement area with the least possible risk factors. This limits possible future problems and therefore reduces the difficulties that refugees and humanitarian workers are confronted with. Furthermore, it created a “straightforward and coherent geospatial decision-making approach [...] to remedy the multidisciplinary problem of refugee camps siting.” (Younes et al., 2022:3). Another advantage is the application of mapping tools to plan, for instance, infrastructure, health care facility distribution or the distribution of vaccination campaigns (Tiede et al., 2017). On top of that, the distant collection of geographic data enables the continuation of work, even when areas are non-accessible due to, e.g., Covid lockdown (Tiede et al., 2021), political insecurities (Ghorbanzadeh et al., 2022) or cholera outbreaks (Curtis et al., 2022). Moreover, since GIS can be characterized as a time-saving tool for data collection, it is able to increase the working speed of humanitarian operations (Tiede et al., 2021). Developed network structures and digitalized workflows of one organization showed to be adaptable for NGOs and IGOs in other working fields like epidemiological or medical. They seem transferable to humanitarian actors in other locations, which allows cross-national development and cooperation (Curtis et al., 2022). Through all this, geospatial technology can train networks in humanitarian aid and limit practical obstacles, and potentially center operational workflows among different actors.

The second direction was determined through indicators about information-sharing processes which also appeared in six out of eight articles. The overriding objective is the gathering of geographic data, which will be collected in big databases and converted into applicable maps. Information can be extracted in various areas and can be of social, infrastructural, environmental, or geographical nature. Those can be, for instance, data about borders, natural surroundings, housing structures, or population density. To optimize collaboration among actors worldwide, collected data can be stored in a standardized international database that everyone can assess. This enables data pooling between actors that collaborate within one setting. It is then possible to centrally deploy data between, for instance, field workers, cartographers, scientists, camp managers, or epidemiologists, which were collected in their individual fields. This simplified the universal access to information and enabled the use of shared resources and hence prevented repeated data collection from individual actors. This is not only possible within one project but can also increase cooperation beyond one specific field. Generally, the decentral provision of geospatial data creates insights into certain areas

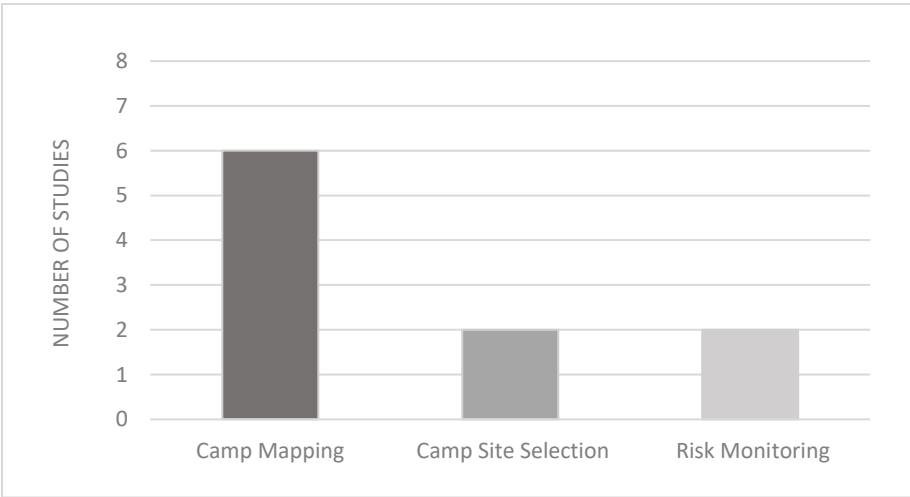
and allows workflows and collaborations to be based on reliable information. This common ground clears the path for the second step of digital transformation – the adequate assessment of the user’s needs. Subsequently, the first pillar of the *Digital Governance Theory*, *reintegration*, is connected to the second pillar, *needs-based holism*.

4.3. Pillar 2: Provision of Humanitarian Aid

Building upon the reintegration measures, the *Digital Governance Theory* follows up with the second pillar: the needs-based holism. As mentioned in the theory section, this relates to multi-level monitoring, prior needs assessment, and client-based service provision within the humanitarian response. The descriptive statistics showed that the research articles focused on three different areas of humanitarian aid where geographic information systems are used: (1) camp mapping, (2) camp site selection, and (3) risk monitoring. Considering the two streams of the *Digital Governance Theory*, those three tasks, however, hardly concern the centrality or network of processes but rather focus on decentralized information-based development.

Figure 4

Different fields of GIS application

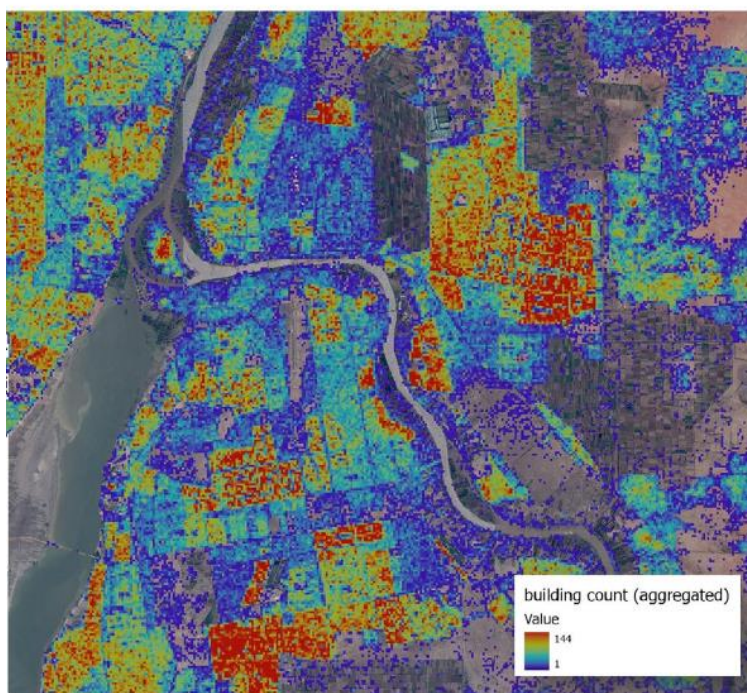


As illustrated above, the majority used GIS to map refugee camps, which were subsequently used for refugee camp management. Data is collected for a variety of map types. The main

type here was the mapping of housing to estimate population as well as population increases and population densities. One example of a density map created by Dirk Tiede can be seen below (Figure 5). This collected information was, for instance, used to assess if the site and housing situation is applying to the minimal standards of refugee settlements created by the SPHERE Movement and the United Nations (Younes et al., 2022). Correspondingly, it can then be used to plan camp enlargements while acknowledging migration streams or dense hotspots to adequately meet the living needs of refugees (Gella et al., 2022). Another type is the creation of infrastructure maps to identify the existence of institutions for health care, education, or governance. In combination with the population estimations, this serves to calculate the number of citizens per institution and statements about exhausted or sufficient capacities. Furthermore, maps illustrate the technical construction of the camp in terms of streets, transportation possibilities, or water and sanitation facilities (Curtis et al., 2022). Additionally, satellite imagery can be transformed into vegetation maps to illustrate the natural surroundings, like borders, water resources, or ground structures. Geographical data can then be used to expand the infrastructure of the settlement while respecting and utilizing the natural environment.

Figure 5

Density Map in Khartoum, Sudan

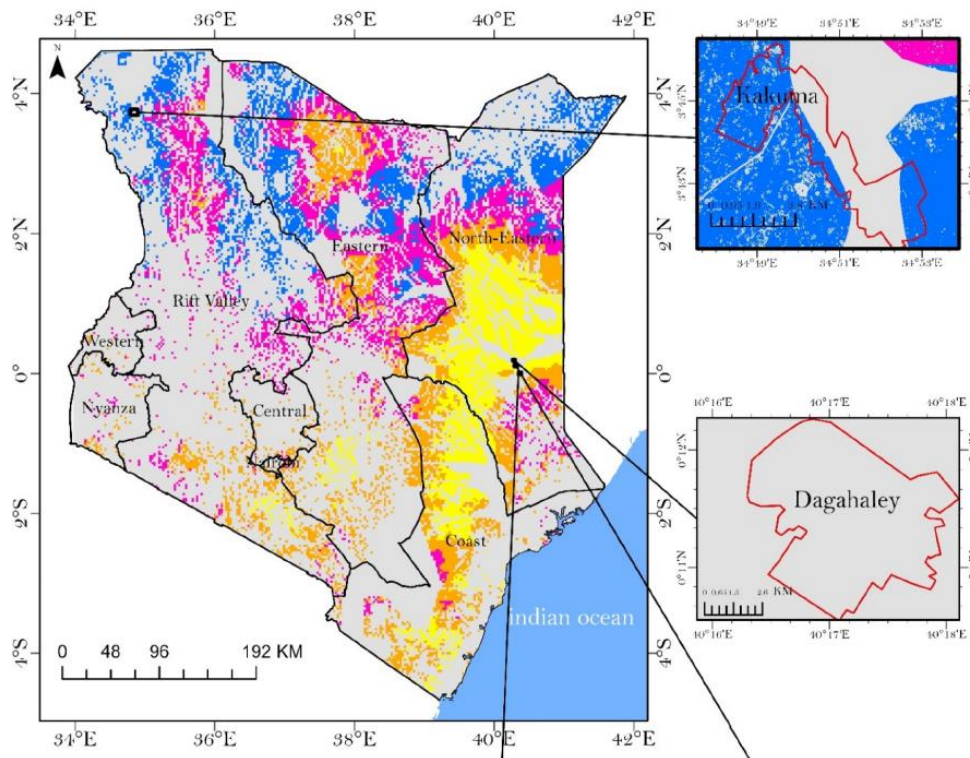


Note. From Tiede, D., Schwendemann, G., Alobaidi, A., Wendt, L., & Lang, S. (2021). Mask R-CNN-based building extraction from VHR satellite data in operational humanitarian action: An example related to Covid-19 response in Khartoum, Sudan. *Transactions in GIS*, 25(3), 1213–1227. <https://doi.org/10.1111/tgis.12766>

The next application option of GIS technology was within camp site detection. The researchers mapped the country of Kenya for 19 geographic, infrastructural, social, and environmental criteria. This information collection created a database about, for instance, slopes, proximity to airports or urban areas, flood risks, or distance to war zones. Through the layering of different maps, it was able to identify the suitable and unsuitable surroundings for refugee camps. Through this, it was also ascertained that the majority of the current refugee camps are located in unsuitable areas. The final map where the level of suitability is highlighted in different colors (high to low: blue – pink – orange – yellow – grey) can be seen below (Figure 6). Through early detection of adequate camp locations, it is possible to minimize risk potential, and pre-emptively avoid difficulties (Younes et al., 2022).

Figure 6

Camp Suitability Evaluation in Kenya



Note. From Younes, A., Kotb, K. M., Abu Ghazala, M. O., & Elkadeem, M. R. (2022). Spatial suitability analysis for site selection of refugee camps using hybrid GIS and fuzzy AHP approach: The case of Kenya. *International Journal of Disaster Risk Reduction*, 77, 103062. <https://doi.org/10.1016/j.ijdrr.2022.103062>

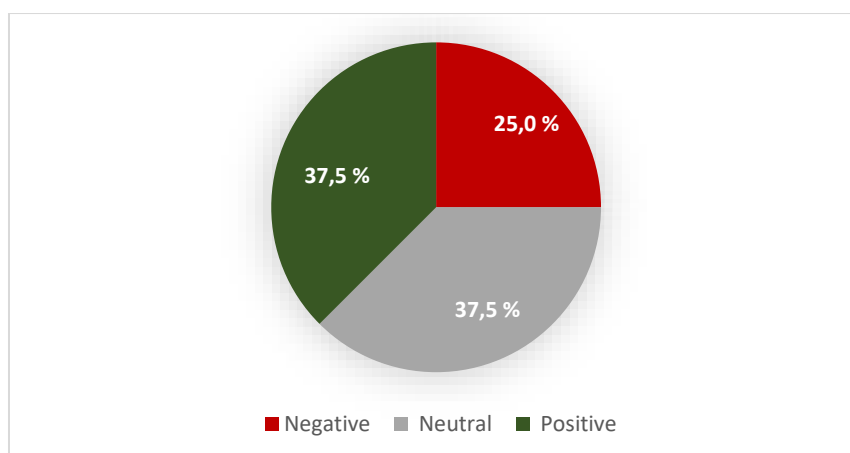
Lastly, geospatial technology was used by scientists and humanitarian organizations to monitor risks, in this case, the spread of cholera. Hence, it expanded from implementation in the humanitarian field to the epidemiological field. Through the monitoring and mapping of cholera outbreaks, it is possible to keep track of developments and respond accordingly. In this case, camp mapping, in terms of health care facilities, water and sanitation, or dense population areas, was used to assess possible hotspots and provide necessary health care. Hence, medical monitoring on small scales helps with early detection and prevents the increase or escalation of epidemiological crises (Curtis et al., 2022).

Concludingly, it can be said that in the reviewed humanitarian and epidemiological field works, geospatial technology enhanced the collection of reliable data that were used to assess the refugee's needs to accordingly manage humanitarian response or, prior to that, enable refugee management to precociously create less risky and more needs-based conditions for the camp settlement.

4.4. Pillar 3: GIS Digitalization within Migration Management

Figure 7

Presentation of the GIS digitalization in the reviewed studies



The third pillar of the *Digital Governance Theory* refers to the complete embedding and implementation of digital technology within the public sector. Related to the reviewed case studies, the question was whether a full digitalization of geospatial technology within refugee management can be observed.

Three of the eight reviewed articles showed indicators of effective digital transformation. Advances in the development of the tool as well as in the implementation of the tool to enhance decentralized information-based transformation were observed. The authors stated an increased uptake of geospatial technology in the humanitarian sector, especially in the last decade, driven by the need for updated information (Ghorbanzadeh, 2020). This is first enabled due to the growing availability, volume, and diversity of GIS and second due to continuous development and technical advances (Ghorbanzadeh et al., 2022). Information-based technological development was therefore enhanced through devices with higher storage capacities, more detailed image quality, better settings, and stronger batteries. This leads to higher flexibility and suitability of the technology for different tasks and areas (Curtis et al., 2022). The use of GIS within camp management can reduce workflows by digitally collecting data and engaging in open data initiatives. Universal digital access for the different governmental and non-governmental actors can support this. This can improve process automatization and reduces staff costs by cutting out the middleman. Costs are also reduced over time through the further development of technology in general, which allows to collect GIS data with less expensive devices over time (Curtis et al., 2022). This development also speaks for the theory's principle of "save to invest". However, those statements only support one direction of digital transformation and are no indicators of the strengthening of network-based development.

Apart from this, many of the reviewed articles did not report at all or barely mention anything about digitalization processes within the third sector since the research was more of a technical nature. Hence, the scientists focused on the technical dimension of different geospatial technologies like GIS imagery, GIS video, CNN, OBIA, hybrid GIS, or deep learning GIS but did not make any statements beyond that.

The above-mentioned positive findings are contrasted with the analysis from the last two articles, which state rather negative aspects of the digitalization of GIS technology. It is said that, for instance, automated trained networks (Tiede et al., 2021), remote sensing, and data

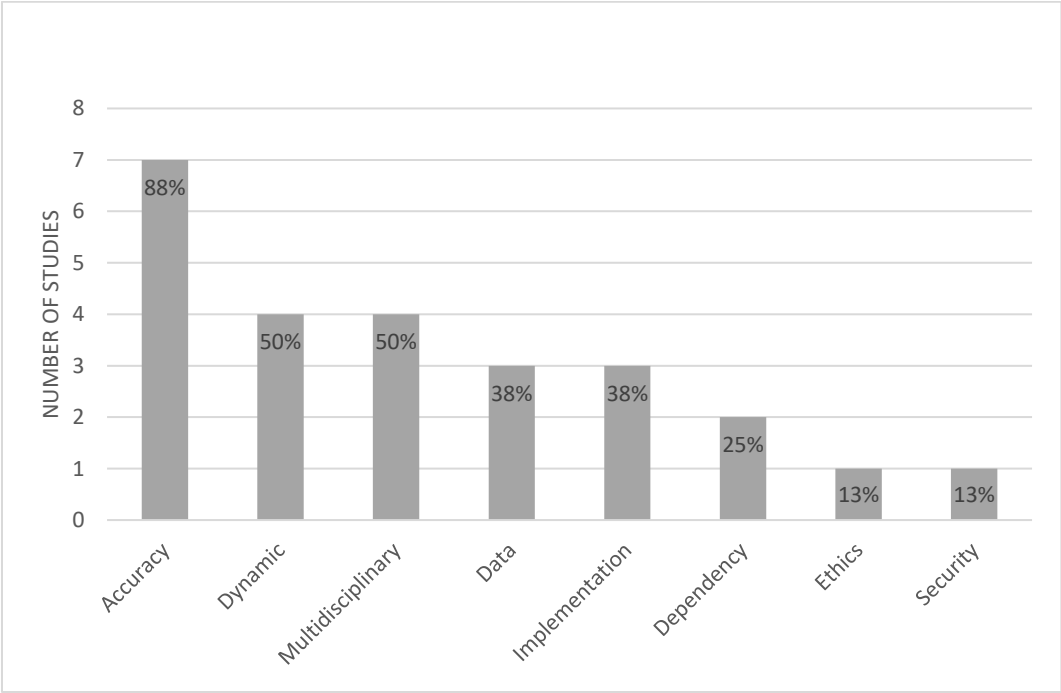
transformation (Lang et al., 2020) face difficulties in refugee camp scenarios and therefore have not yet achieved an effective implementation and need further development.

Furthermore, the process of digitalization is impaired by challenges like data interoperability, inadequate adaptation to the refugee camp setting, or the complexity of the humanitarian sector. These are just a few of the barriers which will further be explored in the next chapter about the challenges and limitations of GIS within refugee camp management.

4.5. Challenges and Limitations

Figure 8

Types and frequency of faced challenges while applying GIS



Although the aforementioned findings demonstrated a variety of benefits for the digital transformation of humanitarian aid, the negative sides of this technical tool have not yet been explored. GIS can be implemented in different ways, but the usage still faces some obstacles and challenges. The systematic review showed that some factors can be found throughout several articles, whereas some factors are only mentioned once. The review identified eight challenges across the various projects, ranked by frequency:

(1) *Accuracy*, (2) *Dependency*, (3) *Dynamic of Camps*, (4) *Ethics*, (5) *Data*, (6) *Security*, (7) *Multidisciplinary*, (8) *Implementation*.

The biggest challenge of using Geoinformation Technology in refugee camps settings is the *accuracy* and detailedness of the collected data and created maps. The application might be able to easily detect buildings and landscape conditions in cities, but it is not programmed to the circumstances in a refugee settlement. In 7 out of 8 articles, a reduced accuracy was criticized, which can be traced back to the following reasons: Firstly, it is complicated by the non-regular structure of the buildings and dwellings (Ghorbanzadeh et al., 2021). They are smaller than constructions in a city, and especially darker colors are not always easily distinguishable from the natural surroundings (Tiede et al., 2017). Due to that, the borders of dwellings can sometimes not be separated, which leads, for instance, to the identification of one building as two, thus to overestimations and hence to a misconception of population data (Gella et al., 2022). Apart from that, it is sometimes not possible to identify the exact locations or structures of buildings and infrastructure (Tiede et al., 2021). This is furthermore impaired by the inaccessibility of some regions and the absence or low quality of big databases for the affected regions (Ghorbanzadeh et al., 2022).

Secondly, half of the articles mentioned difficulties due to the high *dynamic* of refugee camps. Satellite images are usually collected over a longer period of time. However, refugee camps are initially non-permanent settlements that can change drastically with the influx of refugees or due to unstable political conditions (Younes et al., 2022). Frequent and constant monitoring, as well as regular updates, are complicated through that (Younes et al., 2022). Rapid changes within the camp, like strong population increases, make the created maps quickly outdated and less appropriate for further usage (Gella et al., 2022).

The third biggest challenge is related to the *multidisciplinary* and complexity of humanitarian aid. As mentioned earlier in the analysis, humanitarian aid requires multi-level governance and collaboration between various governmental and non-governmental actors (Younes et al., 2022). Correspondingly, also the use of GIS applications depends on the cooperation of the actors involved. The conducted research reported barriers due to the need for experts (Gella et al., 2022) or the cooperation with local offices, for instance, for data transfer (Curtis et al., 2022). Moreover, it is difficult to develop tools that are suitable for humanitarian work based on externally collected data (Lang et al., 2020). As soon as the multi-level process encounters a problem at one interface, technical difficulties may arise.

The above-mentioned problem about the technical design and further usage within refugee management cannot only be attributed to the area of *multidisciplinary* but also to difficulties with *data issues* and the actual *implementation* within humanitarian aid, which both were addressed in three of the publications. The technological dimension can be confronted with many difficulties in, for instance, data collection, data storage, interoperability of different systems, lack of digital tools, or the absence of highly labeled data in the affected areas due to poor international databases and security concerns (Gella et al., 2022; Ghorbanzadeh et al., 2022; Lang et al., 2020). This can be further limited due to legal restrictions on access to databases and satellite providers (Lang et al., 2020).

Practically speaking, the *implementation* encounters difficulties because although the applications exist and are used in the area of geoinformatics, the digitalization in humanitarian aid is not yet advanced (Tiede et al., 2021). The challenge here starts with practical barriers like local internet access challenges or high costs of acquiring and processing satellite imagery (Curtis et al., 2022). Furthermore, institutional and structural barriers among governmental and non-governmental organizations hinder the process of implementation. These are, for instance, the resistance against automatization or the hierarchies to be passed through in the realization of projects and digitalization. On top of that, the design of technology is often inadequate for refugee camp settings. All this first compromises scientific research within refugee management and subsequently impairs practical realization (Ghorbanzadeh et al., 2022). Accordingly, the lack of sustainability and effectiveness within current GIS affects the implementation into humanitarian services (Lang et al., 2020). And even with adapted technology, the transferability to other camps and conditions is still questioned (Ghorbanzadeh et al., 2021).

Another limitation that goes hand in hand with accuracy is the application's *dependence* on natural conditions. The detection of image data can, for instance, be blocked by dusty environments or dense tree populations and complicated through similar backgrounds (Tiede et al., 2017). Hence, this makes the quality of the results dependent on seasons, weather, and differing natural conditions (Lang et al., 2020).

Ghorbanzadeh's article about deep learning initially seemed like one of the most technical research projects, but regarding the challenges of GIS, it addresses several types of limitations. In addition to most of the factors already mentioned, *ethical and security* aspects of geospatial information technology use were also addressed. Collected and mapped data of

refugee settlements touches on ethical issues like high sensitivity, data protection, human rights, and privacy (Ghorbanzadeh et al., 2022). Another dimension might be the fact that "Sharing information between actors such as UN, NGOs, civil protection organisations, etc., may involve a conflict of interest and potentially affect neutrality." (Lang et al., 2020:3). The invention of tools does not necessarily determine a specific user. Therefore, it is not clear who can take advantage of GIS. Humanitarian actors such as the UN or NGOs can take advantage, but the same goes, for instance, for military actors. Furthermore, the safety situation in refugee camps impairs access to certain areas as well as the security of commissioned experts and humanitarian aid workers (Gella et al., 2022). On top of that, GIS implementations in a conflict setting have the potential to affect the neutrality of actors by, for instance, highlighting or covering certain details (Lang et al., 2020).

4.6. Responsible Innovation

As can be seen from this point, a number of challenges arise in the use of GIS in refugee camps. This is due to the fact that the application of digital technologies is associated with many difficulties if it is not adapted to the individual conditions of the place of use. Sociotechnical designs are still a minority within the technical development of digital tools. Therefore, it was scanned whether the scientific and humanitarian field of GIS in refugee camps gives evidence about the existence or lack of responsible innovation.

Similar to the findings of digitalization, most studies have not considered the social dimensions of geospatial technologies and have focused only on the technical dimension of GIS. However, especially the article by Stefan Lang and Omid Ghorbanzadeh went beyond the technical features and covered ethical and social factors of the research. According to Lang (2020), humanitarian organizations do engage in responsible innovation by adopting, testing, further developing, and shaping geospatial technology according to the needs and circumstances in humanitarian aid. These are, for instance, designing new uses of light sources, integrating different types of video or image processors, adding layers, or including patterns and locations (Curtis et al., 2022; Ghorbanzadeh et al., 2022; Lang et al., 2020). Another dimension of sociotechnical perspectives was seen in the article about camp site selection. Although there are no indications about a responsible design of GIS per se, GIS was

used to investigate social factors (next to geographical and infrastructural) to create a holistic base for decision-making (Younes et al., 2022).

Lang, however, specifically expressed the need for responsible redevelopment or redesign of technologies in humanitarian assistance to better meet relief needs and to select the appropriate technology for a given situation from an existing toolkit (Lang et al., 2020). This opinion was also highlighted in the article on risk monitoring, which focused on the goal of increasing local participation in the process of collection, analysis, and discussion in order to obtain the most appropriate results (Curtis et al., 2022). On top of that, it was argued that GIS has good features for precise prediction, for instance, for cadastral applications in cities, but not effectively designed for dwellings and camp infrastructure (Gella et al., 2022).

To conclude, if the reviewed articles dived into the dimension of responsible innovation, only of few statements were made about already existing sociotechnical designs, but the majority rather criticized the inadequate design for the application within refugee camp management and thus stressed the need for further development.

5. Discussion

A systematic review of articles dealing with the interface of GIS and refugee camp management in Africa was conducted to highlight the impact of geographic information systems and to observe what progress and difficulties are encountered in their process of digital transformation.

Through a content analysis, characteristics from three pillars of the *Digital Governance Theory* were found. It was searched for the three pillars (1) *reintegration*, (2) *needs-based holism*, and (3) *digitalization*, each with their two development directions of either creating a *centralized network-based communication-gaining process* or establishing a *decentralized data-based information-gaining process*. The coding obtained results that strongly supported both streams for the first pillar of the theory (reintegration) and found indicators for the data-based stream for the second and third pillars (needs-based holism and digitalization) of the theory.

Adapted to the specific thematic context, the articles were therefore first scanned for indicators of *how GIS is used to support the collaboration and coordination between*

humanitarian actors. Consistent evidence was found in 6 out of 8 articles that stated that the use of GIS, on the one hand, establishes a database of geospatial data which enables cross-national data pooling and information-based decision-making among humanitarian actors. On the other hand, it increases the network of international actors since it improves operational workflows and reduces coordination barriers, for instance, by enabling work in non-accessible areas. Therefore, the first hypothesis, *that the use of GIS mapping is increasing the multi-level cooperation between actors* can be confirmed.

Secondly, it was observed *how actors use GIS to support the provision of humanitarian services to refugees*. The researchers' fields of work can be divided into three main tasks: camp mapping, camp site selection, and risk monitoring. GIS helped to assess the camps' conditions and developments and therefore improved the gain of digital information. The data collected allows humanitarian actors to draw conclusions and make informed decisions about necessary changes in the camp, the suitability of a camp location, or about the planning of humanitarian interventions tailored to the needs of the camp residents and international camp standards. However, there were no signs of a communications gain through GIS which could, for instance, create more flexible and customer-friendly services for the refugees. As a result, the hypothesis that *GIS mapping tools can improve the provision of humanitarian aid to refugees* is partially supported.

Lastly, it was investigated *to what extent GIS tools are properly implemented within refugee camp management in Africa*. A small fraction of the reviewed articles argued an increased databased digitalization process within humanitarian aid, evident by a higher uptake and further development of geospatial technology. Here again, there was no support for a network-based digitalization through GIS which, for instance, could be a channeled online service or universal service access for refugees. Furthermore, many articles did not give indicators about the extent of practical implementation, or rather reported a variety of barriers.

On the basis of the above-mentioned, it can be said that digital transformation, according to the *Digital Government Theory*, can be confirmed to a certain extent. Though, the lack of evidence in some of the papers, as well as contradictory assumptions, show that there is potential for improvement. But the extent to which it is well developed strongly differs by looking at different spheres: science, NGOs, government, and civil society.

The scientific development is the starting point of digital transformation, and according to the findings of the review, it is also the most advanced. However, only when it comes to the

technical nature of GIS since there is still a lack of sociotechnical perspectives. To continuously improve digitalization in humanitarian aid, it is necessary to overcome the many challenges that still hinder the use of geospatial technology. *Responsible Innovation* can be seen as one solution. However, the scientific field of GIS is still very homogeneous and does not include experts from other fields, especially in connection with refugee camp management. This leads to the fact that the technology is advanced in a theoretical sense but that there is still a big implementation gap when it comes to further usage. Scientific knowledge sets the foundation for any further development, but after the theoretical development, the next step is the practical use and implementation beyond the scientific sphere, which is still facing challenges.

Within the third sector, an advanced implementation of GIS was observed. Here, GIS was used in different areas of the field and is further tested and developed. Cooperations between scientists, experts, and humanitarian organizations were seen and led to an uptake of geospatial technologies. However, the practical implication is still rare due to the lack of responsible innovation as well as due to the limited resources within humanitarian aid. The technology is still unsuitable for camp settings which leads to clashes when it comes to the humanitarian response. Acknowledging the individual conditions of refugee camp settings and adapting the technology accordingly could furthermore develop universal GIS tools. This might neglect features that are important in typical Western cities, but in contrast, it would be specialized for camp settlements which would create an adapted and internationally transferrable tool for the humanitarian sector. This could at least overcome the technical barriers: technical adjustments in terms of image capture in camp settlements can resolve the challenges of accuracy, difficulties due to high dynamics of the camp, or dependency on natural conditions. Also, the challenge regarding data storage, international databases, or data interoperability can be addressed when looking at the specific circumstances within refugee management. However, the design of GIS is not only encountering barriers when it comes to the structure of the refugee camp but also regarding the structure of humanitarian aid in general. Here, challenges are especially impairing the third pillar of the digital transformation. To address the implementation barriers or issues due to multidisciplinary, GIS development also needs to acknowledge the structural situation of refugee management and humanitarian actors. These, however, are not just small technical adjustments but rather concern the variety and simplicity of GIS usage. Limiting practical barriers like costs, availability, or complexity of the tool might lead to a higher distribution.

Consequently, it can be said that the solution to the challenges within the level of humanitarian aid is deeply connected to responsible innovation, and only if this premise is fulfilled can the digital transformation subsequently be adequately implemented.

Additionally, so far, GIS within refugee management has practically only been used by the third sector, the non-governmental organizations. But it is necessary to expand the scope and options of GIS application at the level of the government and civil society. One example of an expansion on the citizens' level could be the implementation of participatory GIS use. This bottom-up approach includes different levels of society, which can improve cooperation as well as expand the collection of individual data (Ganapati, 2011).

But lastly, the most important step is an implementation of GIS in refugee management which is publicly administrated. The issue of migration is a public responsibility, so the digital transformation also needs to expand to the government level. However, this is not yet the case. For instance, the camp suitability analysis by Younes resulted in a good recommendation, but the paper did not mention anything about how their information is further used within the government. Subsequently, evaluations about suitable and unsuitable areas are given and could improve camp settlements but are not applied in any way. Public administration would be able to address refugee camp management on a wider scope and with more capacities, hence, the missing sections of the *Digital Governance Theory* could be fulfilled completely. Incorporating the given tools and data into refugee camp management could increase digital governance transformation in both directions - networking and information collection.

Finally, due to the lack of implementation at the different levels, the last hypothesis, in which it was assumed that *GIS is not yet adequately implemented within public administration processes to increase the effectiveness of migration management*, can be confirmed as well.

One remark that shone through the review was related to the ethical dimension. Although this was only covered by Ghorbanzadeh's and Lang's articles, this shouldn't be attributed to a lack of importance but rather to characteristics of the scientific field since the research about geospatial technology barely goes beyond the technical dimension. In a deviation from the other articles, those two articles dove into topics such as data power, data justice, human rights, and security issues. This opens a completely new discourse within GIS technology which has not been recognized much so far. Depending on how GIS tools are used, they can

have positive consequences in terms of process optimization, but at the same time, they can pose a danger when looking into the ethical dimension. The use of technological tools gives power to the user, which can be used or misused in many ways. For example, mapping of refugee population gives insight into living conditions and movements and therefore concerns the individuals' privacy. Especially in crisis areas, this might also affect people's security. Another dimension that was touched on within those articles was the political influence of technology. As mentioned during the analysis of the challenges, mapping and information sharing can affect political neutrality. It is possible to highlight or hide certain factors in the maps to influence decision-making in certain directions. Humanitarian response is complex due to its involvement of many different actors, which might have differing political intentions. How GIS is used by actors and what their intentions are must therefore be considered.

Particularly in humanitarian aid, and here especially with actors such as the United Nations and governmental organizations, human rights and standards must be respected. Thus, the process of digitalization must not impair any existing guidelines like camp standards, refugees' rights, data justice, or data protection guidelines. These threats are, above all, the reason why the application of digital tools needs to be regulated and implemented by public administrators. Only governmental and judicial actors have the authority or ability to shape laws and international regulations to prevent ethical violations. The insights of a systematic review served to demonstrate a knowledge base about GIS use as well as to point out potentials and threats. Building on this, scientists, as well as public administrators, need to acknowledge and incorporate ethical and societal perspectives when it comes to future studies and policy implementations. This could address the root of the problem and can have far-reaching changes for migration management.

This is especially relevant since the proportion of internally and externally displaced people is increasing more and more due to ongoing political, economic, and ecological issues. In particular civil conflicts and the endangering of essential living conditions caused by climate change will intensify this development. Even though refugee camps are initially established as non-permanent settlements, the need for well-established and sufficient refugee camps is present as long as the refugee causes are not resolved and no long-term solution is found. Possible solutions could be scientifically researched best with the cooperation of different

scientific fields, especially in the context of Africa, where the amount of research is still very limited. The review showed that migration, public administration, and geospatial science are weakly connected and that their results rarely go beyond their own research dimension. This research expanded the scope of the *Digital Government Theory* and *Responsible Innovation* to the intersection of GIS technology and refugee camp management, where it has not yet been explored. The review demonstrates the so far underrepresented research areas which need to be explored further. Furthermore, the sociotechnical and ethical perspectives and the further drawn conclusions for public administration show new possible approaches which can be used to optimize and expand digital refugee camp management.

Any research carried out, however, is not free of limitations. As seen in the bibliometric analysis of the co-authorship and the descriptive statistics of the research fields, the reviewed articles represent a narrow research area with high intercorrelations. Thus, it can be questioned if coherences and similarities can be traced back to the actual finding or rather to bias and connections within the network. Additionally, the reviewed articles mostly focussed on small settings of one single refugee camp. Therefore, the given data is limited, and it is debatable whether the findings are representable or transferable to other settings. To increase the diversity of the authorship and humanitarian field to ultimately make more overall assumptions, it is recommended to widen the geographic scope of the literature collection to be reviewed. Solving selection bias could possibly result in more broad outcomes and the reduction of comparability issues. Moreover, it needs to be acknowledged that the topic of migration is accompanied by a high dynamic and complexity, which might affect the reliability of the outcome. Furthermore, research about digital technologies, especially with the connection with the public sphere and migration, is relatively new, which is why it might be too early for more in-depth analyses and conclusions about future prospects.

6. Conclusion

Humanitarian organizations and governments rely on good cooperation, reliable information, and sufficient capacities in order to plan fast and adequate humanitarian responses. Migration movements in Africa are prospectively increasing and not reducing, hence there is a strong need to adequately manage IDP in Camp settlements. The rise of technology could be a

possible solution to combat these issues. Therefore, it was investigated *how the use of GIS mapping has influenced management processes in refugee camps in Africa*. The results showed that Geospatial technology seems to positively affect refugee camp management to some extent, however, it has not reached its full potential. The increased use of digital tools showed to improve collaboration and the information-based assessment of refugee aid, however, it still faces many challenges. Geospatial technology is designed for the use in cities in the Global North but is not adequate for the implementation in the humanitarian sectors and even less for the application in refugee camp settlements in Africa. To solve the many challenges regarding the accuracy, multidisciplinary or data issues, it is necessary to incorporate sociotechnical perspectives in the design of GIS or further develop the digital tool according to the individual conditions given. By doing that, it needs to be acknowledged that digital tools are powerful and can impair data justice and security of the people affected, in this case, IDPs. To stronger respect the ethical and social dimension of GIS, the process of implementation needs to be expanded to the public sector since GIS is so far only used by the third sector when it comes to the work in refugee camps in Africa. As the issue of migration and the accompanied need for human rights protection is the responsibility of the state, it, therefore, needs to be handled and supported on a higher level. The power, resources, and capacities given by public administration can be used to widen the practical and legal scope of geospatial technology and could help to combat migration and establish the most adequate and humane conditions for the refugee camp residents. Nonetheless, the direction of digital transformation cannot be predetermined. Thus, attention to the power of digital tools and their ethical and socio-political influence always needs to be acknowledged in further research as well as in future policy implementations.

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8. Appendix

8.1. List of Documents for Systematic Review

Table 2

List of Documents for Systematic Review

Year	Author	Title	Journal
2017	Tiede et al.	Stratified template matching to support refugee camp analysis in OBIA workflows.	Remote Sensing
2020	Lang et al.	Earth observation tools and services to increase the effectiveness of humanitarian assistance	European Journal of Remote Sensing
2021	Ghorbanzadeh et al.	Transferable instance segmentation of dwellings in a refugee camp-integrating CNN and OBIA	European Journal of Remote Sensing
2021	Tiede et al.	Mask R-CNN-based building extraction from VHR satellite data in operational humanitarian action: An example related to Covid-19 response in Khartoum, Sudan.	Transactions in GIS
2022	Younes et al.	Spatial suitability analysis for site selection of refugee camps using hybrid GIS and fuzzy AHP approach: The case of Kenya	International Journal of Disaster Risk Reduction
2022	Ghorbanzadeh et al.	Mapping Dwellings in IDP/Refugee Settlements Using Deep Learning	Remote Sensing
2022	Gella et al.	Mapping of dwellings in IDP/refugee settlements from very high-resolution satellite imagery using a mask region-based convolutional neural network.	Remote Sensing
2022	Curtis et al.	The Use of Spatial Video to Map Dynamic and Challenging Environments: A Case Study of Cholera Risk in the Mujoga Relief Camp, DRC	Tropical Medicine and Infectious Disease

8.2. Coding Table

Table 3

Coding Table

Codes		
Category	Definition	Example
<i>Digital Governance Theory</i>		
Collaboration	Statements about how GIS is used to enhance collaboration among actors	<i>"This type of car-based SV collection also proved to be an excellent tool for collaboration, with projects developing in Cambodia, Colombia, Ghana, Kenya, Malawi, Nicaragua and South Africa." (Curtis, 2022:3)</i>
Needs-Based Holism	Examples of how GIS mapping improves humanitarian aid service and needs assessment of refugees	<i>"Earth-observation-based mapping plays a critical role in humanitarian responses by providing timely and accurate information in inaccessible areas, or in situations where frequent updates and monitoring are required." (Gella, 2022:1)</i>
Digitization	Indicators about the extent to that GIS is implemented in refugee management	<i>"Even though nearly all assets of remote sensing apply in such demanding scenarios, it remains a challenge to fully implement and sustain a trustful and reliable information service." (Lang, 2020:1)</i>
<i>Challenges to Digital Transformation</i>		
Challenges	Barriers that have impaired any of the above-mentioned categories	<i>"Working in trans-organisational settings, where several humanitarian actors use, produce and share data, poses technical challenges." (Lang, 2020:15)</i>
<i>Responsible Innovation Theory</i>		
Responsible Innovation	Statements about the existence or need for the responsible design of GIS technology	<i>"Information products tailored to the needs of actors in the field, enrich the pool of spatially aware technologies for humanitarian relief support." (Lang, 2020:2)</i>