Rethinking Requirements Engineering for Smart Cities: A Case Study in Indonesia

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***Abstract*—Smart city projects aim to improve the quality of life of citizens and provide solutions to multifaceted urban problems. Technological factors and financial investments are often identified as critical success factors for smart city projects, which equally applies to the Global South. However, in reality, many artifacts produced by Global South smart city projects are not effective despite leveraging suitable technologies and receiving ample funding. We argue that this discrepancy can be primarily attributed to the misalignment between citizens' requirements and the functionalities of the produced artifacts. This paper critically examines the role of requirements engineering in the development of smart cities, with a focus on the Global South. By means of a case study conducted in Indonesia, we identified a highly hierarchical approach for eliciting requirements which significantly contrasts with the participatory approach often employed in the Global North. This hierarchical approach of requirements elicitation impacts the completeness and correctness of the identified requirements. This paper identifies the determinant factors that influence the implementation of requirements engineering within smart city projects in the Global South.**

***Index Terms*—requirements engineering, smart city, global south, public sector, hierarchical approach**

I. Introduction

The accelerating rate of urbanization and the increasing urban population percentage are contributing to the complexity of challenges faced by cities globally, requiring fast and efficient solutions. According to a recent report by the United Nations, 60% of the world's population is expected to reside in urban areas by 2030 [1]. Meanwhile, the urban population in developing countries, especially in Asia, reaches 70% of the total population. This high percentage of the urban population is also accompanied by new urban challenges that encompass socio-economic issues, such as poverty, and socio-political dimension, including public participation in the decision-making process [2].

As a solution for urban challenges, smart cities have emerged as a symbol of ICT-driven urban innovation and development [3]. Smart city projects aim to develop sustainable solutions that enhance the quality of life of urban residents [4]. The concept of the smart city employs a synergy of urban governance and technology, driven by the private sector and governments to improve citizens' quality of life [5]. The International Telecommunication Union (ITU) defines a smart city as *"an innovative city that uses information and telecommunication technologies (ICTs) and other means to improve quality of life, the efficiency of urban operation and services... while* ***ensuring that it meets the needs*** *of present and future generation"* [6]. In the Global North, smart city research predominantly centers around the use of new technology to improve citizens' welfare. Contrarily, the Global South countries still focus on addressing citizens' fundamental needs, employing solutions which do not concentrate on advanced technological innovations but on how the technology can be a solution [7]. In addition, numerous studies on smart cities employ a bottom-up approach, whereas smart cities in the Global South frequently adopt a top-down approach and centralized planning in formulating solutions [5].

The majority of smart city literature stems from Europe and North America, with a notable underrepresentation of academic research from Asia and Africa [3]. The governments in several developing countries have launched national strategies to promote smart city initiatives [2], [8]. However, the Global South countries often encounter financial and technological issues in the implementation of such initiatives [7]. These obstacles can be understandably attributed to the high investments required for technology infrastructure, which is not sufficiently present in the Global South. However, it is questionable whether technological and financial constraints are the *only* concerns with respect to the development of smart city projects in the Global South.

While there could be additional problems concerning the smart city projects in the Global South, such as the inapplicability of software engineering methodologies from the Global North due to pronounced cultural and contextual differences, our work focuses on exploring the requirements engineering process in the Global South. Concretely, this inquiry leads to the following research questions (RQs):

(RQ1) **RE Practices:** How is requirements engineering practiced in a smart city project in the Global South?
(RQ2) **Issues:** What are the issues with the found practices?
(RQ3) **Underlying Factors:** What are the underlying factors that exert influence on the manifestation of these issues?

To answer these questions, we participated in a requirements elicitation workshop in a city in Sumatra, Indonesia, and interviewed the participants regarding the requirement engineering practices in their smart city project. Indonesia is currently working on developing 100 smart cities making it a pivotal case study for analyzing smart city development dynamics.

The major contributions of our work, focused on Global South with Indonesia as the chosen case study, are: (1) identification of a significant challenge of very hierarchical requirements engineering process, (2) a thorough understanding of requirements engineering practices for smart city projects (3) discovering issues with the current requirements engineering practices in the smart city project and (4) uncovering the underlying factors for the absence of systematic approach of requirements engineering practices. Our findings for this work are based on a participatory approach rather than a distant macro analysis.

II. Related Work

A. Requirements Engineering for Smart City Projects

One of the challenges in implementing smart cities is citizen participation [4]. Several countries have attempted to involve the community as collaborators and co-creators in smart city programs. However, the existing solution for this requirements-gathering process heavily relies on community participation and the strong desire of application developers to implement this method [9], [10].

A distinguishing characteristic of a smart city project is the involvement of multiple stakeholders from diverse backgrounds [11]. Several techniques have been proposed to elicit the requirements for this complex project, including scenario-based requirements engineering [11], horizontal requirements engineering for IoT integration [12], and walk-shop, taking a walk in a "smart city", as a way to elicit requirements from citizens [13]. However, these techniques lack consideration for the local context, particularly the socio-cultural aspect.

B. Requirements Engineering in the Global South

Heeks identifies that failure in most e-government projects originated from a large gap between reality and solution design [14]. To mitigate project failures, multiple studies have been conducted concerning requirements engineering in the ICT4D domain. A literature study indicated that research concerning requirements engineering in ICT4D primarily centers around non-functional requirements, with less emphasis on functional requirements or user requirements [15]. Several techniques were also introduced to elicit requirements from the end-users in the ICT4D domain, including Structured Digital Storytelling (SDS) [16] and crowdsourcing [17]. However, this study does not demonstrate the extent to which the resulting system would effectively meet the user's needs.

Most studies on Requirements Engineering in the Global South focus on proposing new techniques or methods for eliciting requirements, but lack thorough investigation into the underlying reasons for these techniques. Furthermore, requirements engineering for smart cities in the Global South, as a complex system, is a relatively under-researched subject.

III. A Concrete Smart City Project

A. Context

Indonesia, as the most populous country in Southeast Asia and the one with the largest geographical area, exhibits the complex challenges and diverse ethnicities typical of nations within the Global South. Additionally, one of the authors is from Indonesia having connections with local municipalities which provided us with a deep understanding of the context. All of these factors collectively made Indonesia a suitable candidate for a prime case study for exploring the implementation of smart city initiatives in similar contexts.

In 2017, the Indonesian government initiated an ambitious project for developing 100 smart cities [8]. In an effort to strengthen local municipalities, the central government has provided a National Smart City Guideline and facilitated the organization of focus group discussions which are attended by specialists from the ICT ministry.

Our research is concentrated on a smart city project called X1, commenced by the mayor in 2021 and is one of the leading smart city projects in City X, located on Sumatra Island, Indonesia. Project X1's initial purpose is to streamline the management of social assistance funds for the underprivileged. Eventually, in 2022, this project evolved by incorporating additional features, transitioning into a super-app that includes multiple government services from various departments in the municipality.

B. Study Participants

This study engaged 15 participants representing 7 departments within the municipal government of City X. Given that Project X1 spans across multiple departments, we requested the municipality to facilitate the selection of participants for this research. The criterion for participant selection necessitated representation from the departments directly involved or impacted by Project X1. Participants originating from the ICT department assumed the role of system developers of Project X1, whereas individuals from differing departments served as business process owners within the scope of this project. Table 1 shows all participants for the interview.

TABLE I
Interview Participants

No.	Participant Count	Role	Department
1	1	Project Manager	ICT
2	1	Website Programmer	ICT
3	1	Android Programmer	ICT
4	1	System Analyst	ICT
5	3	Bussiness Process Owner	Trade and Industry
6	2	Bussiness Process Owner	Civil Registration
7	1	Bussiness Process Owner	Transportation
8	1	Bussiness Process Owner	Social Affairs
9	2	Bussiness Process Owner	Education and Culture
10	2	Bussiness Process Owner	Health

Within this municipality office, ICT plays a pivotal role in the development of smart city applications. Additionally, the department is also tasked with addressing technical requests from other departments such as developing websites for distinct municipal services. However, the department faces constraints due to a limited number of personnel available for system development. Currently, the development team for

the smart city application primarily comprises young individuals, including one senior programmer functioning as project manager and three junior programmers tasked with system development.

C. Research Method

This research was conducted through in-depth interviews with four system developers for Project X1 and eleven other participants from the Department of Trade and Industry, Department of Civil Registration, Department of Transportation, Department of Social Affairs, Department of Education and Culture, and Department of Health. Prior to the interviews, we organized an on-site focused workshop on requirements engineering workshop with all participants to foster a common understanding of requirements engineering principles and practices, following the principle of learning by doing. This workshop was also intended to build sufficient trust in preparation for the in-depth interviews that would follow. This preliminary workshop revealed that for most participants, it was their first opportunity to engage in a discussion focused on the project's requirements. However, few participants mentioned that they had been invited to meetings before, albeit infrequently.

We utilized open-ended questions in interviews to encourage detailed responses and insight [18] To facilitate more comprehensive responses, we conducted interviews in both Bahasa Indonesia, the national language and a local dialect specific to the study's region.

TABLE II
INTERVIEW QUESTIONS FOR DEVELOPMENT TEAM

No	Interview Question	RQ
1	What is your designated role in Project X1 and how long have you been active in Project X1?	N/A
2	Where did the initial requirements of Project X1 come from?	RQ1
3	What did the development team do to acquire information about the features and requirements for Project X1?	RQ1
4	What is the requirements gathering procedure for Project X1 and how did you document the requirements?	RQ1
5	How do you ensure that deliverables align with the specified requirements? Has there been any conflict with stakeholders?	RQ2,RQ3
6	What challenges are commonly encountered during the stages of requirements elicitation?	RQ2,RQ3

The development team was specifically presented with questions aimed at delving into the complexities of requirements engineering practices in Project X1 and identifying any issues encountered during the development process of Project X1. A separate set of questions was also presented to business process owners with the purpose of (1) understanding the underlying business process and eliciting primary requirements, (2) gathering citizen feedback directed towards municipality departments concerning current services, and (3) analyzing communication dynamics during the requirements elicitation phase. The question about citizens' feedback was asked to acquire a deeper understanding of current services and identify potential areas of concern from the citizen's perspective. To provide a general overview, we present primary interview questions in addition to their relationship to research questions in Table 2 and Table 3.

TABLE III
INTERVIEW QUESTIONS FOR BUSINESS PROCESS OWNER

No	Interview Question	RQ
1	What constitutes the primary services provided by your department?	N/A
2	What are the complaints articulated by citizens regarding the services provided?	N/A
3	In the event of transitioning your service into an online platform, what societal challenges are anticipated?	RQ2,RQ3
4	What information can you provide regarding Project X1?	RQ2, RQ3
5	In what manner has the software development team of Project X1 communicated thus far, and what impediments have been encountered?	RQ2

We employed a semi-structured questioning approach during the interviews, subsequently expanding the inquiries based on the responses from participants. The interviews were conducted individually at different times. Due to distance and limited time availability, the interviews were conducted online via a video-conferencing application. Prior to the execution of these interviews, participants' consent was obtained for recording the sessions. The duration of each interview varied between 45 to 60 minutes, and the recording was transcribed to facilitate data analysis. Interviews were conducted using a combination of Bahasa Indonesia and the local dialect, to facilitate communication and close the distance between the interviewer and the interviewee. Language differences were not an issue because the author who conducted the interviews is a native speaker. To maintain the original meaning, audio-to-text transcription was carried out by a transcriber in Bahasa Indonesia. The coded interviews were then organized and translated into English for analysis.

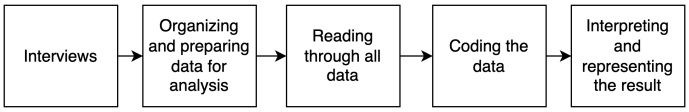

Fig. 1. Data Analysis Process

We adopted the data analysis in qualitative research by Cresswell [18] for the coding process. Fig. 1 illustrates our data analysis process. The transcribed data from interviews was organized and prepared using Atlas.ti. After a thorough reading, the data was coded based on emerging information collected from the interviews, and the themes were identified throughout the coding process. Atlas.ti was used for organizing the documents and codes. Meanwhile, the coding process was conducted manually by thoroughly examining the interview

data. We used a combination of *descriptive coding*, which summarizes the main topic of a statement, and *in vivo coding*, which directly captures language used by participants, to generate the codes. These techniques were employed to capture new information from the participants, given that this research is exploratory in nature. The final step involved making interpretation of the findings and represent them in the qualitative narrative.

IV. Results

A. RQ1: RE Practices

a) Not Performing Systematic Requirements Engineering Practice

The interviews revealed that Project X1 lacks a systematic approach for gathering requirements. The development team stated that the initiative for Project X1 was initiated by a request from the mayor of City X, yet the specific origins of this request remained unclear. Efforts to clarify the requirements' origin through a meeting with the mayor proved futile despite multiple attempts to reschedule.

The project manager shared his insights suggesting that the mayor derived the concept of this project through occasional street visits, during which he gathered inspiration from the public. Regrettably, direct confirmation from the mayor was not possible. However, our interviews suggest that a systematic elicitation of requirements from stakeholders has not been conducted.

The initial inquiry from the mayor was to develop an app aimed at facilitating the distribution of social assistance funds. After obtaining an inquiry from the mayor, the development team engaged in preliminary discussions and gathered pertinent information from concerned departments, specifically the Department of Social Affairs and the Department of Civil Registration. This information collection phase was followed by designing the database for the application. The project manager led the discussion with the team to conceptualize and formulate the database structure. Following this discussion, the development team commenced the coding process to implement this database design. This process was illustrated by a member of the development team, *"All relevant municipality departments provided the required data to us, subsequently we initiate the database design process. However, instead of creating an Entity-Relationship Diagram (ERD), we opted to create a table by defining the necessary data elements using Google Spreadsheets"*.

A notable perspective concerning the requirements elicitation approach in Project X1 was explained by a member of the development team, *"The weak point in the development of Project X1 is the lack of requirements analysis. The reasons behind the need for these apps were not comprehensively investigated, resulting in the inclusion of features that imitated existing apps without a clear functional purpose"*. Supporting this viewpoint, another development team member elaborated,*"despite recognizing the importance of having a Software Development Life Cycle (SDLC), the current practices entail the software development and testing in the absence of documentation. Apart from that, there has been no official confirmation [procedure] from other departments [regarding feature additions]. Meetings are often held impromptu. For instance, when the mayor wants to review the progress of the application, [then we will present the progress]"*. These statements highlight that the team is not performing a systematic approach for requirements engineering practices in Project X1.

b) Strong Hierarchical Approach

Feature modifications or additions within Project X1 may originate not solely from the mayor but occasionally from the project manager as well. To quote from a member of the development team, *"the project manager usually issues instructions for additional features"*. In this case, the development team proceeds with the implementation of the additional feature without reservations. In another interview, a software developer commented on this process of integrating additional features by stating *"I did not know where these requirements originated from, I guess this is an additional request from our project manager"*. These findings suggest a strong hierarchical approach to gathering requirements for Project X1.

c) Lack of Documentation

There is a lack of documentation regarding the requirements or system design of Project X1. A participant from the development team mentioned, *"we didn't consider creating any [requirements] documentation"*. Nevertheless, the project manager argued that the team still performs an internal process of requirements analysis, after which a system prototype is developed based on the inferred requirements. The project manager detailed that this process involves analyzing feedback obtained from the prototype's presentation and formulating ideas for new features. These feature ideas are documented as scribbles or annotations on paper. A participant illustrated this process, *"Our project manager engaged in discussion with us while jotting down notes. The features were sketched on paper, including necessary data. We searched for a [coding] template and executed the coding process. The initial database was established by our project manager."*

d) Utilizing Prototyping Method

The absence of a standard requirements engineering process, however, does not imply a complete disregard for requirements analysis. While standard requirements engineering practices are not formally adopted, the development team proceeds by eliciting primary requirements from the mayor and deriving additional insights from the data collected through various departments. Subsequently, the development team then progresses to develop a functional prototype based on these identified requirements. The prototype is then presented to the mayor to solicit feedback.

The process of prototyping was described by a developer, *"the mayor provided feedback [for this prototype] stating [that] these [particular] department services must be accessible online and integrated with Project X1. Following this, we will make the process flow first. We asked for the data from other departments to determine the requisite fields [for the database]"*. Another team member explained *"After we established the concept [for application]. The appropriateness*

[of this concept] will be deferred to subsequent consideration. Our motto is to prioritize the initial development first, and then address any issues later. Our approach utilized prototyping technique". Subsequently, the developed prototype is presented mainly to the mayor and occasionally to other concerned departments as well. During the presentation, feedback on this prototype was provided which is used by the development team to elicit new requirements. Considering this finding, we can infer that the development team frequently implies the prototyping method in developing applications.

Project X1 utilizes a working prototype to solicit feedback from users. This approach bears the risk of complete rework of entire features based on received feedback. An interview with the project manager revealed that this practice stems from the lack of understanding of requirements engineering best practices and a shortfall in human resources qualified to conduct the requirements engineering process effectively. As a consequence, there is a high risk of misalignment between the application's actual and presumed business processes, posing the potential to impede the development process due to incorrect requirements.

e) Minimum Stakeholder's Involvement

Our interview findings suggest that the participants were not sufficiently involved in this project. This statement has been confirmed by a participant from the development team, *"The communication (meeting) with the department is more focused on socialization [of the app]"*. Moreover, several participants expressed a desire to be more involved in this project. As articulated by a participant from business owner, *"We suggest that the ICT Department continuously explore our needs. The development of a system involves not only programming skills but also understanding what needs to be fulfilled and what solutions should be sought. It would be unfortunate if the system does not meet its purpose accurately. The involvement of our department in this project has been limited, and regardless of the discussions held previously, the input provided cannot be conveyed in detail to the system developers. There is a need for further exploration of our requirements"*. It is noteworthy that this specific participant is an employee of the Civil Registration Department, which most of the data for the main feature of Project X1 primarily originates from.

B. RQ2: Issues

a) Incorrect or Incomplete Requirements

According to the interview, the present software development practice frequently resulted in incorrect and incomplete requirements. A particular instance of incorrect requirements is the digital attendance monitoring feature as a new feature of Project X1. Regarding this feature, one of the participants from the business process owner department mentioned *"It is not really necessary to develop a new feature. We already have an attendance monitoring system which is connected to the attendance monitoring machine in our department office"*. A participant from a different department explained that after inspection, there were a number of inaccuracies in the department's business process in this application. Another participant also mentioned that *"It was a long time ago since we met [with development team]. It was around two weeks prior to this meeting, we had a meeting with the mayor [and development team from the ICT department]. During this meeting, it occurred to us that the ICT department used unrelated data for our department service's feature"*.

b) Communication Deficiencies

This error was corroborated by a member of the development team, who asserted, *"A miscommunication occurred between the concerned departments and programmers. The programmer proceeded to develop the system but eventually realized that the business processes for a feature were not aligned with the established workflow in the concerned department"*. We can conclude that the prevailing approach to requirements engineering has led to poor communication between the development team and the concerned department, where the latter is one of the stakeholders.

c) Late Delivery

Another effect of the current practice of requirements engineering in this project is late delivery. Although we conducted these interviews in July, a participant from the development team told *"We originally planned to launch this app in July, but currently we are still waiting for the data from another department"*. It is noteworthy that another development team disclosed their unawareness regarding the cause of this delay. This statement supports our earlier remarks about poor communication, even among the members of the development team.

d) Technology Resistance

Minimum stakeholder participation in Project X1 resulted in technology resistance. We discussed potential features of this project with the participants. Based on their experience with promoting online services, several participants noted that citizens are unwilling to accept new technology. Specifically, a participant from the Department of Trade and Industry described the reasons behind merchant's hesitation to use online service, *"The reason why users are reluctant to participate lies in our tendency to solely focus on collecting data from them without conveying the benefits, thus leading to their lack of awareness regarding the potential advantages [of the system]."*

A participant from the Department of Civil Registration also explained a case of reluctance towards adopting new technology, *"At the civil registration office, document processing services are guaranteed to be completed within a maximum of one hour [if you directly come to the office] ... This digital service appears too complicated and takes a considerable amount of time [to complete] for the citizens. They prefer a quick and efficient process rather than relying on applications. There is a fear among the public that reliance on applications might disrupt their convenience. [We are concerned that] any negative experiences could be amplified on social media, where public opinion may perceive online services as complicating matters rather than simplifying them."*

Another participant from the Department of Transportation mentioned that there is a challenge in adopting digital parking payment due to resistance from parking attendants. It is

to be noted that in this region, parking attendants oversee parked cars and receive compensation from car owners in exchange for this service. This situation has worsened since some people in this region still do not possess smartphones. Interestingly, this statement originated from participants from different departments.

C. RQ3: Underlying Factors

Our findings indicate that Project X1 lacks the application of systematic requirements engineering practices. Requirements were gathered using unstructured methodology and primarily derived from the mayor's request. Additionally, requirements were also elicited from internal discussion during the prototype presentation without involving the citizens. We realize that some of these practices are common on a few occasions in the Global North. However, we emphasize the strong hierarchical approach used in this project as this approach is common in the Global South's projects. After examining the results of the interviews, we have identified multiple underlying factors contributing to this issue and elaborated on the relationship between these factors and the current requirements engineering practices, as illustrated in Fig. 2.

1) Organizational Policies Factors

Centralized decision making process. The process for identifying requirements in city X is carried out in a distinctly hierarchical manner with the mayor playing a pivotal role in finalizing the system specifications developed by the development team. This practice, characterized by a defined chain of command, is prevalent in developing countries where public policy follows a strict hierarchy. In the case of Project X1, the development team has frequent meetings with the mayor to monitor the project's progress. Communication with concerned departments occurs on a restricted basis, with several departmental representatives reporting only occasional discussions of this project with the development team. The development team primarily depends on instructions from the project manager or the mayor, rather than employing established requirements elicitation techniques to accurately determine the project's needs. This practice is not quite common in the Global North. However, a hierarchical and centrally managed approach allows the government in the Global South to create uniform policies, promoting equitable development across regions. Indonesia, with its heterogeneous cultural and societal character, is probably accustomed to this centralized approach as this approach is also adopted by several regional heads in Indonesia.

Political will. Projects developed in a governmental setting often tend to be influenced by political considerations. Within the realm of requirements engineering, political willingness can serve as a driving force to promote the use of requirements engineering in government projects. A strong hierarchical organization demands strong leadership that can encourage the implementation of the best practices procedures for government projects, one of which is requirements engineering. For instance, the endorsement of requirements engineering practices even by the head of the ICT department may not yield its full potential without the approval from the mayor. One of the participants from the development team mentioned, *"In certain departments, the willingness to provide information to us may be impeded, or information may not be shared at all, especially if there is no direct order from their superior to do so"*. This statement underscores the critical role leadership plays within a hierarchical framework in facilitating the effective practice of requirements engineering.

Resistance to change. It is challenging to elicit requirements from people who have mistrust toward online applications. In an interview, one of the business process owners expressed his concern that the application may not be able to capture all of the public opinion considering some people are unacquainted with the use of the technology. An additional factor for resistance is regulation. A member of the development team noted that some departments are reluctant to share the required data for this application as the regulations forbid data sharing. However, the specific department failed to respond when the development team requested information regarding the regulation. As a potential remedy, one participant suggested that a directive from the head of the department is necessary to accelerate the progress of data sharing for this application.

2) Resources-related Factors

Limited human resources. Contrary to the typical paradigm of a smart city project, characterized by massive projects involving numerous stakeholder people, Project X1 is only developed by a limited number of people as a software development team. In addition to smart city projects, this team is also responsible for different IT projects in the municipality. In this team, people who have a thorough understanding of requirements engineering practices are also limited, if not nonexistent. It is a matter of concern that this situation is also prevalent in other municipalities in Indonesia, leading to a scarcity of individuals to conduct requirements engineering activities.

Accessibility challenges. In an attempt to collect required data from the department concerned, it is crucial to proceed with correct bureaucratic procedures. However, correct bureaucratic procedures frequently entail a complicated process and require additional time. This condition may lead requirements engineering practitioners to renounce requirements engineering practices due to time constraints, as accessing information becomes challenging. In this case, the development team had difficulty retrieving information, resulting in data inaccuracy for social assistance funds information.

3) Knowledge-related Factors

Insufficient requirements engineering training. The project manager has acknowledged that they have insufficient knowledge about standard requirements engineering practices, leading to inadequate practices within the organization. Our interviews revealed that no individual has previously conducted standard requirements engineering practices.

Lack of domain knowledge. Lack of knowledge about the domain leads to misunderstanding of business processes. This is usually solved by involving relevant stakeholders as

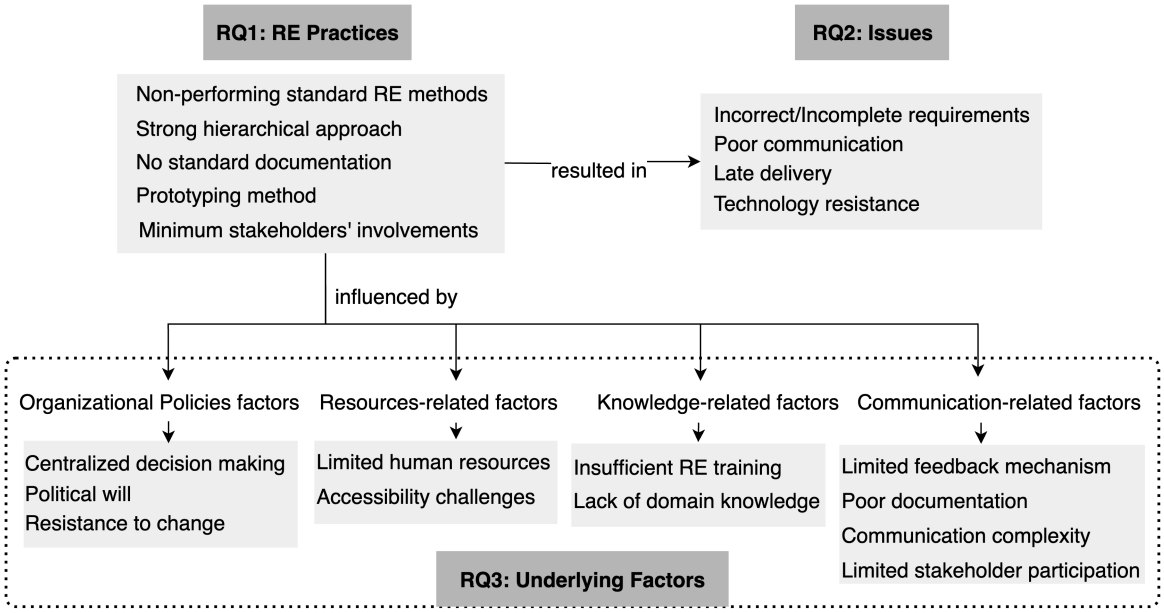

Fig. 2. Requirements engineering practices and the underlying factors.

a domain expert in the development process. However, our interview revealed that the business process owners were not consulted at the start of the project, resulting in misunderstanding and incorrect business processes of existing departmental services. In government projects, practicing requirements engineering becomes notably challenging when knowledge about a domain is poorly understood.

4) Communication-related Factors

Limited feedback mechanism. In Project X1, prototyping was used as a method to elicit requirements. The development team present a prototype in a meeting to collect feedback for the next cycle of development. However, the feedback predominantly originates from the mayor or business process owners. There is no feedback mechanism for obtaining evaluation from citizens, as one of the primary users of this application. The interview participants informed us that the citizens are not involved directly in this project.

Inadequate documentation. Documentation is frequently considered as a method of communication. Effective communication can be accomplished by establishing good documentation. Standardized documentation will make communication more efficient, internally or externally. However, this appeared to be a problem for Project X1. The words that were frequently quoted by our participants were, *"We didn't consider creating documentation"* or *"There is no documentation"*. This absence of requirements documentation may lead to requirements inconsistencies, ambiguous requirements, or incorrect requirements. Requirements document serves as a communication medium for conveying and validating requirements to stakeholders. The inability to create good documentation may prevent the development team from effectively performing requirements engineering practice.

Communication complexity. The diversity of stakeholders is an important issue in smart city development, especially in developing countries. Requirements engineering is commonly applied in companies that have uniform potential customers. However, for government-owned applications, potential customers can originate from diverse backgrounds and problems. Potential customers in a smart city project may include government employees, citizens, or business sectors. This resulted in communication complexity. a number of governments in the Global North offer incentives to citizens to get involved in smart city projects. However, for most countries in the Global South, the government is unable to provide competitive incentives to citizens or private sectors to participate in these projects. We also noticed that the hierarchical approach affects how people communicate within the organization. One interview participant suggested that team members are reluctant to give negative comments on their superior instructions and tend to comply with them. This could lead to miscommunication, potentially resulting in incorrect or incomplete requirements.

Limited stakeholder participation. Stakeholder involvement is essential to the success and sustainability of smart city projects. Multiple participants highlighted differences in business processes for departmental services, noting the distinction of perception between software developers and affected departments. Concerning this, one participant stated *"our participation [in internal meetings] was limited to only a small number of times in Project X1. [because of this] we are concerned that our requirements are thoroughly examined [by the development team]"*. Regarding citizens participation, one participant mentioned *"one of the challenges for citizens participation is involving people who are unfamiliar with mobile applications, together with resistance [to use mobile application] from a certain segment from the community"*. If this issue persists, it may lead to the software develop-

ment team or requirements engineering practitioners failing to conduct requirements engineering activities for the project effectively.

V. Discussion

A. Hierarchical Approach in the Global South

Some of the issues uncovered during our investigation may manifest in any project regardless of their location, whether in the Global South or the Global North. Numerous projects suffer from inadequate documentation, lack of stakeholder involvement, and resistance to change. Very often, ICT projects face budget constraints, resulting in limited capacity of human resources.

In many cases, smart city projects in the Global South are comprehensive and infrastructure-focused. This results in highly complex, and very large projects, with all the risks of such projects.

However, the most striking finding is the strong hierarchical control of smart city projects in Indonesia. The government is in control, and decisions about requirements and setting priorities are made by the mayor. This introduces the risk that the requirements as set by the mayor may not be the same as the requirements by the citizens and organizations in the city. There is a sort of feedback loop in the form of prototyping, but the way it is done right now is quite expensive and it is doubtful whether it is very effective. We have indications that the hierarchical control of smart city projects is prototypical for Southeast Asia. The solution for this is not easy; the top-down way of working is part of the culture and difficult to change.

To support our analysis, we investigated *power distance* theory proposed by Hofstede et al. Power distance was defined as the extent to which less powerful members within institutions and organizations in a country expect and accept unequal distribution of power [19]. This concept revealed that countries with a higher score of power distance tend to use a stronger hierarchical approach than countries with a lower score of power distance.

In terms of the relation between a strong hierarchical approach and smart city performance, we compared power distance theory with the IMD Smart City Index (SCI) released by the IMD World Competitiveness Center in collaboration with the World e-Government Organization (WeGO). The SCI ranks 141 cities across the world in terms of smart city performances by capturing the perceptions of residents in each city on issues related to structures and technology applications available in their city [20]. This report also included multiple cities from 5 Southeast Asia countries; Indonesia, Vietnam, Malaysia, Thailand, and the Philippines. Using tools provided by [21], we conducted a comparative analysis of the power distance between highly ranked index smart cities in the Global North and Southeast Asia and presented the comparison Fig. 3. For comparative purposes, only the highest-ranked city of a country in the SCI Index is in this figure. For instance, Indonesia is placed at rank 102 on Smart City Index, as Jakarta (ranked 102) is the highest-ranked city, rather than Medan (ranked 112) or Makassar (ranked 113).

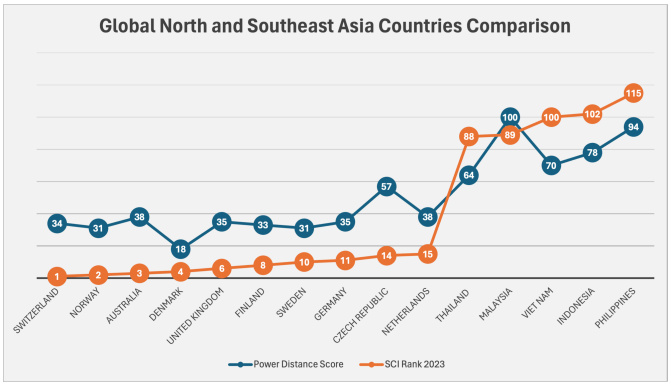

Fig. 3. Comparison of Power Distance Score and SCI Index of Global North and Southeast Asia.

By analyzing Fig. 3, it can be assumed that the power distance score affects the performance of cities in terms of smart city projects. Most of the Southeast Asia countries have higher power distance scores relative to the countries in the Global North. In contrast with the rankings of smart cities, which are lower than those of countries in the Global North.

B. Threats to Validity

1) Participants Selection.
The selection of participants is one of the most crucial issues in this study. We believe that the mayor has the main role in this project as the initial idea for this project originated from him. Unfortunately, we could not arrange a meeting with him due to a scheduling conflict. In an interview with the development team, it was mentioned that the mayor obtained these requirements by meeting with citizens on the street. However, it remained unclear to us what specific activities were undertaken by the mayor to acquire these requirements.

2) Country Representation.
The Global South consists of numerous countries characterized by diverse cultures and political environments. Recognizing the distinction between regions, we understand that situations in Africa, South America or the Middle East might vary from those in Southeast Asia. In the context of Southeast Asia, the Association of Southeast Asian Nations (ASEAN) has facilitated smart city initiatives through the establishment of the ASEAN Smart City Network (ASEAN-SCN). As a member of ASEAN with a cultural affinity to Malay culture, we aspire for Indonesia to effectively represent ASEAN in the broader context of Global South countries. However, we are aware that a more comprehensive study is necessary to capture the Global South situation related to requirements engineering practices in the Smart City projects.

VI. Conclusions and Future Work

This paper presents a systematic approach to the practice of requirements engineering for smart cities in the context of the Global South. We understand that even though the issues

in the Global South may be similar to those in the Global North, the causal factors might differ. Therefore, it needs a different approach for requirements engineering practices in the context of smart city projects in the Global South. Factors such as resources-related issues, knowledge-related issues, communication issues, and organizational policy issues, which are significantly influenced by a strong hierarchical approach, are issues that are currently not widespread in the Global North.

We believe that it is imperative to tailor standard requirements engineering practices to the local context for smart city projects in the Global South. Comprehensive research involving multiple local governments from the Global North and the Global South is necessary to gain a better understanding and provide better solutions for requirements engineering practices in the Global South. Further research is also essential to adapt the current existing RE techniques or develop new potential approaches suitable for highly hierarchical settings, such as in the Global South.

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