

Modelling Data Warehousing and Business Intelligence Architecture for Non-profit Organization Based on Data Governances Framework

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Abstract

Information systems research for non-profit organizations is an opportunity to make a contribution to the field of information systems, the adoption of information systems in this field is relatively tedious and there are few studies that examine this area; consequently, there are several research gaps in the domain of non-profit organizations that need to be solved. This research will focus on the development of data warehouse architecture and business intelligence for non-profit organizations. In this study, the Soft Systems Methodology (SSM) technique will be employed to develop a data warehouse architecture and business intelligence. This research will interview twenty individuals to collect primary data, review organizational policy documents, and conduct an open-ended survey. The obtained data will then be qualitatively analyzed, resulting in the formation of rich picture diagrams, CATWOE analysis, and conceptual models, which will ultimately form a data warehouse architecture and business intelligence. This research has produced a microservices-enhanced data warehouse architecture and business intelligence for non-profit organizations.

Keywords: Data Warehouse; Business Intelligence; SSM; Non-Profit; Information Systems;

1. Introduction

The goal of "altering the organization's status quo in search of improvements," which translates to offering a customer-satisfying product or service, justifies the adoption of a new technology, which can lead to innovation. In an effort to remain competitive on the market, organizations have turned to the reorganization of their processes as a means of meeting cost-cutting requirements and enhancing their internal resources. As a result, the information system made possible by information technology (IT) makes it easier to find solutions and spot opportunities for innovation and development. Initiatives involving information technology are deemed successful if users continue to employ them after their initial acceptance [1], [2]. A non-profit organization is an organization with legal personality, a mission of public service, and tax-exempt preferential treatment. Independent in nature, it does not distribute profits to internal members for profit-making purposes. Non-profit organizations are not only an important vehicle for public expression and the provision of social services but also an essential means for the public to attain orderly participation in public life, and they play an increasingly vital role in the field of social construction [3]. Furthermore, Information technology is fundamental to the majority of non-profit organizations. It plays such an essential role in the service provision and management of nonprofits, where increased competition for foundation funds, loss of geographic advantage, and the multiplier effect are important considerations. Innovative applications of information technology should enable nonprofits to maximize their potential in a variety of areas as well as enable all process become more efficient. Using information technology instruments, it is possible to provide efficient, low-cost services while also satisfying financiers' and regulators' reporting requirements. In addition, by utilizing information technology, nonprofit organizations can come up with novel approaches to not only provide new services to new client groups but also expand the reach of existing services. Finally, information technology can be used to attract

donors, administer the resources and capabilities of nonprofit organizations more effectively and efficiently, and enhance their services and internal operations [4], [5].

Despite the fact that the nonprofit context is distinct from that of for-profit organizations, both theoretical and empirical research are essential for furthering knowledge of IS strategies, applications, and use in the NPO context. Based on the conclusion of a 2017 study by Connolly et al., it is evident that NPO contexts could provide a viable environment for numerous fascinating research projects with wide-ranging effects. The study suggests that a recent interest in data analytics, data management as well as business intelligence could increase IS attention to NPO research, thereby diversifying the IS community's research contributions [6]. This research is consistent with 2013 research conducted by Imboden, in which it was stated that information security policies are essential in non-profit organizations due to the transmission and exchanging of sensitive data and that privacy must be maintained. Moreover, public confidence played a crucial role in determining the continued existence of non-profit organizations. Therefore, nonprofit organizations must have dependable organizational information security policies to safeguard their data [7]. On the basis of the presentation of previous studies, it is clear that it is essential to provide a solution to the issue of data exchange, which will be related to data governance and the maintenance of data privacy in organizations.

Numerous organizations are realizing that customer data is a valuable corporate asset that must be carefully protected and actively managed or 'governed' [8]. Furthermore, Data must be managed as an asset within the IT environment and must not be taken for granted. Since enterprise IT is a living ecosystem, a comparison to the human body can be made. Data is analogous to the blood in a living organism. Typically, the data governance component entails identifying the necessary processes, procedures, policies, and organizational structure to effectively manage all the data assets involved in the organization's data warehouse. Data governance is the process by which decisions concerning data investments in an enterprise and the management of data as a strategic corporate asset for competitive advantage are made [9].

Integration of data is the foundation of business intelligence systems, which are essential components of decision support systems. There are two primary types of data integration: physical data integration, which includes data warehouses, and virtual data integration, which includes data virtualization [10]. Data Warehouse and Business Intelligence systems are divided into two primary components as data-driven Decision Support Systems: data warehousing ("getting data in") and business intelligence ("getting data out") [11]. Data warehouses and business intelligence are solutions that ensure data sent to other entities is only a meaningful summary and does not violate the data owner's privacy. According to prior research, the purpose of data warehousing is to extract, transform, and import data from various source systems into a centralized repository. The fact that data is distributed across heterogeneous source systems creates numerous integration issues and obstacles, whereas Business Intelligence retrieves data from the Data Warehouse to provide business users with data-driven decision support. Using reporting tools and dashboards, data can be presented, investigated, or input into data mining models to derive predictions and insights from analytical data. Dimensional [11], [12]. Furthermore, The benefits of the snowflake data warehouse schema are relational, semi-structured, elastic, highly available, durable, cost-effective, secure, and performance [13]. On the basis of the presentation of previous studies, it is evident that it is vital to provide a solution to the issue of data exchange, which will be related to data governance and how to maintain data privacy in organizations. Data warehouses and business intelligence are solutions that ensure data sent to other entities is only a meaningful summary and does not violate the data owner's privacy. According to previous research, DW/BI systems are designed, developed, and used to support the analytical requirements of various departments or business areas within an organization by providing a "single truth." Moreover, Data Warehousing and Business Intelligence are integral components of the implementation of data governance. Data warehousing and business intelligence management are essential for data administration, particularly for decision-making. A properly designed data warehouse can enhance data integrity and uniformity [11], [13], [14]. According to the previous study, research on data governance is crucial for non-profit organizations. This research will establish a national model for the data governance of non-profit organizations, enabling the exchange of data and determination of data access to take privacy concerns into account.

In addition, the research questions for this study are: “How are Data Warehouse and Business Intelligence models suitable for the data governance model of a non-profit?”

2. The Proposed Model

Nonprofit organizations (NPOs) operate in an increasingly complex and turbulent environment in today's digital society. Indeed, the disruptive force of the digital transformation¹, decreased public confidence and trust², decreased public investment³, and increased demand for transparency and accountability⁴ have fundamentally altered the way non-profit organizations operate. A non-profit organization is an organization with legal personality, a mission of public service, and tax-exempt preferential treatment. It is independent and does not distribute profits to internal members for the purpose of making profits. Non-profit organizations not only play an important role in reflecting public appeals and providing social services but also in facilitating the public's orderly participation in public life, and they play an increasingly vital role in the field of social construction. Information security is a crucial foundation for e-government information sharing and determines the quality of the shared data. Some government agencies are concerned that the sharing of information resources will result in the disclosure of departmental information or the emergence of a variety of information issues[3], [15]. In 2006, Richard Heeks divided the E-Government strategy into three categories: centralization, decentralization, and hybrid. According to Richard Heeks, since the subject of this study is a decentralized organization, it must take a decentralized approach when designing its governance. This method has a number of benefits, including the adoption of local values for the constructed system and faster system development, whereas the centralized system has several flaws. That is, it takes a long time to implement and use, local entities have no flexibility, and it increases dependence on the center. In implementing this method, the decentralized system also faces a challenge, namely how to manage data that may be shared or accessed by other systems. The challenge to the decentralized E-Government method is comparable to the issue of developing an information system for religious organizations, namely the protection of personal information[16]. The focus of this investigation will be religious organizations. This organization has a dynamic structure because it is comprised of local churches, multiple levels of congregations, and congregations at the national level. Each entity within this organization has independent management, and its purpose is to report a summary to the congregation above. In this research primary data will gather through in-depth interview with informants from various organization in Indonesia. Figure 1 depicts the model of the organization's information system in this study.

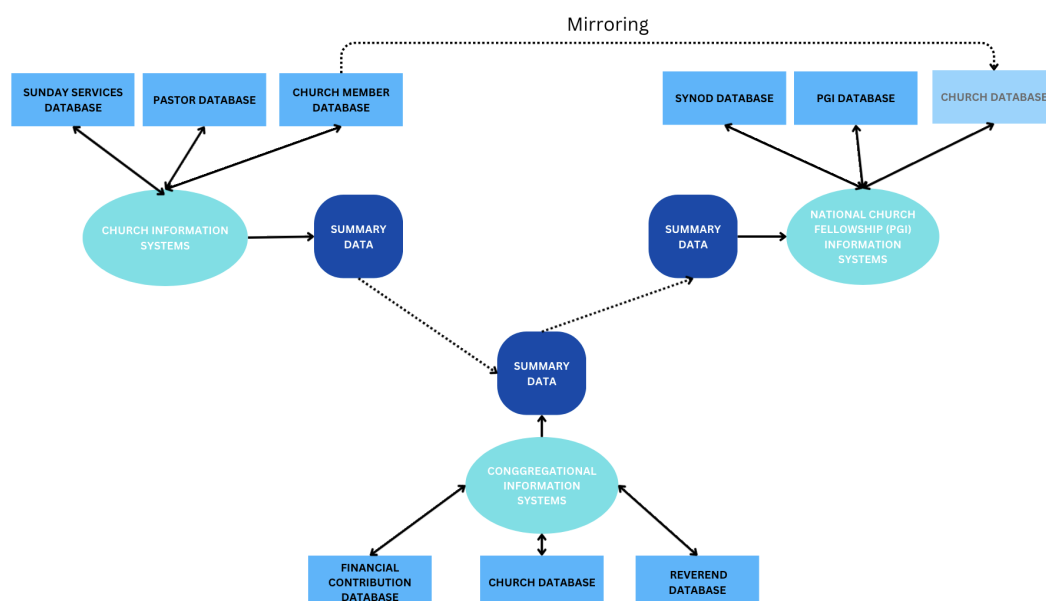


Figure. 1. Proposed Information Governance Model.

3. Methodology

Soft systems are characterized by a significant social, political, or human component. In this system, the object and method of study are unknown. Despite their complexity and obscurity, the observer is able to study soft systems as learning systems. Soft Systems Methodology (SSM) developed by Checkland is one of the most well-known and influential approaches to the study of soft systems. In 2001, Checkland created the concept of the Soft Systems Methodology (SSM). It is based on Husserl's (1983) phenomenology and derives its components, such as Schleiermacher's (1974) significance of context, from hermeneutics. As a result, it investigates problems or phenomena with a significant social, political, or human component. The transformational process becomes the focal point of the research [17], [18].

Soft systems methodology (SSM) is a method for addressing pernicious problems and devising actions to improve difficult circumstances. It is based on systemic reasoning and recognizes the varied perspectives of change agents. The development of SSM began in the 1970s, more than 50 years ago, and an early version of the methodology consisted of seven steps: (1) problem situations considered problematic; (2) problem situations articulated; (3) root definitions of relevant purposeful activity systems; (4) conceptual models of the systems named in the root definitions; (5) comparison of models and the real world; (6) changes that are systematically desirable and culturally feasible; and (7) implementation. The seven-stage model evolved into a two-stream model emphasizing that SSM must consider both a logic-based analysis, i.e., an evaluation of the tasks involved in the situation, and a cultural analysis, i.e., an assessment of the social and political culture influencing the situation. Later, the methodology was modified into a four-step, less rigid procedure. The objective of (1) learning about the problematic situation, including its cultural and political dimensions, is to gain a general understanding and perspective of the problematic situation. To facilitate this, the methodology necessitates the creation of a situational diagram that illustrates the interrelationships between the involved actors, structures, and processes. The second activity, (2) Formulate relevant purposeful activity models, necessitates the development of conceptual models outlining how activities in the given situation could be structured. This is not meant to be a flawless implementation model, but rather a tool to help structure the discussion regarding feasible and desirable problem solutions. The objective of the third activity, "Discuss the situation using the models," is to identify implementable and desirable changes. In the fourth activity, "Taking action to improve," the results of the previous three activities, i.e., the modifications decided upon, are evaluated and implemented as necessary [19]–[23].

This study will utilize four of SSM's seven stages and combine them with a more technical model of data management. The combination and results of these methods constitute a contribution to this study's research. In addition, hermeneutics will be added to the SSM in order to interpret the text in the primary documents compiled for this study. Hermeneutics is frequently utilized in interpretive research, and it is also regarded as a "philosophy of meaning interpretation." Hermeneutics focuses initially on "a method of interpreting textual data." Additionally, hermeneutics can be used to comprehend a text that is analogous. Hermeneutics is frequently utilized in interpretive research, and it is also regarded as a "philosophy of meaning interpretation." The primary concern of hermeneutics is "a method for interpreting textual data." Hermeneutics can also be used to interpret an analogous text (such as an organization or an author-created document). Hermeneutics was originally used to interpret sacred texts and the law. Hermeneutics is closely linked to the reading process and "the art of understanding all forms of communication, not just written text [24].

In this study, MaxQDA and NVivo software will be utilized for the hermeneutics interpretation procedure. These are the steps in the interpretation process:

1. Establishing primary data from interviews, organizational policy and strategy documents, and open-ended survey results.
2. Implementing open coding processes.
3. The use of crosstab matrix and project map to summarize and connect the code.

Table 1 and Figure 2 below detail the research stages and results for each stage that apply the five SSM procedures.

Table. 1. Research Stages and Output.

| Research Steps | Input | Process | Output |
|--|---|---|---|
| 1. Determining Problem situation. | Interview results as primary document | Coding analysis utilizing MaxQDA and NVivo | Connecting the code that presents the issue |
| 2.Expressing problem situation. | Code Summary from coding process | Connecting the code then expressing the issue using a Rich Picture Diagram | Rich Picture Diagram |
| 3.Root cause analysis. | Rich Picture Diagram | Analyzing the problem's root cause | CATWOE analysis table |
| 4.Modelling conceptual diagram. | CATWOE analysis table, Rich Picture Diagram | Modeling the transformational activities rooted in the original definition. | Conceptual diagram |
| 5.Modelling Data Warehouse and Business Intelligence Model for Non Profit Organization | Conceptual Diagram | Modeling Data Governance at the National Scale | Data Warehouse and Business Intelligence Architecture |

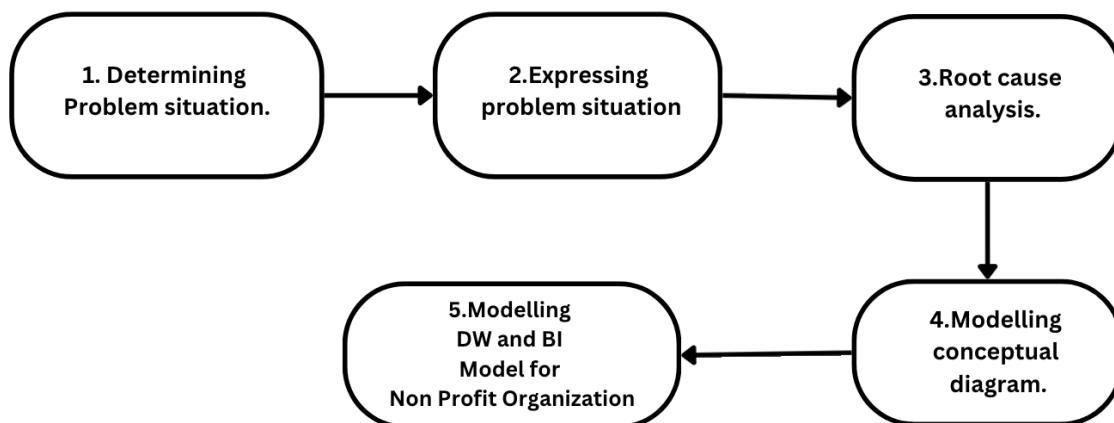


Figure. 2. Research steps

4. Results and Discussion

4.1. Determining Problem Situation

In the present investigation, primary data were collected from a national religious organization. In order to collect primary data, twenty leaders of national congregations from each of Indonesia's major islands were interviewed, organizational policy documents were reviewed, and an open-ended survey was conducted. Table 2 displays the regions that participated in the interviews for this study. All of these primary documents are analyzed using the following three hermeneutic procedures:

1. Preparing primary data from interviews, organizational policy and strategy documents, and open-ended survey results. In this stage, twenty primary documents, organizational strategic policy documents, and survey results are entered into the MaxQDA application for hermeneutic analysis. The triangulation of these three categories of primary documents is the most important aspect of qualitative research. As stated by

Marshall et al. in their 2013 study, which was cited by Hennik et al. in 2022, according to the principles of qualitative research, a sample size of 20 is sufficient and is estimated to have reached data saturation.

2. Employing open coding methods. The 22 primary documents undergo the coding procedure at this stage. The coding procedure involved assigning codes to words, phrases, sentences, paragraphs, and images from the source document.
3. The use of a crosstab matrix and project map to summarize and connect the code. Following the creation of a theoretical code model to determine the relationship between codes, variables will be assigned to the informant profile, such as the informant's educational background, the size of the organization he or she leads, and his or her geographic location. So that the relationship between informant variables and existing codes can be viewed, codes from MaxQDA will be exported to NVivo for analysis using the project map feature. Figures 5 and 6 depict the Code Theory model and the project map results of the relationship between variables and codes.

Table. 2. Primary Data Sources

| Geographical Location | Number of Informants |
|-----------------------|----------------------|
| Java Island | 8 |
| Sumatera Island | 4 |
| Kalimantan Island | 1 |
| Papua Island | 1 |
| Sulawesi Island | 3 |
| Nusa Tenggara Timur | 1 |
| Maluku Island | 1 |
| Bali Island | 1 |

The above table 2 indicates that the informants hailed from five major islands and two smaller islands in Indonesia, total numbers of informants is 20 persons. These locations were sampled so that the major islands of Indonesia could be represented and the needs of the existing organizations could be assessed from a macro perspective. In the diagram 3 and 4 below, the analysis process is divided into two categories: organizations located on the island of Java and organizations located outside of the island of Java. On Java Island, infrastructure is still in the process of being developed.

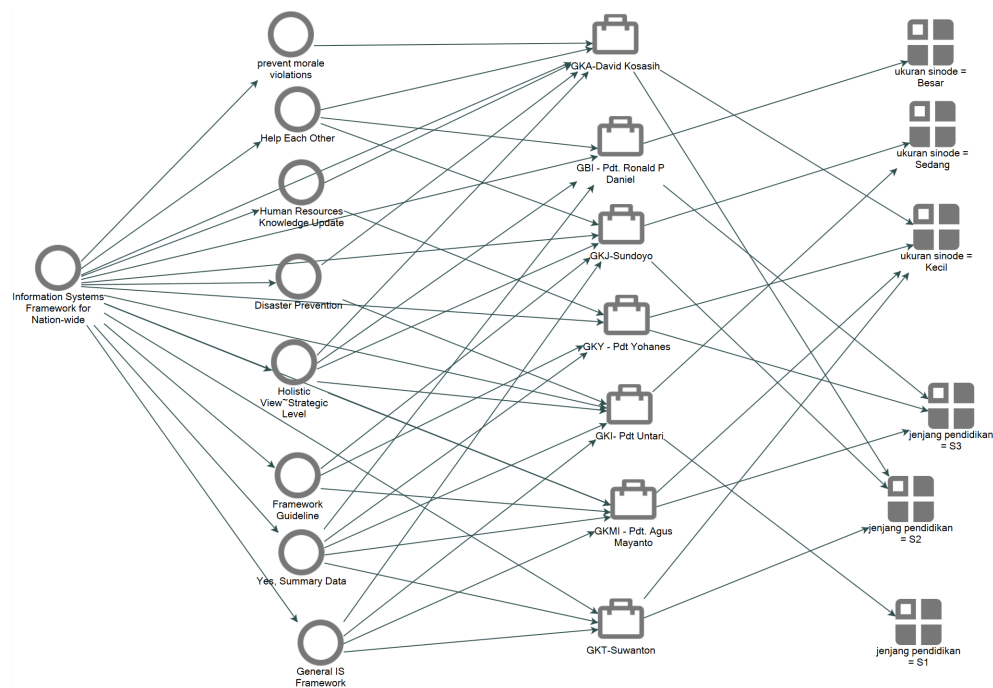


Figure. 3. NVivo Project Map From Java Island Informants.

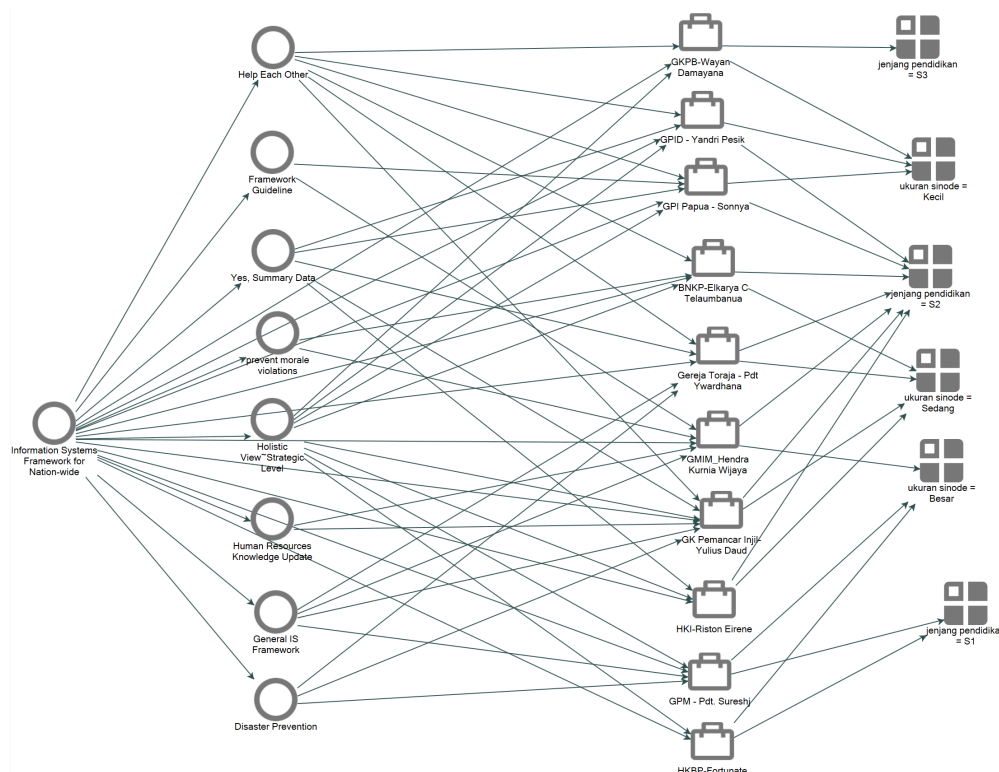


Figure. 4. NVivo Project Map From Outside Java Island Informants.

Figures 3 and 4 illustrate the need for data processing to generate strategic information at each organizational level; this data processing cannot be separated from the requirement for summary data. Based on this, it appears that each level of the organization requires a data warehouse and business intelligence mechanism.

4.2. Expressing Problem Situation

It is the subsequent phase of the SSM program. Based on the outcomes presented in the previous subsection, the Rich Picture Diagram depicted in Figure 5 was generated.

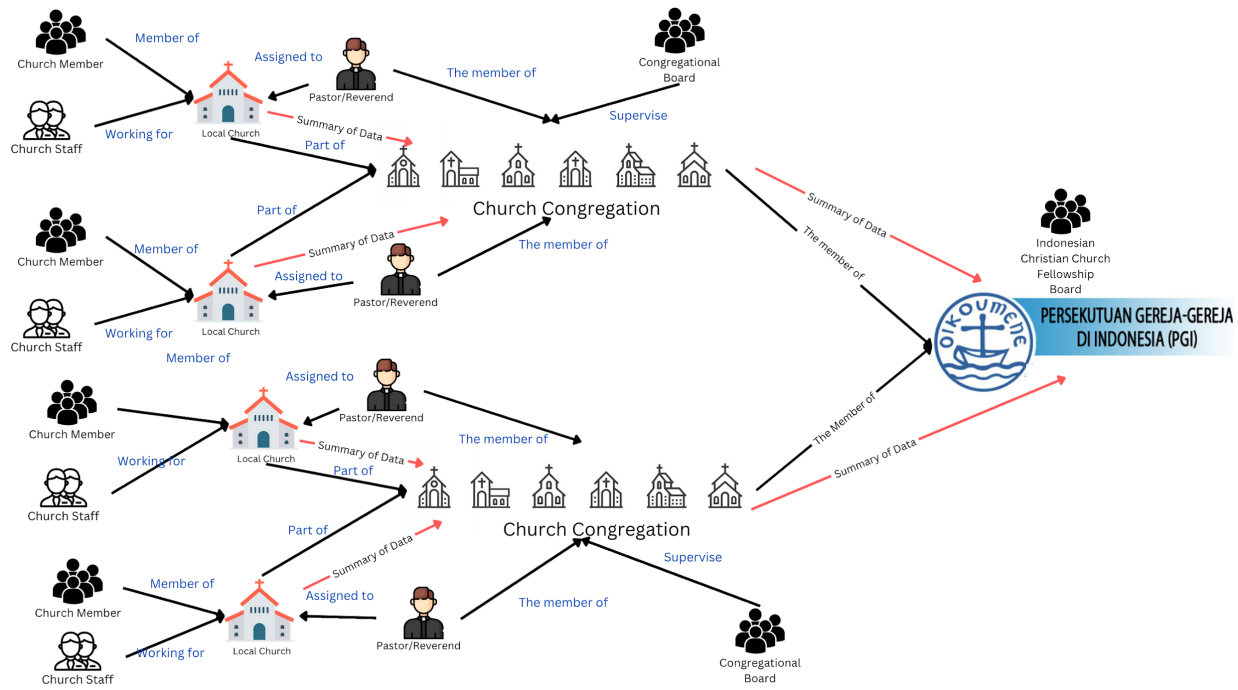


Figure. 5. Rich Picture Diagram Expressed as a Problem Situation.

In Figure 5, it is depicted that the congregation above the local church will receive data in the form of a data summary; this, of course, requires a data warehouse so that the summary of the data sent is useful data and can be used to view strategic matters from the organization's higher level on. Our other research has revealed that data privacy is also an important aspect of data governance in socio-religious organizations; with the existence of a data warehouse, data security and privacy concerns in each local church will be supported.

4.3. Root Cause Analysis.

As an official statement of intent, CATWOE can be expressed using a root definition. Based on the CATWOE and its root definition, a human activity system (HAS) is created to direct the execution of the transformation's specified output. Once the respective HASs have been established for all transformations, they are implemented. A precise definition of the activity to be modeled is required to construct a model of the concept of a complex purposeful activity for use in an SSM-based study. These definitional statements, the 'root definitions' of SSM, are based on a description of a transformative activity[25], [26].

CATWOE is a root cause analysis tool developed by SSM. A mnemonic tool for remembering the following data about the human activity system [19], [23] :

1. Customers: the recipients or those targeted of the problematic circumstance and improvement measure.
2. Actors are those involved in the circumstances and carrying out the improvement intervention.
3. Transformation is the process of evolution.
4. Worldview: Assumptions underlying the intervention's value and significance for improvement.
5. Owners: Actors responsible for establishing the interference and determining whether it will be implemented.

6. Environmental obstacles and catalysts are contextual factors that could have an effect on the challenging circumstance and the development intervention.

CATWOE analysis summary presents in the table 3 below.

Table. 3. CATWOE Analysis.

| CATWOE Elements | Description |
|-----------------|---|
| C | Nation-wide Church Fellowship, Congregations, Local Church |
| A | Board, Elder, Pastor, Secretary, Administration Personnel. |
| T | Membership database can be summarized simply and remain confidential. |
| W | Data Warehouse and Business Intelligence can make data summarization run efficiently while preserving data confidentiality. |
| O | National Church Fellowship, Congregations, Local Church |
| E | National government policy, local government rules. |

4.4. Modelling Conceptual Diagram.

Building a conceptual model is defined in this section as "combining the activities required to describe the transforming process" or "defining and connecting the activities required to accomplish the transforming process"[27]. In this phase, these root definitions are utilized to develop conceptual models. Initially, conceptual models are comprised of seven or so activities, each with a significant verb, organized in a logical sequence, and representing the minimum activities required to accomplish the transformation enshrined in the root definition [28]. Based on rich picture diagram and CATWOE analysis, figure 6 depicts the conceptual model for data governance.

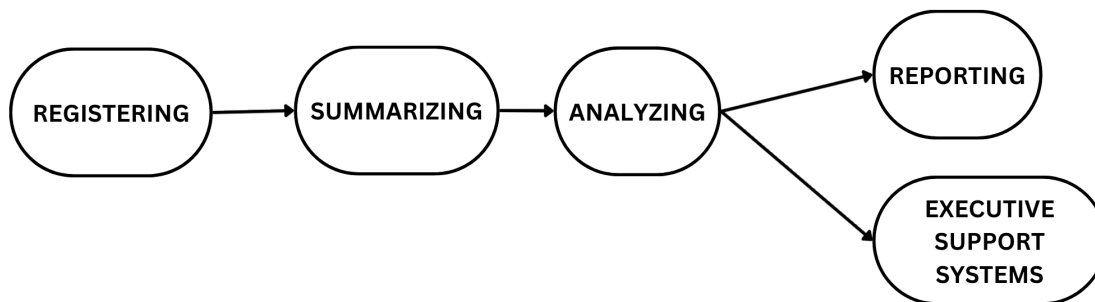


Figure. 6. Conceptual Model Diagram.

The activity begins with data registration, followed by data summarization for additional analysis. Additionally, variables for local, regional, and national congregational executive support systems will also be reported.

4.5. Modelling Data Governance and Business Intelligence Model.

Data Warehouse and Business Intelligence systems are divided into two primary components: data-driven systems and metadata-driven systems. Executive Assistance Systems Data warehouses and business intelligence are solutions that guarantee data sent to other entities is a meaningful summary and does not compromise the privacy of the data owner. According to previous research, the objective of data warehousing is to extract, transform, and import data from multiple source systems into a centralized repository. Business Intelligence retrieves data from the Data Warehouse to provide business users with data-driven decision support, whereas the fact that data is distributed across heterogeneous source systems creates numerous integration issues and obstacles. In our previous research, we determined that data privacy is one of the most important issues in the area of data governance for non-profit

organizations. As a result, in this research, we propose a microservices-enabled data warehouse architecture to maintain data confidentiality. The architecture of the data warehouse proposed in this research is depicted in Figures 7 and 8.

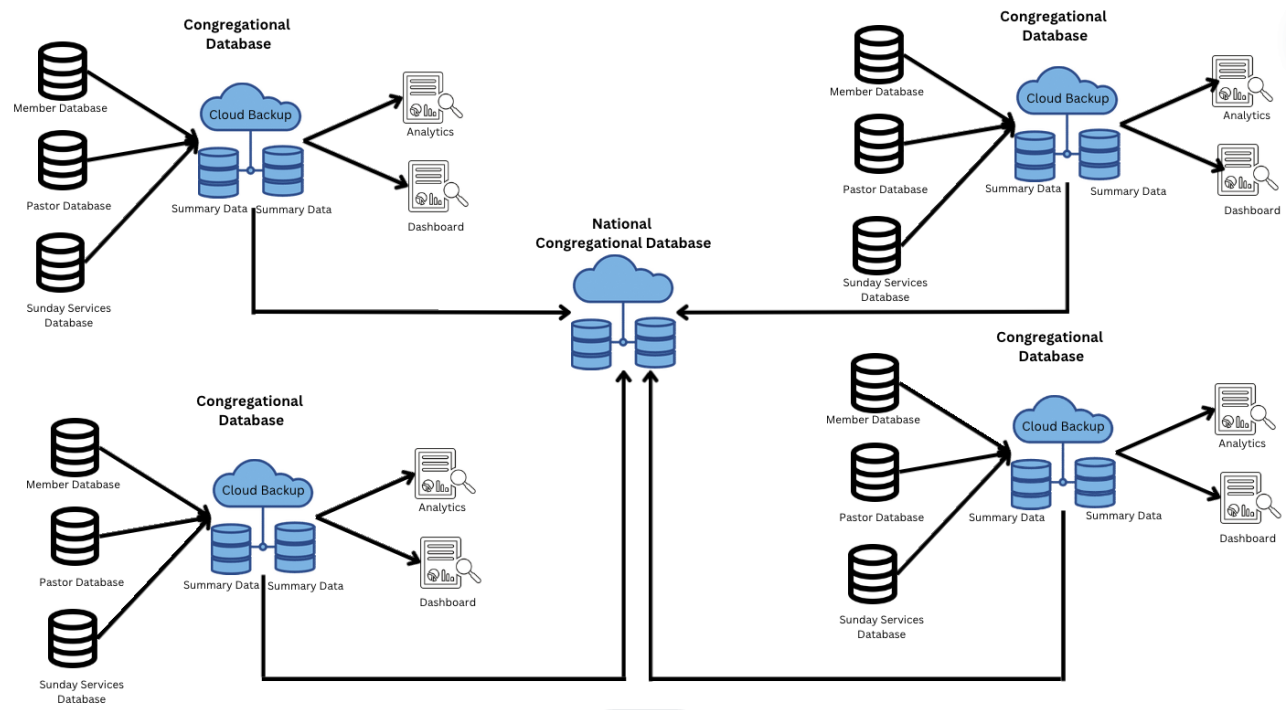


Figure. 7. Data Warehouse Architecture Proposed.

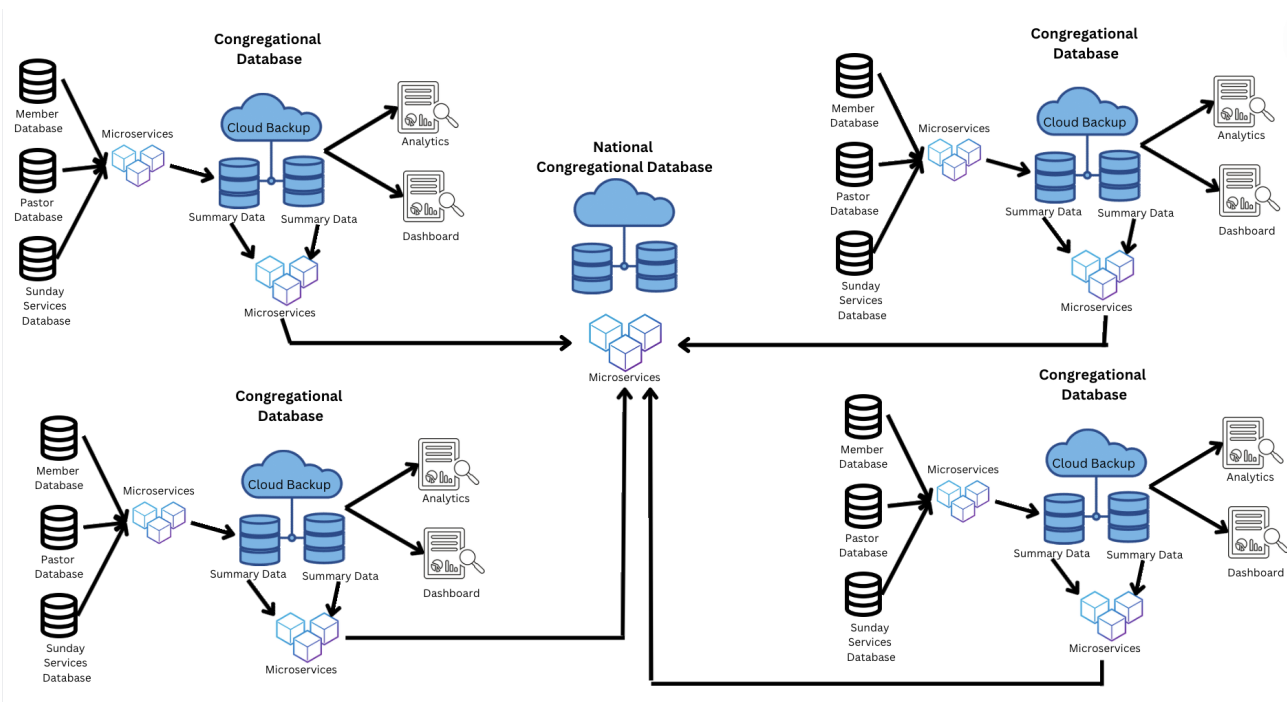


Figure. 8. Data Warehouse Architect Empowering with Microservices.

In Figure 7, a data warehouse architecture is designed for local churches and congregations. In this architecture, the data warehouse will reside in the congregation, and the data warehouse at the congregation level above will be synchronized with the data warehouse at the congregation level below. In this data warehouse, only summary information is stored for strategic organizational decision-making, whereas detailed data will be stored in the databases of each local church. This is consistent with the findings of previously conducted interviews. The created architecture will support the organization's business intelligence model; by directly accessing the data warehouse, it will be easier to see the organization's needs in outline, and the access process will be accelerated.

Figure 8 depicts the process of sending a summary of data between nodes in the architecture proposed in this study. The process of sending data will be carried out by microservices in each local church, as depicted in the figure. This is done to ensure that the data privacy process is maintained. The process of sharing and sending data through microservices is carried out in order to prevent the system from having direct access to the database. In the future, if necessary, configuration changes can be made to the built microservices to accommodate the needs of data summaries. Additionally, prior research indicates that microservices are required for database access. In addition, microservices can be defined as a strongly encapsulated and loosely coupled application service with a well-defined scope that can be deployed independently, run in a separate process, communicate using lightweight technologies, and be intended to offer a business high availability and scalability. This research proposes a data warehouse architecture with microservices that empowers previous research that has already identified microservices for the integration and storage of external data for each data source and domain. A is an illustration of a domain 1 data source. A second data source may also originate from the first domain, but it employs distinct concepts and technical terminology. The term "company" can also be used interchangeably with "enterprise" and "organization." Moreover, the organizational responsibility of microservices in specialized departments can improve data governance[29]–[31].

4.6. Discussion

For the next research discussion, it is necessary to conduct a comprehensive trial to determine if the proposed architecture can actually meet the information needs of non-profit organizations. Trials must also be conducted in areas with inadequate information technology infrastructure. Through this trial, opportunities for enhancing the proposed architecture and equipping it with the proposed technology for underdeveloped countries will be identified. Another research opportunity in this research is conducting study in governance for information systems in non-profit organization areas.

5. Conclusion

The SSM process can be used to develop data warehouse and business intelligence models for non-profit organizations, particularly religious organizations. During the SSM process, problems in the field can be properly mapped, resulting in a solution for the required data warehouse architecture. Future research could examine the efficacy of the proposed architecture at multiple locations of non-profit organizations, including religious organizations and other non-profits.

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