

A New Framework for Information System Development on Instant Messaging for Low Cost Solution

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Abstract

The increasingly inexpensive Internet has spurred the growth of online information system services in various companies. Almost all services are available in forms on web or mobile applications. For small companies, this particular system is more difficult to implement as it requires a substantial cost allocated for hosting, domain and server devices. The solution is to develop a framework for building information system services through Instant Messaging (IM) such as Telegram, Line or XMPP / Jabber using the Design Science Research Methodology. This proposed framework has the ability to transform the existing information system services into chat services with RBAC role, session, validation and natural interaction using Indonesian-language conversations. The framework that consists of Initiate layers, business process and communication, memory group and OLTP DBMS will produce low-cost solution for the development of integrated information systems service.

Keywords: *natural language processing, instant messaging, framework, business process conversion, low cost information system development*

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1. Introduction

The invention of the internet has triggered a very rapid development in the field of information systems. The increasingly inexpensive Internet has fueled the growth of web based information systems in the various organizations. This trend gives a positive impact to improve the speed and quality of service for all relevant stakeholders.

Developing a web / mobile service based on the form requires a variety of infrastructure at the side of the company and the users. The company requires the services of a programmer, hires servers, buys domains and provides bandwidth on the server side. All of them require considerable routine expenses. On the users' side, they can access the service only through the browser and is not conveniently accessible in the mobile platform. In the web architecture, the Users must also have a good internet connection because it does not only allow the access of texts but also guarantee good display of graphical data. Therefore, alternative solutions are needed to develop information system services which contribute economic benefit for the information systems' owners and provide ease of access for users.

Alternative solutions arise with the development of information system services through various backbones provided by Social Media Messenger or Instant Messaging (IM) such as Facebook messenger, Twitter, Line, Telegram and more. IM was chosen because it can eliminate some of the great cost needed in some areas such as domain, hosting, web server and internet connection. This is possible because IM is a communication service that mostly can be used with free of charge including bot services and its integration through the API. IM will be used as a free backbone for passing data from local databases.

IM is a well-known communication platform. Based on the survey, all people online in America, 79% are Facebook users, 32% Instagram and 24% are Twitter users [1]. Other reports say that during January 2017, Facebook users reached 1.871 million followed by Whatsapp, FB Messenger 1000 million, WeChat 600 million, Twitter 317 million and Telegram 100 million [2]. IM technology is also predicted to become more dominant and begin to shift the use of SMS technology [3]. If the IS service can be accessed via IM, it will certainly become an affordable and practical solution. This model will not be difficult to be made public because the users are

very familiar of its usage and this model does not require any additional applications. By utilizing a number of studies on data passing through IM media and NLP algorithms for database access, a new framework will be developed as a low cost solution of information system development through the IM platform.

2. Related Work

2.1. Researches on IM Utilization to Access Information Systems

To support the exchange of data between databases by using Yahoo Messenger (YM), has designed a model developed for distributed databases with horizontal fragmentation approach [4]. Each incoming message will automatically be processed by the autorespon layer according to the defined business process standards. Further research is conducted to exchange data on separate and non-distributed database structures [5]. Other models for data exchange between databases have also been tested successfully on the Google Drive platform [6]. The data exchange model in these three studies is available through defining certain keywords [4, 5, 6].

In addition to the use of YM, Twitter has also been used as a medium to communicate with other social media applications using streaming APIs. Through the architecture named Aperator, users can broadcast messages from Twitter to other social media users. Aperator development is then done by providing 2 types of transaction services namely mention and request by using the keyword [7, 8]

Jabber (XMPP) is a simple, flexible, and highly intuitive IM technology [9]. This protocol has been tested on smartphone devices for real-time chat environments with many users and the achievement of efficiency in educational institutions. This research aims to produce the model of implementation on instant messaging (IM) in web and android applications [10]. The use of IM has also been utilized in the implementation of E-learning in higher education, by designing applications that run using micro-web on mobile devices [11].

In this research group [4-11], IM (YM, Twitter, XMPP or self-built apps) and Google Drive have started to be associated with data access services from a database with a keyword-based access model and have no permissions settings for users, validation and sessions.

2.2. Research on Natural Language Processing for IM Services

2.2.1. Interface for Data Access to DBMS

Up to this present time, various researches developing the access model to database are grouped into Natural Language Interface to Database (NLIDB) and Keyword Based Interface to Database (KBIDB). NLIDB works by modeling language rules and KBIDB works by compiling the set of services into specific keywords [12-16]. To improve the accuracy, the NLIDB approach is combined with KBIDB [17]. Other improvements were made using the ontology approach [18]. Test results with 100 data input obtained precision by 86% and recall 84%.

In this study group, all models were developed for the translation of natural language to SQL notation without a feedback dialog and was only used to run select command in SQL. The resulting model is not associated with the IM service and only connects to the database engine instead of the query browser and works only with the English domain.

For Indonesian domains, NLP-based applications have been developed to perform data searches on academic databases. Each input from users will be translated into 1 query and given an answer based on the production rules and does not involve dialogue for answers [19, 20]. This study developed a natural language recognition model to access the database in lieu of browser queries and limited to select operations. This study is limited in providing access to a database in a static xml format and can not move to another database in runtime mode.

2.2.2. NLP and IM

For chat-based conversation processing with short message characters, several chat engines have been developed. The machine has successfully won several championships in Loebner's annual competition in artificial intelligence. The case of the object of research is the development of the engine to engage in a dynamic conversation with a certain personality such as a historical figure or imagination [21-26].

Another study was conducted to develop a chat-based interaction model whose source of knowledge was drawn from Wikipedia and DBpedia. Users can interact as if with a character in the past with English and have successfully tested for Hitler's character [27]. Chatbot has also been tried to be designed to provide FAQ services for e-commerce cases on Artificial Intelligence Markup Language (AIML) machines using Latent Semantic Analysis [28].

For the Indonesian language, the Alice engine has been tested with a pattern matching which requires that all patterns pointing to a single meaning should be written as much as possible with possible variations [29]. Research on the AIML platform has also been tested with a website application interface and is able to provide 80% accuracy [30].

Improved pattern recognition was performed by applying a number of algorithms such as the TF-IDF weighted algorithm combined with the use of the Vector Space Model [31] method, the Sentence Similarity Measurement algorithm [32] and by using pattern-matching combined with the Bigram algorithm on the AIML engine [33]. Other improvements were made by implementing the automatically learned Information extraction system for English [34].

Among all the researches on chatbot, most of them applied pattern matching approach refined with some algorithms such as sentence formation and weighting. This present research focused on text mining algorithm, pattern matching and performance improvement. Any particular researches modeling access to integrated information system services involving multiple databases, multiple roles, input validation, referential integrity and session management have not yet found.

3. Research Method

This study uses information system development model based on Design Science Research Methodology (DSRM) which consists of several important stages including problem formulation, preparation of study materials for alternative solutions, design and development, implementation, evaluation and communication/reporting [35]. Problem formulation and preliminary studies have been described in the introduction and related works sections.

3.1. System Overview

The basic idea to be developed is to design a model of information system service through communication in the form of chat as presented in Figure 1.

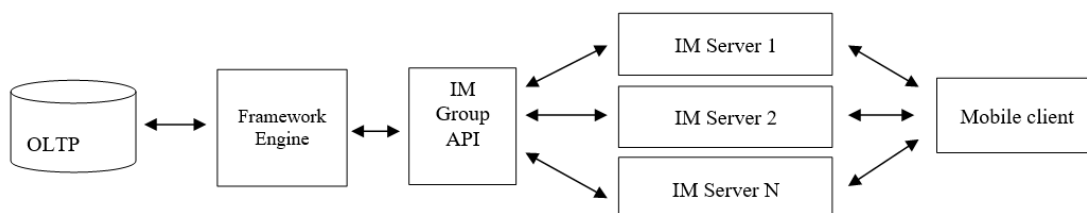


Figure 1. System overview

This service will replace all models of form-based services in web / mobile applications. Through the chat service, users can perform the search function, input, edit, deletion of data and other functions such as an information system. Users can communicate using natural conversations in Indonesian language without being restricted by the use of special keywords. This model is expected to develop a low-cost access model on the side of system's owners and users.

3.2. Framework Architecture

We propose a framework named ISONER (Information System on Internet Messenger) which consists of several blocks as shown in Figure 2. This study provides a complete framework in accessing information systems ranging from conversion of business rules, access

rights, validation rules and interaction models using natural language that has never been done by previous research as a single framework.

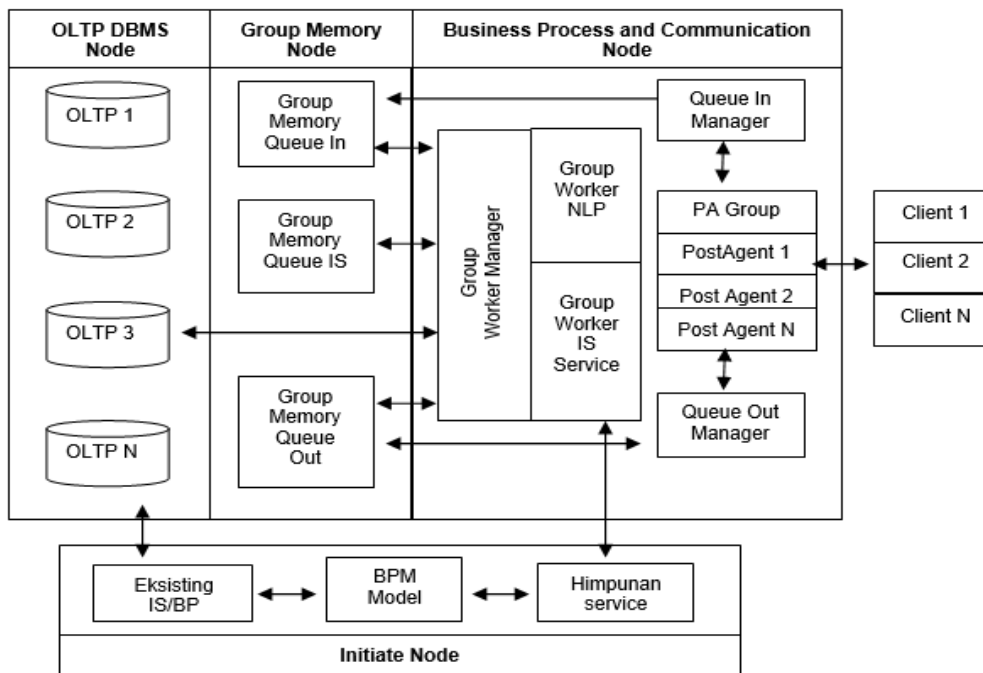


Figure 2. Framework architecture

This framework works by building 4 nodes, consisting of:

- 1) Initiate Node is used to perform all the initial preparation process, which consists of blocks:
 - a) Existing Information System / Business Process is a block for documenting the existing business process and can be stored in the form of DFD or UML. Existing systems can come from business processes that are still managed manually or already available in the services of an Information System.
 - b) The BPM Model is used as a guide to transfer the business process documentation results into a SQL syntax set that the DBMS engine understands.
 - c) BPM Integrator is used to perform various stages of integration, including:
 - Integration of various syntax SQL to form an integrated business process where by 1 business process can consist of multiple SQL commands on BPM model layer especially for multilevel process such as master detail.
 - Integration of input validation rules to validate all processes automatically with reference to the data type and size of a field.
 - Integration of permission rules for Role-Based Access Control (RBAC) determination against the set of business processes that have been created and session settings.
- 2) Business Process Node contains a set of services that can process every requests coming from users with various platforms being used. This node consists of several blocks, namely:
 - a) The Post Agent Group consists of multiple Post Agents that function to receive and send messages to external users and work like a postman to receive and deliver messages as intended.
 - b) Que in Manager is responsible for retrieving all incoming messages for inclusion in the memory queue for further processing.
 - c) Que out Manager is in charge of retrieving all messages in the memory queue to be sent to users requesting service via Post Agent.
 - d) Group Worker Manager is responsible for managing the distribution of jobs by reading queues in the que in memory and forwarding to the NLP Group worker section to know exactly what the users want and being led to start consulting with group worker IS.

- e) Group Worker NLP used to manage messages from Group Worker Manager based on predefined NLP rules. NLP rules work on the greeting and recognition of application/services menu.
 - f) Group Worker Information System Service used to process the work of NLP Worker and communicate with OLTP Database to perform operations in accordance with the service handled. This includes checking for input validation, RBAC and session.
- 3) Group Memory Node consisting of:
- a) Group Memory Queue In used to manage all incoming message queues,
 - b) Group Memory Queue IS used to manage queues related to NLP processing or information system services,
 - c) Group Memory Queue Out used to manage outbound message queues.
- 4) OLTP DBMS nodes consisting of various OLTP databases to store and manage transaction data from all existing business processes / Information Systems.

3.3. How Framework Works

In general, this framework works by performing two-way interaction with users through IM service. The following section will describe in detail how this framework works.

- 1) Application users using IM such as telegram or other can interact in the form of conversation with Indonesian language. The interaction is done with the account / bot on the Post Agent Group layer according to the IM used.
- 2) All incoming messages in Post Agent Group will be retrieved by Que in Manager and temporarily stored in Group Memory Que In and marked as 'not yet processed'.
- 3) Group Worker Manager will forward incoming messages to the NLP Group Worker section to be processed through mutual interaction so that the type of information system service desired by the users can be known. In this recognition process, Group Worker Manager will store the conversation history in the Que Memory Group IS. The results will be sent to Group Worker IS. NLP algorithm will be applied in this section according to the settings in the application and it will work to manage the greeting and service recognition. Every messages in Que in manager that has already been processed will be marked as 'already processed'
- 4) Group Worker Manager will forward the results of the requested service to Group Worker IS and perform interaction to the OLTP layer according to the content of the requested service.
- 5) Group Worker Manager will forward all messages that wish to be sent back to users as the response to previous interaction, from the NLP workgroup and Group Worker IS group by saving those messages in Group Memory Que Out and they will be marked as 'unprocessed'
- 6) Que out manager will retrieve all messages in queue order and forward them to the recipient via the corresponding Post Agent. Messages sent can be data processing results according to users' requests and confirmation messages that require a response / answer from users or a final confirmation. If a message has already been processed, it will be marked as 'has been processed'.

4. Result and Analisis

4.1. Implementation and Testing

To prove this framework can run, has developed a prototype consisting of:

- 1) OLTP built on MySQL database engine
- 2) Initiate Node by using PHP
- 3) Node of Business processes with python with matching algorithm provided by MySQL [36] and SSM-based Bigram available in python library [37]
- 4) Client with telegram

The test was performed by prepare the operating table, equivalent operation, the equivalent of the database, the equivalent of the table, the equivalent field, database service list and others as in Tables 1-10.

Table 1. Operation/List of Service

Id_op	Operation_name
1	insert data mahasiswa
18	input data pegawai

Table 2. Database/list of Information System

Id db	Database name	Alias
1	db_data	Simak
5	payment	pembayaran

Table 3. Equivalent of Operation Table

Id_op	Equivalent
1	input data mahasiswa
2	ubah matakuliah

Table 4. Equivalent of Database Table

Id	Equivalent	Id db
12	simak	1
13	sim akademik	1

Table 5. List of Role

Id role	Role name
1	admin
2	student

Table 6. List of Table

Id	Table name	Id db
1	tb_mhs	1
2	tb_mk	1

Table 7. Role Detail

Id operasi	Id operasi
1	1
18	18

Table 8. Equivalent of Field

Id	Equivalent	Id field
12	No Induk	1
13	Nama Mhs	1

Table 9. User Role

User id	Id role
12	1
13	1
15	1

Table 10. Equivalent of Table

Id	Equivalent	Id table
12	mhs	1
13	murid	1
15	matkul	2

Each request from the users will be first matched to the operation table, then to the equivalent of operation, equivalent of database, equivalent of table and the equivalent of field. If it fails, the next match will be made on the greeting table and if it is not found, users will be directed to select forward chaining as the option. By adding a chaining based on forward chaining algorithm, the users will be given a response in the form of a list of available information systems such as those in the database table. Then, the users will be led to select the application menu in accordance with the selected system. By applying this process, the user will certainly get the desired service. After the users select the desired services based on their access rights, an interaction process will be performed to receive input data from the user, perform validation and display the results.

The entire data in Tables 1-10 will be prepared by the BPM application on the initiate block to produce the service as shown in Figure 3.

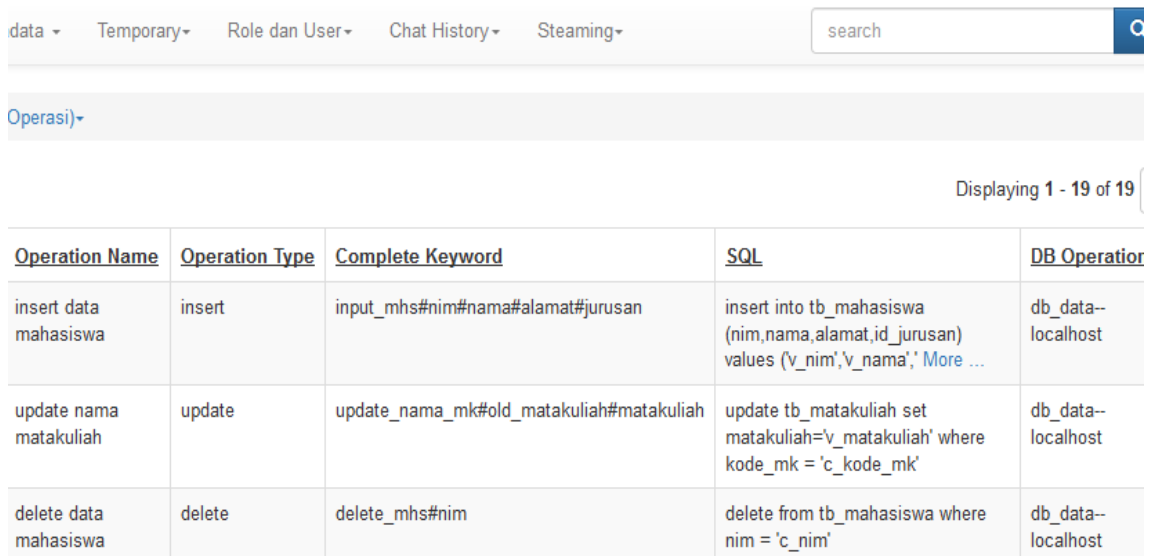


Figure 3. Business process migration

Prototype testing is done by performing an interaction using dialog in Indonesian with Telegram as IM. The results are displayed in Table 11.

Table 11. Testing Result

No	Chat Id	Incoming Message	Respon(Ngram, Threshold=0.5)	Stop Hop/Sum of Hop
1	12 (sukarsa2)	insert data mahasiswa	Pilih operasi yang cocok : 1 - insert data mahasiswa 2 - delete data mahasiswa 3 - reset	Operation table/1
2	13 (sukarsa3)	insert mahasiswa	Pesan tidak dikenali, silahkan pilih sistem informasi yang diinginkan : 1 - Simak 2 - kepegawaian 3 - reset	Forwad chaining/6
3	14 (sukarsa4)	input data mahasiswa	Pilih operasi yang cocok : 1 - insert data mahasiswa 2 - delete data mahasiswa 3 - reset	Operation table/1
4	15 (sukarsa5)	input mahasiswa	Pesan tidak dikenali, silahkan pilih sistem informasi yang diinginkan : 1 - Simak 2 - kepegawaian 3 - reset	Forwad chaining/6
5	16 (sukarsa6)	update matakuliah	Pesan tidak dikenali, silahkan pilih sistem informasi yang diinginkan : 1 - Simak 2 - kepegawaian 3 - reset	Forwad chaining/6
6	17 (Sukarsa7)	ubah matakuliah	Pilih operasi yang cocok : 1 - update nama matakuliah 2 - reset	Equivalent of operation table/2
7	18 (sukarsa8)	hapus mahasiswa	Pilih operasi yang cocok : 1 - delete data mahasiswa 2 - reset	Equivalent of operation table/2
8	19 (sukarsa9)	matakuliah	Pilih operasi yang cocok : 1 - update nama matakuliah 2 - reset	Equivalent of operation table/2
9	20 (sukarsa10)	mahasiswa	Pilih operasi yang cocok : 1 - delete data mahasiswa 2 - reset	Equivalent of operation table/2
10	21 (sukarsa11)	matkul	Pilih operasi yang cocok : 1 - insert data mahasiswa 2 - update nama matakuliah 3 - delete data mahasiswa 4 - reset	Equivalent of table/4

Based on the above test results, the matching process has managed to provide a response in the form of services that are specific .e., service in the form of application menu list (test number 1, 3, 6, 7, 8, 9, 10) or in the form of information system list of service (test number 2, 4, 5) that requires an advanced dialog until it finds the application menu list. The best computational times are given by the tests of numbers 1 and 3 and the worst are numbers 2, 4 and 6. The RBAC rules also work on tests of numbers 2, 4 and 6.

The test result in Telegram application in Figure 4 shows the data input process, the value of which is a foreign key which refers to other tables. It is usually completed with combo box model. Figure 5 shows the input process using validation rules and checking access rights.



Figure 4. Interaction and validation based on referential integrity using foreign key



Figure 5. Interaction and validation using data type and size

4.2. Advantages of the Framework

4.2.1. Improvements of Precision and Recall

To improve the framework capability in terms of precision and recall [18], a threshold parameter of the NLP method will be added. The threshold value of the matching algorithm in MySQL shows the number of options to be displayed according to the matching rank. In N Gram, if the selected threshold value gets bigger, it will generate fewer options displayed to the users. The displayed options are sorted from the option with the best match value. If the matching algorithm fails to find the available operation, the chaining algorithm based on forward chaining in the Worker Group section ensures the users will get the service in accordance with the permissions it has, although it may take a longer processing time. Thus, the value of Precision and Recall will increase and will get closer to 100%.

This framework is distinctive compared to other existing researches because previous researches provided only 1 output for 1 input from users so it was possible that the NLP part failed to provide the intended services to users. In contrast, this proposed framework provides several options to be chosen by users for each input. To overcome the constraints of limited rows of data displayed in mobile devices and to offer comfortable experience to users, this framework is equipped with an option to configure pagination.

4.2.2. Cost-effective, Practical and Simple

Technically, the selection of IM will give some advantages. IM is an application developed by many vendors and most of them are free, so the process of building the interface will not require any costs. IM can run on cross-platform OS and cross devices with very minimal bandwidth requirements because it only transmits data in the form of text. On the server side, companies do not require hosting and domains and can run the IM on PC devices with a more cost-efficient bandwidth connection. Users are also given the convenience of not having to memorize various keywords because the interaction is done with the help of Natural Language Processing so that it can interact with the system with the language used in daily conversation.

The algorithm model works with no attention to the rules of sentence patterns so that it can meet various styles of users input language according to chat characters in chat using short and irregular phrases. Hence, this model can be applied to conversation dialogues by using various languages other than Indonesian to provide access service to information system by using IM.

5. Conclusion

The framework model consisting of initiate blocks, business processes and communication block, group memory and OLTP layers has been able to build chat-based information system services using daily Indonesian language conversations. This framework comes with validation rules, referential integrity checking, RBAC settings and session management. By using N Gram, MySQL matching, threshold boundary determination and forward chaining based slope, algorithms have been able to increase the value of precision and recall to near 100%. To speed up computing time in matching messages, the operating equivalent dictionary should be made as complete as possible so that the matching process can stop at most with 2 hops. Since the recognition model is done by ignoring the sentence pattern, it enables the framework to work well in natural languages other than Indonesian. This model is a cost-effective, fast and simple solution in its implementation. To improve performance, further research is needed to develop load balancing in handling the growth of data access in enterprise-wide systems.

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