MODELING OF AIR TRAFFIC CONTROL (ATC) DASHBOARD USING REAL TIME BUSINESS INTELLIGENCE

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Abstract:- Air Traffic Control (ATC) started in 1922, Indonesia Flight system around 1980, The rapid development of development is a company MITRE partnership network. Unfortunately ATCDashboard is a research done in order to implement a dashboard system that can help ATCofficers zizahand ATC Chief in making decisions, especially in arranging the landing aircraftsbased on the information on the ATC Dashboard. The ATC system now is able to create estimatetime of aircraft to enter the initial gate of arrival in the air, but only one aircraft data is displayedin the ATC system so it takes time to apply to all aircrafts. This paper, proposes a solution ATCDashboard with Real-time Business Intelligence is a function generated from ETL (extract,transform and loading) process is performed using the Change Data Capture (CDC) approach tochange data over a certain period so the data can be moved in real-time on ATC Server. The aimthis study is to provide the acceptable ATC Dashboard quality that can be used by the ATC officerand ATC Chief in order to help them making decisions, and hopefully this can be example forother airports in arranging landing aircrafts. This research contribution in providing a real timeinformation on Management Traffic Controller (MTC) Aircraft, especially real-time BI usingKimball to make information ATC officer and chief.

Keywords : Modeling ATC, Dashboard Using Real Time, Business Intelligence

1. Introduction

Management of data processing for decision-making activities has experienced significant developments such as real-time data warehousing. By collecting and processing data in real-time it will be possible to get the data needed in real-time BI process. Muller and Maasdorp (2011) point out the dominance of the DIK model in information science. they have three conjectures as to why knowledge management practitioners and authors prefer the DIK model. The first one concerns information theory background, the second one is about simplicity, and the third one rests on accumulative worldview. The green leaf model indicates that the organization is alive and healthy just like a living organism. The green leaf has the components which include data, tacit knowledge, explicit knowledge, intellectual capital, intellectual intelligence, ICT (Information and Communication Technology) which give birth to Artificial Intelligence, library, records management, information, best practices, human capital and knowledge workers.

Air Traffic Complexity : A large number of studies deal with the relationship between complexity and the workload of air traffic controllers. The concept of complexity as the "weight" of the traffic situation, that is possible the impact of appropriate traffic situations on the workload of air traffic controllers. The concept and size of airport traffic complexity is used in this regard research proposed by Krstić Simić and Tošić, 2010 (* 2004). Complexity through traffic characteristics, ie as a measure of quantity and the quality of traffic interactions at airports and airports.

Transportation systems are the blood vessels of modern civilization. To cure the chronic thrombosis of these vessels, significant efforts are put into development of efficient methods and tools for road network planning and traffic management.Today the air traffic industry is facing daunting problems caused by the increase of traffic and limited capacity of airports. In this paper we introduce business intelligence benefits through the integrated and intelligent operational

decision support for the future global system of air traffic control and management. We show the way in which it will benefit airlines, airports, controllers and pilots, and passengers too.From an optimization point of view, ground movement of aircraft can be considered as one of the most important airside operations at an airport, since it connects several problems together: the runway sequencing problems for arrivals and/or departures, the stand holding problem and the gate assignment problem.

Problems exist ATC system only displays detailed data of one aircraft only on the monitor screen, so it takes a long time if it should be applied to all the aircraft data that is in the ATC system. Similarly, forecasting the density of the number of aircraft that will be handled ATC officers in the area of responsibility. ATC system can only display information of one aircraft and if must combine data of all aircraft. Resulting takes a long time, while the time it takes to decide the order of the aircraft landing in seconds. If late in deciding, it will also change the initial planning in determining the landing sequence of the aircraft.. If a wrong decision, it will increase the workload of ATC and will cause a delay or delay aircraft in the air that impact on flight schedules, fuel consumption and most importantly disadvantage consumers of aircraft service users. And that often happens during rush hours.

Air tra□c control (ATC) is a set of ground-based services provided by air tra□c controllers to aircraft in order to prevent any collisions by separating aircraft, supply relevant information and advisories for the safe operation of flights, as well as alert and assist search and rescue organisms. Air Traffic Systems are 4 service units consisting of Flight Information Service, Alerting Service, Air Traffic Advisory Service and Air Traffic Control (ATC) Service. ATS is the guidance and aircraft arrangement given ATC (Air Traffic Control) with special lane.

Air tra□c management (ATM) under its current paradigm is reaching its structural limits considering the continuously growing demand. The need for a decrease in tra□c workload opens numerous problems for optimisation, from capacity balancing to conflict solving, using many di□erent degrees of freedom, such as re-routing, flight-level changes, or ground-holding schemes. Air traffic management is increasing the amount of air traffic in Indonesia's airspace, especially large airports. Based on data from AirNav Indonesia, the amount of air traffic is growing significantly from year to year and this phenomenon requires the use of new technologies and new methods to manage and accommodate this growing air traffic growth, dapat dilihat paa : http://www.airnavindonesia.co.id/. Many airports in Indonesia have reached their maximum capacity during peak hours. The irregular pattern of air traffic distribution results in density at the airport, causing additional time for the aircraft to maneuver and wait for the take off or landing queues resulting in delay of several flights during peak hours.

Namely, for the busy airport during peak hours, arrive queue delay, taxi-out / at times and queue queuing delays increased, which induces additional, unnecessary fuel consumption and gas emissions. By 2035, airport delays will increase from about 1 minute / flight in 2012 up to 5-6 minutes in 2035, change it from minor / intermittent to permanent, major contributors to delays. To avoid that, the airport got either to be enlarged, or (since enlargement is not possible at most cases), to make the most of the available resources as efficiently as possible probably.

The system (analyzed in this research) boundaries are : 1). for arriving aircraft – from FAF, to the moment of arriving on the apron; 2). for departing aircraft - from the moment of push-back or start-up clearance request, until a given time after departure.

Objective researh, namely : 1. Helping ATC officers plan for early plane guidance in determining the landing order of the aircraft, 2. Generate real-time data warehouse concept design as real-time business intelligence support in ATC Dashboard design, 3. Produce ATC Dashboard application to support officer decision and ATC Chief in arrangement of landing order of aircraft without interrupting transactional process on ATC server.After we see the desire to design BI for the needs of this ATC, then submitted research Wang, Fan dan Fu about paper analyzes the airport business intelligence application architecture blueprints, system functional architecture and application analysis theme based on the application background of business intelligence system construction of the Shanghai Airport Group.

In general Turban E., Volino ask BI is the workings of the Business intelligence system are several components working together to build the Business intelligence system, where the organization's data resides in the operational database, such as sales data, inventory, and customers.

Tables 1. Study Review

Title	Methods	Result Research
ETL Process Modeling Conceptual for Data Warehouses: A Systematic Mapping Study, (Lilia Munoz, Joze- Nuberto Mazon, & Juan Trujillo, 2011).	Systematic Maping Study	This systematic mapping study states that there is a clear classification of ETL process modeling approaches, but that they are not enough covered by researchers. Therefore, more effort is required to bridge the research gapin modeling ETL processes.
Applying Human Centered Design Process for Designing Air Traffic Control Interfaces.(Satoru Inoue, Kazuhiko Yamazaki, Hajime Hirako,Toshiya Sasaki	Survey results of high effectiveness, with a process of Human Centered Design that can be executed simply compared with current available techniques.	In this research, we focused on task analysis of air traffic controllers in actual en-route Air Traffic Control (ATC) in an experimental activity based on a Human-Centered Design (HCD) approach. In this analysis, we conducted a simulation at one of the air traffic sectors of the Tokyo Area Control Center. After analyzing the current ATC work, we developed a prototype design of the future ATC interface for Air Traffic Controllers based on our findings.
Key Performa Indicator Analysis dan Dashboard Vizualization in A Logistic Company (Joonatan Piela, 2017) [15]	Key Performa Indicator for Logistics	In the beginning of this study theories for performance measurement and visualization are introduced. These theories are utilized in the creation of operating model and dashboard plan for the case company. In addition, based on the executed interviews, this study addresses the case company's measures that affects the performance measurement. Based on the results of this study, there can be concluded that used measures are eligible for different processes. However, many of those measures should be improved by visualization. By adapting the created operating model and the dashboard plan, the case company is able to share appropriate measures to the right user groups. With these models the case company is also able to utilize the principles and benefits of effective visualization.Finally

		future recommendations on how to utilize variousissues, that have an effect on to the models, are introduced.
Overview of Dashboard Approach Methods In the Business intelligence process. (Kusnawi. 2011) [16].	The Essence of the dashboard lies in the data / informatioan presented in it, as well as ways to present om order to be easily understood by its users. With the methodology has been developed that is PureSahre, Noetix and Brightpoint.	The three methodologies contain the key elements required in dashboard development in BI, ranging from meta-information gathering, user dashboard assessment, and presentation of information. However, these three methodologies provide different focusand emphasis on dashboard development
Design of Data warehouse Sales to Support the Executive Detailed Information Needs *Skin Care* (Darudiato, S. 2010) [17].	*Nine-Step Metodology*	The data can be integrated and support the global information that can be viewed from different angles as solutions to existing problems
An Online Method for the Real-time Aircraft Arrival Sequencing and Scheduling Problem (Fang Jing & Yan Ran, Ji Xiaopeng, 2014) [18]	Script creation for landing sequence of aircraft based on trajectory calculation of aircraft on ATCsystem	The timing method is generated to determine the landing order of the aircraft in real-time

(Source: GIA Air Craft)

Data Set
The following datasets were identified: 1.Traffic and route data (flights, aircrafts and movements data), 2. Airspace and sector data (data related to airspace structure and air infrastructure), 3. Information data (data necessary for the safe operation of flights), 4. Equipment data (data related to technical infrastructure) [12].

2. ResearchMethodology

The datawarehouse design model of the Kimbal methodology has 9 steps as follows : a) Choose the Process : The selection of the selected business process is the landing order of the aircraft used in the arrangement of aircraft landing sequences and the estimated number of aircraft entering the initial gate of air arrival, b) Choose the Grain : Grain is a potential factor that can be analyzed, namely by deciding the fact table to be displayed including the number of aircraft entering the gateway GAPRI and NOKTA in real time,

Table 2. Gapri dan Nokta

Number	Field name	Type	Number	Field name	Type
1	ACID	Varchar	1	ACID	Varchar
2	AC_TYPE	Varchar	2	AC_TYPE	Varchar
3	ADEP	Varchar	3	ADEP	Varchar
4	GAPRI	Varchar	4	NOKTA	Varchar
5	ROT_GAPRI	Varchar	5	ROT_NOKTA	Varchar
6	Sektor	varchar	6	Sektor	Varchar

(Source: GIA Air Craft)

a) **Identify and Conform the Dimensions** : Identify the dimensions for each existing fact table, Setting up the appropriate dimension grain tables and selecting the records to be displayed in the facttable,

Table 3. Fact table

Number	Field name	Type
1	No	int
2	SFPI	Int
3	Tanggal	Varchar
4	ACID	Varchar
5	A_REG	Varchar
6	AC_TYPE	Varchar
7	Flight_Type	Char
8	PBN	Varchar
9	C_FL	Int
10	X_FL	Int
11	RIU	Int
12	ETD	Char
13	Tgl_ETD	Varchar
14	ATD	Varchar
15	Tgl_ATD	Varchar
16	ATA	Varchar
17	ETA	Varchar
18	Tgl_ATA	Varchar
19	Tgl_ETA	Varchar
20	ADEP	Varchar
21	ADES	Varchar
22	Route	Varchar
23	Point_Entry	Varchar
24	Time_Entry	Varchar
25	Point_Exit	Varchar
26	Time_Exit	Varchar
27	Sector	Varchar
28	Est_point	Varchar
29	FL_Rec	Varchar
30	Tipe_Trav	Varchar
31	POB	Varchar
32	Status_data	Varchar
33	TnG	Varchar
34	Opr_info	Varchar
35	Remark	Varchar
36	Validasi	Int

(Source: GIA Air Craft)

b) **Choose the Facts** : Choose facts that match the grains and dimensions that have been determined in the previous stage. The possible table to choose is the Aircraft Dimension table, NOKTA Dimension Table, GAPRI Dimension Table, Time Dimension Table relates to the ATC fact table so in the TAC fact table will contain id numbers on each dimensiontable,

Table 4. Information Data

Number	Field Name	Type	Information
1	SFPI	Varchar	Data code per flight number
2	Tanggal	Varchar	Flight date
3	ACID	Varchar	Describes the flight number
4	AC_TYPE	Varchar	Describes the aircraft type
5	ADEP	Varchar	Explains the airport of origin
6	ADES	varchar	Explains the destination airport

7	ETA	varchar	Explains the estimated arrival at the airport
8	GAPRI	varchar	Air gate name for arrival traffic from East and South
9	ROT_GAPRI	varchar	*Required Time Over* GAPRI. The time that the pilot has to accomplish or fulfill in order of landing sequence if the distance or time with the plane in front
			of the same is not standar
10	SYS_RTO_GPR	varchar	Automatically calculate GAPRI gate estimates if any are equal to or less than 3 minutes
11	NOKTA	varchar	Air gate name for arrival traffic from North and West
12	ROT_NOKTA	varchar	*Required Time Over* NOKTA. The time that the pilot has to accomplish or fulfill in order of landing sequence if the distance or time with the plane in front of the same is not standard
13	SYS_RTO_NKT	varchar	Automatically calculate GAPRI gate estimates if any are equal to or less than 3 minutes
14	Status	varchar	Status for lock or unlock data already dicapture
15	Sektor	varchar	Territory or Sector area which is the responsibility of ATC
16	Remark	varchar	Information that can be filled manually by ATC officers

(Source: GIA Air Craft)

1) **Store Precalculations in the Fact Table** : In accordance with the grain, each fact has data that can be calculated, at this stage determined the calculation. For example the facts in this case the fact about the number of aircraft entered by calculating the number of aircraft entering the gate NOKTA or GARPRI within a certaintime,
2) **Round Out the Dimension Tables** : In this process is done to determine the time limit for data to be taken and moved into the fact table, and determine the duration duration of the company's information needs. For example, because of the need for this aircraft landing sequence information in real time, transactional data required from the extraction of ATC servers in unnormalized table format isrequired.,
3) **Choose the Durations of the Database** : This process is the determination of time limits for data taken and transferred into fact tables. Determination of this duration of ATC information requirement is a real time requirement that is utilized for monitoring the landing order of aircraft,
4) h) **Determine the Need to Track Slowly Changing Dimensions** : This process is to observe the data changes from the dimension table. The way that can be done there are three namely: a. Dimension attribute that has been changed and rewritten by adding a new row or a new column, b. The dimension attribute that has changed creates a new dimension, c. The dimension attribute that has changed creates an alternative so that the old and new attribute values can be accessed together on the samedimension,
5) i). **Decide the Physical Design** : Physical design for critical design warehouse data is about extract, Others are an additional physical design that affects administration, backup, pegging performance, and security in accessing and storing data and capacity analysis of storage media. Electronic transfer and load (ETL) processes and estimate storage capacity of the media. Any see to table 5. Load dataprocess

3. Result and Disccussion

Tipe analysis practical :

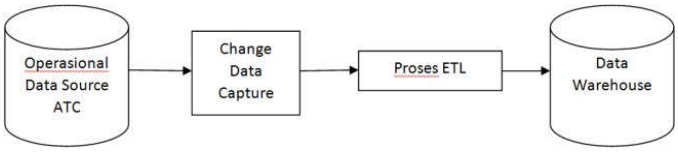
a) Instruction which providing immediately or standing by thetiming
b) Increment physical workload by providinginstructions
c) Affecting aircraft spacing by reducing speedinstruction
d) Common type oftasks
e) Limited instruction by air spacerestriction
f) Need to consider the wind factor to provideinstruction
g) Instruction without using map information[13].

The parent data of the aircraft information table to be searched for includes the arrival of aircraft from the North and West through the NOKTA gate. While the aircraft coming from the East and South through the gate of GAPRI. rimary data obtained from interview and field observation. Secondary data obtained from the data object research in the form of database from ATC server, literature study and scientific writing.

a) Software Requirement : NotePad+ by Scitilla component and Xamp in which are Apache, PHP andMySql
b) Data Requirement : Fact table for whole data tableas compiled whole data tables and then done filtering the data as needed, ie data tables NOKTA and GAPRI
c) Data collected : Table 4. Information Data for chose facttables

Design

Change data capture is an important element to optimize the extract process from source system. Change data capture not to re-extract all data from the source, but only retrieve the changed and latest data



Picture 1. Process Change Data Capture

Study Document

ATC Study Document, besides time constraints, there are other assumptions for ATC tasks in our ATC system. Before specific ATC tasks are described in Section 2.3.3, we give general characteristics of an ATC task [3,4].

1) All tasks are periodic. Although each task has its own deadline, all of them must becompleted by the system deadline D, or the system periodP.
2) All deadlines are known at the task releasetime.
3) Aperiodic jobs are handled by a special task in a particular time slot in everycycle.
4) Tasks are independent in that there is no synchronization between them nor shared resources. The static schedule fixes release times and deadlines for eachtask.
5) Overhead costs for interrupt handling are included in each taskcost.
6) Task execution isnon-preemptive.
7) Task deadlines are all hard and critical. None can be preempted or deleted without possible adverse e□ects.

ETL process is loading data GAPRI and NOKTA, loaded into datawarehouse which is a combination of data

Table 6. Load Data Process

No	Nama field
1	No
2	SFPI
3	Tanggal
4	ACID
5	A_REG
6	AC_TYPE
7	Flight_Type
8	PBN
9	C_FL
10	X_FL
11	RIU
12	ETD
13	Tgl_ETD
14	ATD
15	Tgl_ATD
16	ATA
17	ETA
18	Tgl_ATA
19	Tgl_ETA
20	ADEP
21	ADES
22	Route
23	Point_Entry
24	Time_Entry
25	Point_Exit
26	Time_Exit
27	Sector
28	Est_point
29	FL_Rec
30	Tipe_Trav
31	POB
32	Status_data
33	TnG
34	Opr_info
35	Remark
36	Validasi

DATA WAREHOUSE (Data Gabungan)
SFPI
Tanggal
ACID
AC_TYPE
ADEP
ADES
ETA
GAPRI
ROT_GAPRI
SYS_RTO_GPR
NOKTA
ROT_NOKTA
SYS_RTO_NKT
Status
Sektor
Remark

(Source: GIA Air Craft)

From the scheme is a new database to accommodate the data from the parent database, because there is only one entity then there is no relationship between entities, so that only formed one table.

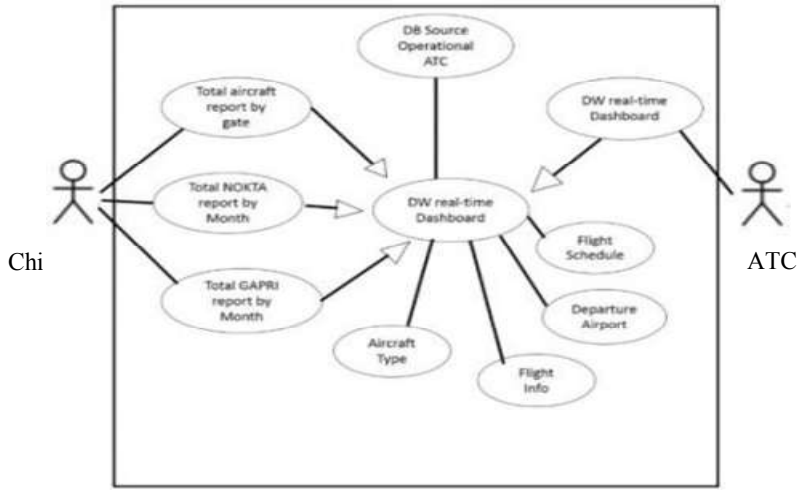
Table 6. Combine Atribut

Number	Nama field	Information
1	SFPI	NOT NULL
2	Tanggal	NOT NULL
3	ACID	NOT NULL
4	AC_TYPE	DEFAULT NULL
5	ADEP	DEFAULT NULL
6	ADES	DEFAULT NULL
7	ETA	DEFAULT NULL
8	GAPRI	DEFAULT NULL
9	ROT_GAPRI	DEFAULT NULL
10	SYS_RTO_GPR	DEFAULT NULL
11	NOKTA	DEFAULT NULL
12	ROT_NOKTA	DEFAULT NULL
13	SYS_RTO_NKT	DEFAULT NULL
14	Status	DEFAULT NULL
15	Sektor	DEFAULT NULL
16	Remark	DEFAULT NULL

(Source: GIA Air Craft)

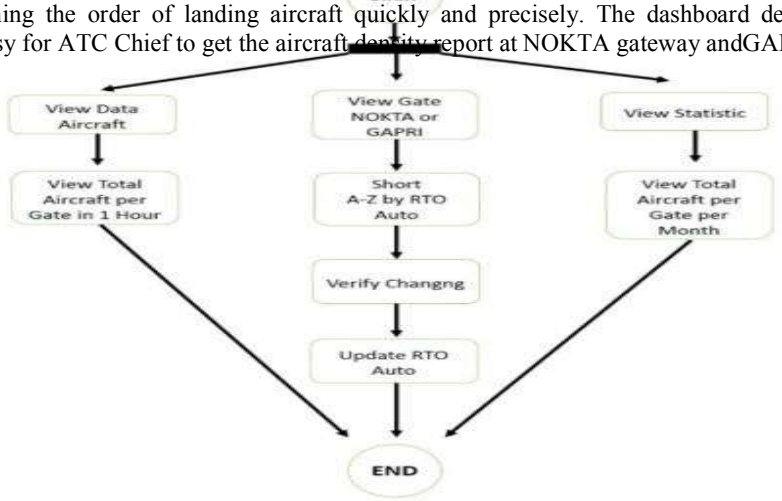
UML Design

The design will be created with unifed Modeling Language (UML). Diagrams created with Usecase Diagrams and Activity Diagrams. Usercase Diagram illustrates the intercations that occur between the actor and the system ..



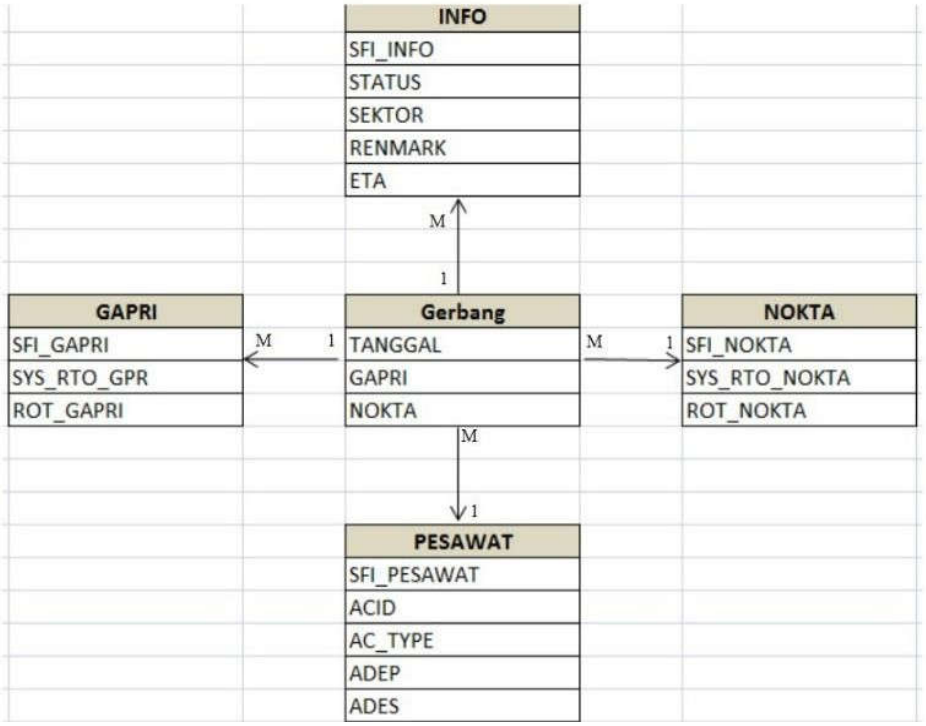
Picture 2. Use Case Activity Users ATC Dashboard Application

Actor Chief of ATC and ATC Officer with interaction viewing of ongoing information that has been processed by the system. Use case design proposed dashboard can provide solutions to problems that occur at this time especially during solid hours where ATC officers have problems in determining the order of landing aircraft quickly and precisely. The dashboard design also makes it easy for ATC Chief to get the aircraft identity report at NOKTA gateway andGAPRI.



Picture 3. Activity Diagram Process

Class Diagram ATC modeling The dashboard in this study was built with a data warehouse, which consists of severalclass



Picture 4. Diagram Class Data Warehouse ATC Dashboard

Graphical User Interface Design

Picture 5. Main page design

The main page of the dashboard ATC application is used to view all the data of the plane that will

land according to the gate used. The main menu display can view the estimated number of the arrival of the plane, this application also provides information about the order of landing aircraft according to the gate to be passed.

Picture 6. Gate Graph Design

The next step is to design a graphic page that is used to view traffic data based on the date whose search is grouped by month. After the design stage of application design has been completed, the next stage is the implementation. In building the ATC dashboard for aircraft landing arrangements, note the principles of the planned dashboard, among others :

1) The resulting dashboard presents information on the number of aircraft that will enter both the GAPRI and NOKTA gates
2) The resulting dashboard displays a clear and effective dashboard visualization taking into account the limitations of the monitorscreen
3) The resulting dashboard comes from a data warehouse derived from several valid databases so it can be one of the ATC officers and ATC Chief in makingdecisions.
4) The system-generated dashboard can also be seen to pay attention to the data security level by setting the permissions to the system.

Design Testing

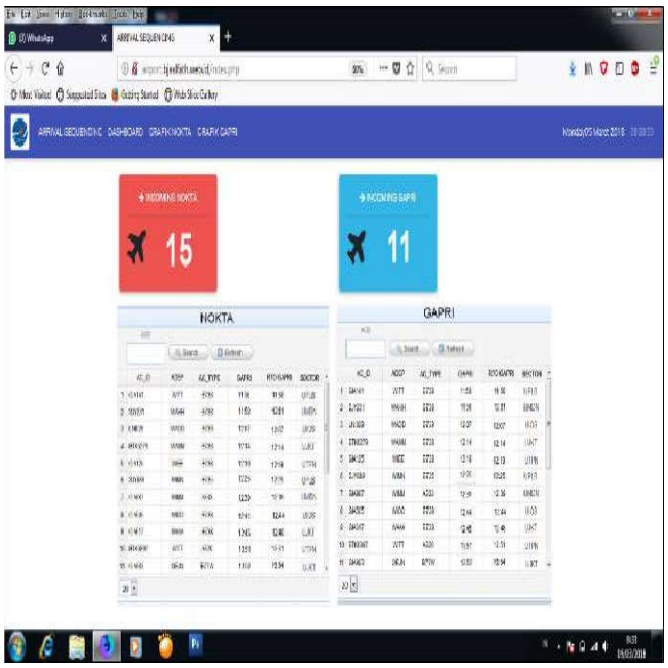
Black Box testing is testing the system without considering the internal logic structure software engineering. ATC Testing The following dashboards use a test in the form of data retrieved from the data center that has been created according to the need field in the database and data warehouse. Black box testing don on : Field Table, Main Page, Gapri Page dan Nokta Page all the testing results have been well resolved

4. Result and Discussion

a. Result DesignDashboard

The initial view that the user will find is a dashboard that provides information about the number of aircraft that will enter each of the NOKTA gateways and GAPRI gates within the next 1 (one) hour. The order of landing is based on the estimated time of the aircraft entering the NOKTA or GAPRI gates. Aircraft that have an earlier time based on the calculation of the system will then occupy the earliest sequence as well as next. If there is an estimated time equal to or less than 3 (three) minutes then the system will automatically calculate and provide estimation suggestions shown in the table in the SYS_RTO_GAPRI column or on

SYS_RTO_NOKTA. Each of the gate information is displayed in a different table. Each of the gate information is displayed in a different table. Data displayed on dashboards or tables will be updated automatically by the system every 3 (three) minutes to generate real-time data that can be used directly by ATC officers or ATC Chief on duty.



Picture 7. Main Course

Dashboard in figure 7 which contains information on the number of aircraft that will enter the gap gate or NOKTA can be used as parameters for the Chief ATC to balance the number of aircraft on each gate. The objective is to balance workload of ATC officers and the capacity of runway usage for landing aircraft later. If the estimated number of aircraft at the gate of GAPRI is much more then it will be transferred to NOKTA gate and vice versa. ATC Chief can also search for aircraft data directly by selecting search field or search. The data displayed is based on the results of records per day collected in the pastmonth.

b. Display Record Amount of Arrival

In addition to displaying aircraft arrival information data by gateway in real-time, the system also displays the results of the record number of aircraft arrivals based on the gates in the form of tables and graphs. It can help the ATC Chief analyze the aircraft density at each gate to minimize and anticipate the number of delays caused by the density of aircraft movement.

Gambar 5.2. NOKTA Graph Record View and GAPRI Graph Record View

4. CONCLUSION

Based on the design, development and implementation of ETL, several conclusions can be put forward :

1) ATC Dashboard modeling research using real-time business intelligence for the regulation of aircraft landing sequence with case study at Jakarta Air Traffic Service Center (JATSC) has been successfully done through ETL process integrated with CDC, data warehouse development process,.
2) From this research activity generated ATC Dashboard application that displays information about the amount of aircraft data on the arrival gate in air and information about the sequence of landing aircraft inreal-time.
3) ETL in real-time data warehouse can be implemented by using Change Data Capture integration in ETL tool, which detects data and captures changes in data

or transactions that occur in data sources so that data can be displayed in real-time.

4) The results of this study are the ATC dashboard that can be used by ATC officers and ATC Chief to help them make decisions for airports in arranging aircraftlanding.
5) Application ATC The resulting dashboard is good software, has been tested its quality and can meet the needs of users, from the results of testing the system using Black Box testing method, the test results 100% successful, as thedata.

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