Data Warehouse Design for Firefighters Operational at the DKI Jakarta Fire Department

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Abstract **–This paper proposed two models of data warehouse schema for the fire department of DKI Jakarta, where the 1st model contains six tables consisting of 3 fact and 3-dimensional tables, and the 2nd model only contains three fact tables. The 2nd model denormalises the 1st model, where the number of tables is less than the 1st model, where at the end of the day, the 2nd model will reduce the join table process, which increases the SQL performances. These two models have been recognised as fact constellation schema with more than one fact table and sharing dimension and sub-dimension tables. The database resources were collected from http://data.jakarta.go.id under the Fire and Rescue Service Agency. Those two data warehouse schema models were developed based on a report sector list, a report on Hydrants list, and vehicle register reports. This paper proposes to support Automatic Identification Systems (AIS) research, particularly implementing the data warehouse concept.**

Keywords **– Data warehouse fire department, Data warehouse firefighters, data warehouse fire brigade, fact constellation fire department, Fact constellation firefighters.**

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1. Introduction

DKI Jakarta, as the capital of Indonesia, is a province that has a land area of 664.01 km2 and also has an archipelago located to the north of DKI Jakarta covering an area of 1,800 hectares with a total of approximately 110 islands stretching from the north to the south has an ocean area of 6,977.5 km2. Regarding government administration, the DKI Jakarta province has the Seribu Islands Regency and 5 municipalities, 44 subdistricts and 267 sub subdistricts, and DKI Jakarta has a population of 11,240,000 people based on the 2023 census.

The DKI Jakarta Provincial government is responsible for transparency and use of data, where this secondary data will be used by interested parties such as government institutions, non-governmental organisations, and others to help support research, which in the end can support the welfare of the Indonesian people and especially the residents of DKI Jakarta.

As seen on the website http://data.jakarta.go.id, based on data for December 2023, there are 2,270 datasets, 7,100 data files from 53 government organisations in DKI Jakarta, which cover 27 topics which are groupings of data such as education, health, local, population, transportation, environment, tourism and culture, social work, public work, and disaster management.

This paper is interested in exploring disaster management since the occurrence of natural disasters in the unitary state of Indonesia, such as the earthquake in West Nusa Tenggara, the tsunami disaster in Palu and Donggala, and the tsunami disaster in the Sunda Strait. Furthermore, in this paper, we only limit the danger of fire in DKI Jakarta and the data is obtained based on information on disaster events in the city of DKI Jakarta in 2020 from the DKI Jakarta Regional Disaster Management Agency as seen at https://bpbd.jakarta.go.id/elibrary/category/3 and Table 1, Column 2 shows the number of disaster events per month in 2020. Column 3 shows the number of fire disasters that occurred per month, and Column 4 shows the percentage of fire disasters that occurred per month. As an example, Table 1 shows that there were 90 disaster events in January 2020, and 45 were fire disasters with a percentage fire disaster value of 50.00%= (45/90*100). Overall, the last row of Table 1 shows an average of 90.08 disaster events and an average of 57.67 fire disasters. Hence, the average percentage of disaster events in 2020 in DKI Jakarta is 67.06%.

Table 1. Fire disasters in DKI Jakarta in 2020

Month in 2020	Number of disaster events	Number of fire disaster	% of fire disaster
January	90	45	50,00 %
February	79	43	54,43 %
March	81	42	51,85 %
April	81	59	72,84 %
May	84	57	67,86 %
June	71	63	88,73 %
July	76	65	85,53 %
August	91	79	86,81 %
September	72	61	84,72 %
October	84	65	77,38 %
November	157	59	37,58 %
December	115	54	46,96 %
(Average)	**90.08**	**57.67**	**67.06 %**

Seeing that the average number of fire disasters per month in 2020 was 57.67 and the average percentage of fire disasters was 67.06%, as seen in Table 1, it cannot be denied that the role of firefighters is very much needed by the DKI Jakarta province in maintaining comfort and safety.

One of the spearheads in creating security, comfort, and peace for the people of DKI Jakarta Province is the firefighters who can reduce the number of fires in the last few years to the maximum.

Apart from that, the number of hydrants is also determined according to the number of operational firefighting vehicles. To implement this, it is necessary to record data so that the relevant agencies can use the information for urban spatial planning carried out by the licensing and construction services for main roads, residential roads, and village roads by the public works agency. So far, extinguishing activities carried out by firefighters have only been recorded manually, where information on extinguishing activities is displayed in the form of a simple table. Apart from that, this simple table needs to clearly describe each group of firefighters who carry out extinguishing activities as a form of responsibility to their superiors and the community. Moreover, the data recorded in the manual table is used to produce information their supervisor needs in decision-making.

Meanwhile, we know that an information system is an arrangement of people, processes, data, and information technology that work together to collect data and information, store processes, and provide data as information/output to support an organisation's business processes. Information systems in an organisation have the task of capturing and managing data to produce valuable and practical information that helps the actions of the organisation and all levels of management that use it. Information systems in their implementation will require the support of information technology, and people usually think that information systems will only be meaningful with the help of information technology. Therefore, adequate information technology support will help the decision-making process quickly and accurately.

The DKI Jakarta Provincial office has significant data sources that can be processed into something useful. Data taken from these various sources can be managed more efficiently and effectively by utilising data warehouse (DW) technology, where this DW source can be used to assist in the decision-making process, which speeds up the creation of queries or reports using DW, which is abnormal data. In addition, DW is not new hardware or software, but a computer environment can use the database to speed up the creation of strategic information more efficiently. In its application, DW gets its data through the extraction transformation loading (ETL) process, which receives data from system operations that are directly related to customers, such as TPS (transactional processing system) or OLTP (online transactional processing).

DW is a continuation of the normalisation of the database model carried out by a non-normalized process that uses familiar database model data sources applied to daily transaction processes that are free from data repetition and have many database tables. However, DW itself is inversely related to its usefulness in the transactional database model, where DW will have data repetition as a form of a non-normalized database.

Building and developing DW is by providing a system that uses DW data as a star schema or snowflake schema where the data is drawn from transactional data. Thus, the primary purpose of implementing this DW system is to provide relevant information that can be justified through the ETL process, and the provision of data can be timely considering that it uses unnormalised data, which reduces the number of joins between database tables, which certainly speeds up the query process. In addition, the application of DW is very much needed by all levels of management, especially at the top management level, where information is displayed in an easy-to-understand format so that decisions that are carried out as services to the public are made based on valid data obtained through the ETL process. In comparison, the data warehouse changes the standard database model to be abnormal, resulting in data repetition and a reduction in the number of database tables, which improves the performance of computer technology applications.

2. Previous and Current Information Technology Implementation in the Fire Department

From several similar previous studies conducted by other researchers, there needs to be more information from recent research papers regarding the application of data warehouses in firefighting. Therefore, we have included only a few literature reviews that can demonstrate the application of computer science in firefighting. Starting from America, where the New York City Fire Department implemented an extension of the Simple Triage and Rapid Treatment (START) algorithm, which was trained using the scenario of two trains colliding with 28 cases [1]. The New York Fire Department also employs a Geographic Information Systems (GIS) model for its fire prevention and safety programs. This system was built to create a model that can estimate areas with increasing fire potential and group them into areas with the potential for fire risk [8]. In addition, in carrying out its duties, the New York City Fire Department (FDNY) implements five missions: prevention, protection, mitigation, response and recovery. Condition intelligence and exchange of information related to fire hazards in selected areas are at the core of the prevention and protection mission, and public information and warning are at the core of the five mission objectives [16].

In addition, geographic information systems (GIS) are also implemented by the Baltimore City Fire Department (BCFD) for firefighting planning, whether they occur in rural or urban areas, and to evaluate the fire prevention they provide [2]. Likewise, using GIS technology also helps increase disaster response time, in this case, reducing the call response time at the Nantucket Fire Department (NFD) to 5 minutes. In the USA, the standard response time for emergency calls, especially those related to disasters, is 9 minutes [7].

Furthermore, provincial fire departments in the Chicago area and all US fire departments use the FireCrowd app nationwide as a system prototype for open collaboration. This is done primarily in emergency response conditions and disaster management response times. This application is also expected to improve knowledge management in fire service safety protocols in the US, especially those related to firefighter safety [9].

Meanwhile, information technology implementations in several cities, such as building a Decision Support System (DSS) consisting of one WebGIS application and two mobile applications for land and air vehicles, were implemented in the City of Agueda, Portugal, to help extinguish forest fires [10]. In addition, a fire department scheme database application in Poland was built to improve fire department performance in handling reports and reduce operational costs [14]. Next, the Fuzzy Analytical Network Process (ANP) determines factor priorities. On the other hand, fuzzy Dematel was used to test the causal relationship between elements that influence the implementation of Knowledge Management (KM) in the Tehran Fire Department [3]. The optimisation model algorithm was built with GAMS and CPLEX 9.1, which was implemented in the Santiago Fire Department (SFD), Chile, to determine the location of fire stations and manage fleet assignments [5]. Similarly, in Chennai, Tamil Nadu, India, a GIS-based emergency response management system was implemented to optimize firefighting services in the densely populated city of Chennai and link fire emergency response data at all existing fire stations [11].

The use of GIS as a supporting technology for firefighting has also been applied, such as cluster models of fire spread and micro-level fire spread simulations modelled using GIS data in simulation models of city damage due to large earthquakes, including fire outbreaks and the spread of urban fires, as predictions and prediction of post-earthquake firefighting activities [6].

In addition, an optimisation problem for determining the jurisdictional area of activity of each fire department is proposed, where the evaluation criteria adopt disaster loss minimisation, and the Google Map API is used to support appropriate decision-making regarding the location of fire departments [17].

Specifically for forest fire disasters, Dubey *et al*. implemented an early fire detection model using a Raspberry Pi microcontroller and several sensors with three-phase fire monitoring, namely before, during, and after a fire during forest fire disaster, and the data was analysed using an Artificial Neural Network (ANN) algorithm [12]. Additionally, Yan *et al*. carried out forest fire recognition from image data using the Neural Network algorithm. Image data containing forest fire images is used to recognize fires based on static and dynamic features, combining fire parameters and fire shape. Furthermore, the extracted components were tested with the backpropagation neural network algorithm [13].

Furthermore, Yun *et al*. used Generative Adversarial Neural Networks (GANN) to enhance images, enhance very dark fire and smoke patterns in videos, and identify flashovers [4]. Flashover, namely the rapid growth of fire as the fire spreads, is very frightening for the safety of firefighters and has only been done manually so far. Also, the best location of the fire department station for natural response and recovery was implemented using a modified binary genetic algorithm (GA), coding with General Algebraic Modeling Systems (GAMS) [15].

3. Data Source Preparation

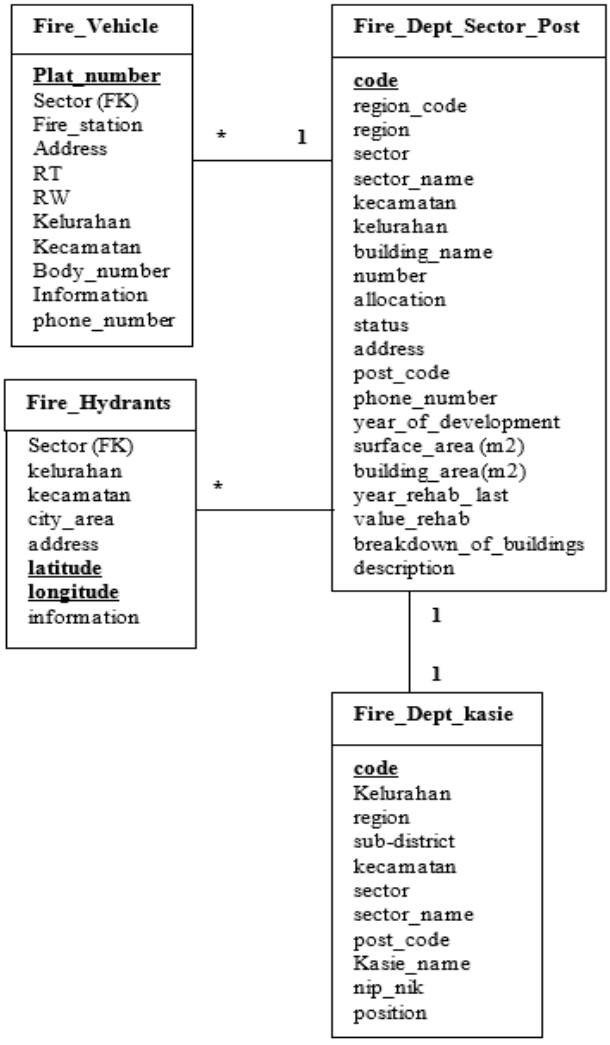

Figure 1. Database model design of Data Source from DKI Jakarta Fire Department

Since we are interested in a fire disaster, we focused our data on the department that correlates to fire disaster. On the website http://data.jakarta.go.id/organization, 114 organisations in DKI Jakarta share their data.

One of them is the Fire and Rescue Service Agency, which has 13 datasets in the form of CSV files. We focus on four datasets as accurate data shown in Bahasa, as shown in Figures 2 and 5.

Figure 1 shows the class diagram of the database model of the Fire department of DKI Jakarta, where there are four tables: Fire_Dept_Sector_Post, Fire_Vehicle, Fire_Hydrants, and Fire_Dept_kasie. As seen in Figure 1, each record in table Fire_Dept_Sector_Post has many forms in tables Fire_Vehicle and Fire_Hydrants and has one record in table Fire_Dept_kasie. It means each post-sector fire department has many fire vehicles and hydrants, and one Kasie leads each post sector as head of a post-sector. Next, the detail of the four tables in Figure 1:

a. Data DKI Jakarta Vehicle Code and Vehicle Fire Code Data, with 169 data record lines consisting of 11 columns: sector, fire_station, address, RT, RW, kelurahan, kecamatan, plat_number, body_number, information, phone_number. The data are shown in Figure 2 and as table Fire_vehicle in Figure 1.
b. Data on the Number of Fire Hydrants Per Location and Conditions in DKI Jakarta, with 860 data record lines consisting of 8 columns: sector, kelurahan, kecamatan, city_area, address, latitude, longitude, information. The data are shown in Figure 3 and as table Fire_Hydrants in Figure 1.
c. Data DKI Jakarta Fire Department Sector Post Data, with 281 data record lines consisting of 21 columns comprising columns: code, region_code, region, sector, sector_name, kecamatan, kelurahan, building_name, number, allocation, status, address, post_code, phone_number, year_of_development, surface_area (m2), building_area(m2), year_rehab_ last, value_rehab, breakdown_of_buildings, description. The data are shown in Figure 4 and as table Fire_Dept_Sector_Post in Figure 1.
d. Data on the DKI Jakarta Fire Department, with 278 data record lines consisting of 11 columns comprising columns: kelurahan, code, region, sub-district, kecamatan, sector, sector_name, post_code, kasie_name, nip_nik, position. The data are shown in Figure 5 and as table Fire_Dept_Kasie in Figure 1.

The data used in this paper is taken directly from the official website of the DKI Jakarta Fire Department, wherein in the currently running process, there is no OLTP (Online Transactional Processing) as a day-to-day business application activity. Alternatively, this OLTP is often referred to as TPS (Transactional Processing System), which is usually used to obtain data through the transaction process, which will eventually be transferred to DW through the ETL process. In addition, the built DW model will undoubtedly be obtained based on data in the form of an Excel file, and of course, the ETL process will be carried out manually to transfer the Excel file to DW. In addition, DW allows several reports to be generated in its application, where a fact table in DW can build one or more words.

sector	Fire Station	Address	RT	RW	Kelurahan	kecamatan	PlatNumber	Body_number	Information	Phone number
I	KANTOR SUDIN JAKARTA PUSAT	Jl. KH. Zainul Arifin No.71			Duri Pulo	Gambir	B 9193 OQ	111.0	Kantor Sudin	
I	KANTOR SUDIN JAKARTA PUSAT	Jl. KH. Zainul Arifin No.72			Duri Pulo	Gambir	Ambulance	181.0	Kantor Sudin	
I	KANTOR SUDIN JAKARTA PUSAT	Jl. KH. Zainul Arifin No.73			Duri Pulo	Gambir	Storing	133.0	Kantor Sudin	
I	KANTOR SUDIN JAKARTA PUSAT	Jl. KH. Zainul Arifin No.74			Duri Pulo	Gambir	B 8603 XG	151.0	Kantor Sudin	
I	KANTOR SUDIN JAKARTA PUSAT	Jl. KH. Zainul Arifin No.75			Duri Pulo	Gambir	B 9822 OQ	194.0	Kantor Sudin	
I	KANTOR SUDIN JAKARTA PUSAT	Jl. KH. Zainul Arifin No.76			Duri Pulo	Gambir	B 9821 OQ	195.0	Kantor Sudin	
I	KANTOR SUDIN JAKARTA PUSAT	Jl. KH. Zainul Arifin No.77			Duri Pulo	Gambir	B 9099 FQ	162.0	Kantor Sudin	
I	KANTOR SUDIN JAKARTA PUSAT	Jl. KH. Zainul Arifin No.78			Duri Pulo	Gambir	B 8877 AW	192.0	Kantor Sudin	
I	KANTOR SUDIN JAKARTA PUSAT	Jl. KH. Zainul Arifin No.79			Duri Pulo	Gambir	B 9191 EQ	176.0	Kantor Sudin	
I	KANTOR SUDIN JAKARTA PUSAT	Jl. KH. Zainul Arifin No.80			Duri Pulo	Gambir	B 9336 BQ	Smoke Removal	Kantor Sudin	
I	POS JATI BARU	Jl Taman Jati Baru	3	1	Cideng	Gambir	B 9323 HQ	172.0		
I	POS SEK NEG	Jl Majapahit, Perkantoran			Kebon Kelapa	Gambir				
I	POS BALAI KOTA	Jl.Medan Merdeka Selatan, Perkantoran			Kebon Kelapa	Gambir	B 8132 AX	164.0		021 3822884
I	POS WALIKOTA	Jl. Tanah Abang I, Perkantoran			Petojo Utara	Gambir	B 9201 OQ	121.0		
II	POS TANAH ABANG	Jl. Fachrudin	5	4	Kampung Bali		B 9006 PHA	143.0		
II	POS TANAH ABANG	Jl. Fachrudin	5	4		Tanah Abang	B 9818 GA	132.0		
II	POS KEBON MELATI	Jl. H Awaludin	1	17	Kebon Melati	Tanah Abang	B 9005 PHA	134.0		
II	POS MPR / DPR RI	Komp. Gedung MPR/DPR	2	3	Gelora	Tanah Abang	B 9379 LQ	161.0		021 42802686
II	POS MPR / DPR RI	Komp. Gedung MPR/DPR	2	3	Gelora	Tanah Abang	B 9392 BQ	167.0		021 42802686
II	POS MPR / DPR RI	Komp. Gedung MPR/DPR	2	3	Gelora	Tanah Abang	B 9391 BQ	168.0		021 42802686
II	POS KARET	Jl. Penjernihan Raya	2	3	Bendungan Hilir	Tanah Abang	B 8627 ER	198.0		021 4200508
III	POS T I M	Jl. Cikini Raya, Gd TIM			Cikini	Menteng	B 9921 PQ	114.0		
III	POS T I M	Jl. Cikini Raya, Gd TIM			Cikini	Menteng	B 9633 KQ	173.0		
IV	SEKTOR JOHAR BARU	Jl. Johar Baru Utara I			Johar Baru	Johar Baru	B 9948 KQ	197.0	Kantor Sektor	021 65866642 - 021 4200508
IV	SEKTOR JOHAR BARU	Jl. Johar Baru Utara I			Johar Baru	Johar Baru	B 9800 HQ	174.0	Kantor Sektor	021 65866642 - 021 4200509
IV	SEKTOR JOHAR BARU	Jl. Johar Baru Utara I			Johar Baru	Johar Baru	B 9223 OQ	112.0	Kantor Sektor	021 65866642 - 021 4200510
IV	SEKTOR JOHAR BARU	Jl. Johar Baru Utara I			Johar Baru	Johar Baru	B 9371 LQ	152.0	Kantor Sektor	021 65866642 - 021 4200511
IV	SEKTOR JOHAR BARU	Jl. Johar Baru Utara I			Johar Baru	Johar Baru	B 9020 PHA	Ranger Ka.Sie	Kantor Sektor	021 65866642 - 021 4200512

Figure 2. Data table of Fire_Vehicle

sector	kelurahan	kecamatan	City Area	Address	latitude	longitude	Information
VIII		Sawah Besar	Jakarta Pusat	Toko Sin Lie Seng, Jl. Pasar Baru	-61.642.439	1.068.340.969	
VIII		Sawah Besar	Jakarta Pusat	Toko Canada, Jl. Pasar Baru	-61.636.252	106.833.818	
I	Cipulir	Kebayoran Lam	Jakarta Selatan	Depan SESKOAL, Jl. Ciledug Raya	-6.238.087	106.772.017	
I	Cipulir	Kebayoran Lam	Jakarta Selatan	Depan POS Pemadam Cipulir, Jl. Ciledug	-6.237.955	10.676.773	
I	Cipulir	Kebayoran Lam	Jakarta Selatan	Depan Perguruan Muhammadiyah, Jl. Pa	-6.234.554	106.771.973	
I	Cipulir	Kebayoran Lam	Jakarta Selatan	Komplek Lemigas, Jl. Panjang Cidodol H	-6.237.936	106.767.287	Tertutup Pohon
I	Grogol Utara	Kebayoran Lam	Jakarta Selatan	Depan Masjid Asirot, Jl. Asirot	-6.225.498	106.777.707	
I	Grogol Utara	Kebayoran Lam	Jakarta Selatan	Depan Apotik, Jl. Asirot Depan Rumah N	-6.225.593	106.774.952	
I	Grogol Utara	Kebayoran Lam	Jakarta Selatan	Depan Toko Dewi / Rmh F1-1C, Jl. Kema	-62.107.408	1.067.843.843	Tertutup Taman
I	Grogol Utara	Kebayoran Lam	Jakarta Selatan	Depan Masjid Al-Azhar, Jl. Kemandoran	-6.210.731	106.790.205	
I	Grogol Selatan	Kebayoran Lam	Jakarta Selatan	Univ. Moestopo, Jl. Simpruk	-6.229.284	106.796.412	Tertutup Warung K5
I	Grogol Selatan	Kebayoran Lam	Jakarta Selatan	Jl. Kebayoran Lama / Jl. Limo	-6.224.979	1.067.785	
I	Grogol Selatan	Kebayoran Lam	Jakarta Selatan	Depan Pertokoan Pasir Bata Putih, Jl. Ke	-6.235.118	106.784.576	
I	Grogol Selatan	Kebayoran Lam	Jakarta Selatan	Jl. Kebayoran Lama Hook / Jl. H. Jiban	-623.366	106.780.392	Tertutup Warung K5
I	Pondok Pinang	Kebayoran Lam	Jakarta Selatan	Depan Masjid Agung, Jl. Ciputat Raya	-631.065	106.747.258	As Dol
I	Pondok Pinang	Kebayoran Lam	Jakarta Selatan	Depan Rumah No. 26, Jl. Metro Pondok	-6.281.372	10.678.039	
I	Pondok Pinang	Kebayoran Lam	Jakarta Selatan	Gd. Hijau Raya / Jl. Bukit Hijau No. 9	-6.279.712	106.779.159	
I	Pondok Pinang	Kebayoran Lam	Jakarta Selatan	Jl. Kartika Utama Hook, Jl. Alam Elok No	-6.265.139	10.678.168	
I	Pondok Pinang	Kebayoran Lam	Jakarta Selatan	Depan Fed Ex, Jl. Ciputat Raya	-6.280.198	106.772.294	
I	Pondok Pinang	Kebayoran Lam	Jakarta Selatan	Depan Pabrik AQUA, Jl. Ciputat Raya Ho	-6.267.862	106.774.966	
I	Pondok Pinang	Kebayoran Lam	Jakarta Selatan	Depan Puskesmas, Jl. Ciputat Raya Deka	-6.249.753	106.778.049	Tutup Meter & Man
I	Pondok Pinang	Kebayoran Lam	Jakarta Selatan	Metro Pondok Indah, Jl. Tb. Simatupang	-6.288.012	106.777.946	
I	Pondok Pinang	Kebayoran Lam	Jakarta Selatan	Jl. Gedung Hijau I Dekat Jalan Bukit Hija	-6.276.602	106.776.463	
I	Pondok Pinang	Kebayoran Lam	Jakarta Selatan	Depan Kantor Pemadam, Jl. Pasar Juma	-6.289.206	106.775.036	
I	Pondok Pinang	Kebayoran Lam	Jakarta Selatan	Depan Pondok Pinang Centre, Jl. Ciputa	-6.273.549	106.773.966	
I	Pondok Pinang	Kebayoran Lam	Jakarta Selatan	Pasar Pondok Indah Sebrang Kantor Paj	-626.066	10.677.618	
I	Kebayoran Lama Utara	Kebayoran Lam	Jakarta Selatan	Depan Masjid Al-Ahyar, Jl. Kramat I	-6.234.558	106.784.831	
I	Kebayoran Lama Utara	Kebayoran Lam	Jakarta Selatan	Depan Pos Pemadam Tanah Kusir, Jl. Ci	-6.250.081	106.778.098	

Figure 3. Data table of Fire_Hydrants

Code	Region_code	region	Sector	Sector_name	kecamatan	kelurahan	buildingName	number	allocation	status	Address
11	1	Sudin Damkar-PB Kota Admini	1	Sektor Gambir	Gambir	Duri Pulo	Kantor Sudin Jakarta Pusat	1	Kantor Sudin	Dijaga	Jl. KH. Zainul Arifin No. 71
1112	1	Sudin Damkar-PB Kota Admini	1	Sektor Gambir	Gambir	Cideng	Pos Cideng	1	Pos Pemadam	Dijaga	Jl. Taman Jatibaru
1113	1	Sudin Damkar-PB Kota Admini	1	Sektor Gambir	Gambir	Gambir	Pos Set Neg	1	Pos Pemadam	Dijaga	Jl. Veteran
1114	1	Sudin Damkar-PB Kota Admini	1	Sektor Gambir	Gambir	Gambir	Pos Balaikota	1	Pos Pemadam	Dijaga	Jl. Merdeka Selatan
1115	1	Sudin Damkar-PB Kota Admini	1	Sektor Gambir	Gambir	Kebon Kelapa	Belum Tersedia	0	Belum ada Pos/Sektor	None	
1116	1	Sudin Damkar-PB Kota Admini	1	Sektor Gambir	Gambir	Petojo Utara	Belum Tersedia	0	Belum ada Pos/Sektor	None	
1117	1	Sudin Damkar-PB Kota Admini	1	Sektor Gambir	Gambir	Petojo Selatan	Pos Walikota	1	Pos Pemadam	Dijaga	Jl. Tanah Abang 1
1121	1	Sudin Damkar-PB Kota Admini	2	Sektor Tanah Abang	Tanah Abang	Kampung Bali	Pos Tanah Abang / Pos Kampung Bali	1	Pos Pemadam	Dijaga	Jl. Fachrudin
1122	1	Sudin Damkar-PB Kota Admini	2	Sektor Tanah Abang	Tanah Abang	Kebon Melati	Pos Kebon Melati	1	Pos Pemadam	Dijaga	Jl. Awaludin
1123	1	Sudin Damkar-PB Kota Admini	2	Sektor Tanah Abang	Tanah Abang	Kebon Kacang	Belum Tersedia	0	Belum ada Pos/Sektor	None	
1124	1	Sudin Damkar-PB Kota Admini	2	Sektor Tanah Abang	Tanah Abang	Bendungan Hilir	Pos Karet/ Pos Ben Hil	1	Pos Pemadam	Dijaga	Jl. Penjernihan Raya
1125	1	Sudin Damkar-PB Kota Admini	2	Sektor Tanah Abang	Tanah Abang	Gelora	Pos MPR / DPR	1	Pos Pemadam	Dijaga	Jl. Gatot Subroto
1126	1	Sudin Damkar-PB Kota Admini	2	Sektor Tanah Abang	Tanah Abang	Karet Tengsin	Pos Karet	0	Belum ada Pos/Sektor	None	
1127	1	Sudin Damkar-PB Kota Admini	2	Sektor Tanah Abang	Tanah Abang	Petamburan	Belum Tersedia	0	Belum ada Pos/Sektor	None	
1131	1	Sudin Damkar-PB Kota Admini	3	Sektor Menteng	Menteng	Menteng	Pos TIM	0	Belum ada Pos/Sektor	None	
1132	1	Sudin Damkar-PB Kota Admini	3	Sektor Menteng	Menteng	Pegangsaan	Belum Tersedia	0	Belum ada Pos/Sektor	None	
1133	1	Sudin Damkar-PB Kota Admini	3	Sektor Menteng	Menteng	Cikini	Pos T I M/ Pos Cikini	1	Pos Pemadam	Dijaga	Jl. Cikini Raya
1134	1	Sudin Damkar-PB Kota Admini	3	Sektor Menteng	Menteng	Gondangdia	Belum Tersedia	0	Belum ada Pos/Sektor	None	
1135	1	Sudin Damkar-PB Kota Admini	3	Sektor Menteng	Menteng	Kebon Sirih	Belum Tersedia	0	Belum ada Pos/Sektor	None	
114	1	Sudin Damkar-PB Kota Admini	4	Sektor Johar Baru	Johar Baru	Johar Baru	Kantor Sektor Johar Baru	1	Kantor Sektor	Dijaga	Jl. Johar Baru Utara 1
1142	1	Sudin Damkar-PB Kota Admini	4	Sektor Johar Baru	Johar Baru	Kampung Rawa	Belum Tersedia	0	Belum ada Pos/Sektor	None	
1143	1	Sudin Damkar-PB Kota Admini	4	Sektor Johar Baru	Johar Baru	Galur	Belum Tersedia	0	Belum ada Pos/Sektor	None	
1144	1	Sudin Damkar-PB Kota Admini	4	Sektor Johar Baru	Johar Baru	Tanah Tinggi	Belum Tersedia	0	Belum ada Pos/Sektor	None	
115	1	Sudin Damkar-PB Kota Admini	5	Sektor Cempaka Putih	Cempaka Putih	Cempaka Putih Timur	Kantor Sektor Cempaka Putih	1	Kantor Sektor	Dijaga	Jl. Komplek Rawakerbo/Ra
1152	1	Sudin Damkar-PB Kota Admini	5	Sektor Cempaka Putih	Cempaka Putih	Cempaka Putih Barat	Pos Cempaka Putih	1	Pos Pemadam	Dijaga	Jl. Cempaka Putih Barat Ra
1153	1	Sudin Damkar-PB Kota Admini	5	Sektor Cempaka Putih	Cempaka Putih	Rawasari	Pos Rawa Kebo	0	Belum ada Pos/Sektor	None	
1161	1	Sudin Damkar-PB Kota Admini	6	Sektor Kemayoran	Kemayoran	Kemayoran	Kantor Sektor Kemayoran	1	Kantor Sektor	Dijaga	Jl. Angkasa Pura Raya Blok
1162	1	Sudin Damkar-PB Kota Admini	6	Sektor Kemayoran	Kemayoran	Gunung Sahari Selatan	Belum Tersedia	0	Belum ada Pos/Sektor	None	

Figure 4. Data table of Fire_Dept_Sector_Post

kelurahan	Code	Region	sub-district	kecamatan	Sector	Sector_name	Post Code	Kasie_name	nip/nrk	Position
Duri Pulo	1.11.1	1.0	Kota Administrasi Jakarta Pusat	Gambir	1.0	Sektor Gambir	10140.0	Senggono	196104031981031004/071198	Kepala Sektor I Gambir
Cideng	1.11.2	1.0	Kota Administrasi Jakarta Pusat	Gambir	1.0	Sektor Gambir	10150.0	Senggono	196104031981031004/071198	Kepala Sektor I Gambir
Gambir	1.11.3	1.0	Kota Administrasi Jakarta Pusat	Gambir	1.0	Sektor Gambir	10110.0	Senggono	196104031981031004/071198	Kepala Sektor I Gambir
Kebon Kelapa	1.11.4	1.0	Kota Administrasi Jakarta Pusat	Gambir	1.0	Sektor Gambir	10120.0	Senggono	196104031981031004/071198	Kepala Sektor I Gambir
Petojo Utara	1.11.5	1.0	Kota Administrasi Jakarta Pusat	Gambir	1.0	Sektor Gambir	10130.0	Senggono	196104031981031004/071198	Kepala Sektor I Gambir
Petojo Selatan	1.11.6	1.0	Kota Administrasi Jakarta Pusat	Gambir	1.0	Sektor Gambir	10160.0	Senggono	196104031981031004/071198	Kepala Sektor I Gambir
Kampung Bali	1.12.1	1.0	Kota Administrasi Jakarta Pusat	Tanah Abang	2.0	Sektor Tanah Abang	10250.0	Syarifudin	196205041986101001/108165	Sektor Tanah Abang
Kebon Melati	1.12.2	1.0	Kota Administrasi Jakarta Pusat	Tanah Abang	2.0	Sektor Tanah Abang	10230.0	Syarifudin	196205041986101001/108165	Sektor Tanah Abang
Kebon Kacang	1.12.3	1.0	Kota Administrasi Jakarta Pusat	Tanah Abang	2.0	Sektor Tanah Abang	10240.0	Syarifudin	196205041986101001/108165	Sektor Tanah Abang
Bendungan Hilir	1.12.4	1.0	Kota Administrasi Jakarta Pusat	Tanah Abang	2.0	Sektor Tanah Abang	10210.0	Syarifudin	196205041986101001/108165	Sektor Tanah Abang
Gelora	1.12.5	1.0	Kota Administrasi Jakarta Pusat	Tanah Abang	2.0	Sektor Tanah Abang	10270.0	Syarifudin	196205041986101001/108165	Sektor Tanah Abang
Karet Tengsin	1.12.6	1.0	Kota Administrasi Jakarta Pusat	Tanah Abang	2.0	Sektor Tanah Abang	10220.0	Syarifudin	196205041986101001/108165	Sektor Tanah Abang
Petamburan	1.12.7	1.0	Kota Administrasi Jakarta Pusat	Tanah Abang	2.0	Sektor Tanah Abang	10260.0	Syarifudin	196205041986101001/108165	Sektor Tanah Abang
Menteng	1.13.1	1.0	Kota Administrasi Jakarta Pusat	Menteng	3.0	Sektor Menteng	10310.0	Jumadi, S.A.P	196107201985031008/087913	Sektor Menteng
Pegangsaan	1.13.2	1.0	Kota Administrasi Jakarta Pusat	Menteng	3.0	Sektor Menteng	10320.0	Jumadi, S.A.P	196107201985031008/087913	Sektor Menteng
Cikini	1.13.3	1.0	Kota Administrasi Jakarta Pusat	Menteng	3.0	Sektor Menteng	10330.0	Jumadi, S.A.P	196107201985031008/087913	Sektor Menteng
Gondangdia	1.13.4	1.0	Kota Administrasi Jakarta Pusat	Menteng	3.0	Sektor Menteng	10350.0	Jumadi, S.A.P	196107201985031008/087913	Sektor Menteng
Kebon Sirih	1.13.5	1.0	Kota Administrasi Jakarta Pusat	Menteng	3.0	Sektor Menteng	10340.0	Jumadi, S.A.P	196107201985031008/087913	Sektor Menteng
Johar Baru	1.14.1	1.0	Kota Administrasi Jakarta Pusat	Johar Baru	4.0	Sektor Johar Baru	10560.0	Turut Abimanyu, S.Sos	196310021986091001/107947	Sektor Johar Baru
Kampung Rawa	1.14.2	1.0	Kota Administrasi Jakarta Pusat	Johar Baru	4.0	Sektor Johar Baru	10550.0	Turut Abimanyu, S.Sos	196310021986091001/107947	Sektor Johar Baru
Galur	1.14.3	1.0	Kota Administrasi Jakarta Pusat	Johar Baru	4.0	Sektor Johar Baru	10530.0	Turut Abimanyu, S.Sos	196310021986091001/107947	Sektor Johar Baru
Tanah Tinggi	1.14.4	1.0	Kota Administrasi Jakarta Pusat	Johar Baru	4.0	Sektor Johar Baru	10540.0	Turut Abimanyu, S.Sos	196310021986091001/107947	Sektor Johar Baru
Rawasari	1.15.1	1.0	Kota Administrasi Jakarta Pusat	Cempaka Putih	5.0	Sektor Cempaka Putih	10570.0	Achmad Faisal, SH	196107021986031006/109791	Sektor Cempaka Putih
Cempaka Putih Timur	1.15.2	1.0	Kota Administrasi Jakarta Pusat	Cempaka Putih	5.0	Sektor Cempaka Putih	10510.0	Achmad Faisal, SH	196107021986031006/109791	Sektor Cempaka Putih
Cempaka Putih Barat	1.15.3	1.0	Kota Administrasi Jakarta Pusat	Cempaka Putih	5.0	Sektor Cempaka Putih	10520.0	Achmad Faisal, SH	196107021986031006/109791	Sektor Cempaka Putih
Gunung Sahari Selatan	1.16.1	1.0	Kota Administrasi Jakarta Pusat	Kemayoran	6.0	Sektor Kemayoran	10610.0	Slamet Riyadi, S.Sos	196303041986031014/107871	Sektor Kemayoran
Kemayoran	1.16.2	1.0	Kota Administrasi Jakarta Pusat	Kemayoran	6.0	Sektor Kemayoran	10620.0	Slamet Riyadi, S.Sos	196303041986031014/107871	Sektor Kemayoran
Kebon Kosong	1.16.3	1.0	Kota Administrasi Jakarta Pusat	Kemayoran	6.0	Sektor Kemayoran	10630.0	Slamet Riyadi, S.Sos	196303041986031014/107871	Sektor Kemayoran

Figure 5. Data table of Fire_Dept_Kasie

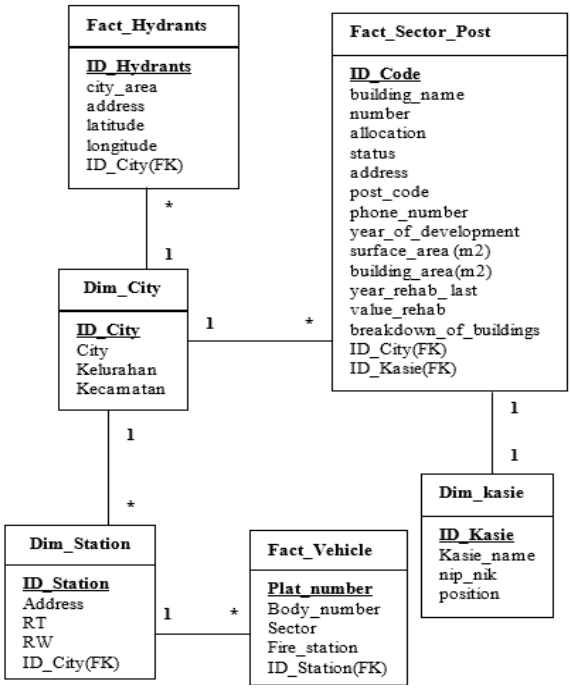

Figure 6. 1st Data Warehouse (DW) schema model design for DKI Jakarta Fire Department

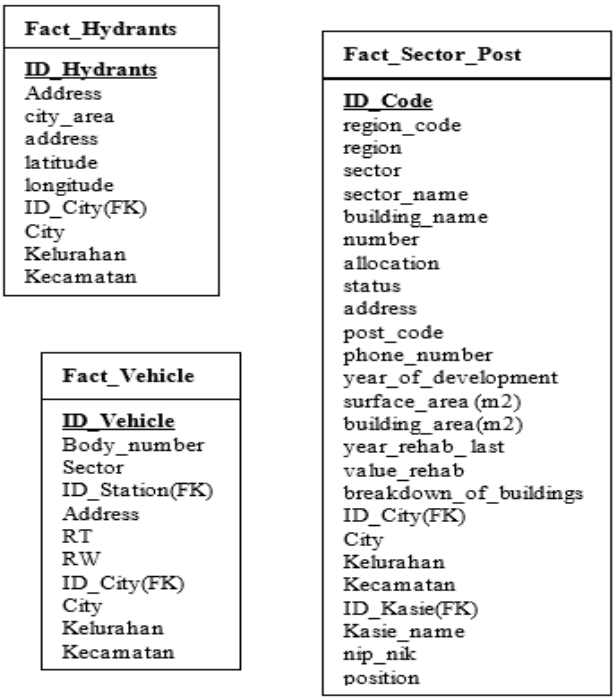

Figure 7. 2nd Data Warehouse (DW) schema model design for DKI Jakarta Fire Department

4. Data Warehouse Model Design at the Fire Department of DKI Jakarta Province

Based on the analysis of 4 Excel tables downloaded from the DKI Jakarta fire department's official website at http://data.jakarta.go.id/organization, as shown in Figure 1 with four tables such as Fire_vehicle, Fire_Hydrants, Fire_Dept_Sector_Post, Fire_Dept_Kasie. Thus, there are 2 data warehouse models schema design as shown in Figures 6 and 7, and both of them are categorised as fact constellation schema data warehouses, where each model has more than one fact table [18].

The development of a data warehouse is created based on the needed reports by high-level management [19] and user requirements by top-level management.

Based on the interviews, the 3 most reports listed below are required by the Fire Department's high-level management. In this case, the 3 reports will be made based on the query results of the two data warehouse models above, and the reports are:

a. Report sector list, where this report will display attributes such as ID_code, building_name, City, kelurahan, ID_kasie, and kasie_name.
b. Report on the Hydrant list, where this report will display attributes such as Id_Hydrants, City,_area, latitude, longitude, city, and kecamatan.
c. Vehicle Register Report: this vehicle listing report will display attributes such as Plat_Number, body_number, ID_Station, Address, ID_City, and City.

The 1st data warehouse schema model in Figure 6 has six tables, which consist of 3 fact tables, such as Fact_Hydrants, Fact_Vehicle, and Fact_Sector_Post, and three-dimension tables, such as Dim_city, Dim_Station, and Dim_kasie. Specifically, dimension table Dim_city has two behaviours, such as dimension and sub-dimension tables:

a. As a dimension table when dealing with fact tables such as Fact_Hydrants and Fact_Sector_Post.
b. As a sub-dimensional table dealing with fact table Fact_Vehicle and table dimension such as Dim_Station.

Meanwhile, the 2nd data warehouse schema model in Figure 7 has three fact tables: Fact_Hydrants, Fact_Vehicle, and Fact_Sector_Post. The 2nd DW schema model design in Figure 7 is created based on denormalisation on the 1st DW schema model design in Figure 6 where:

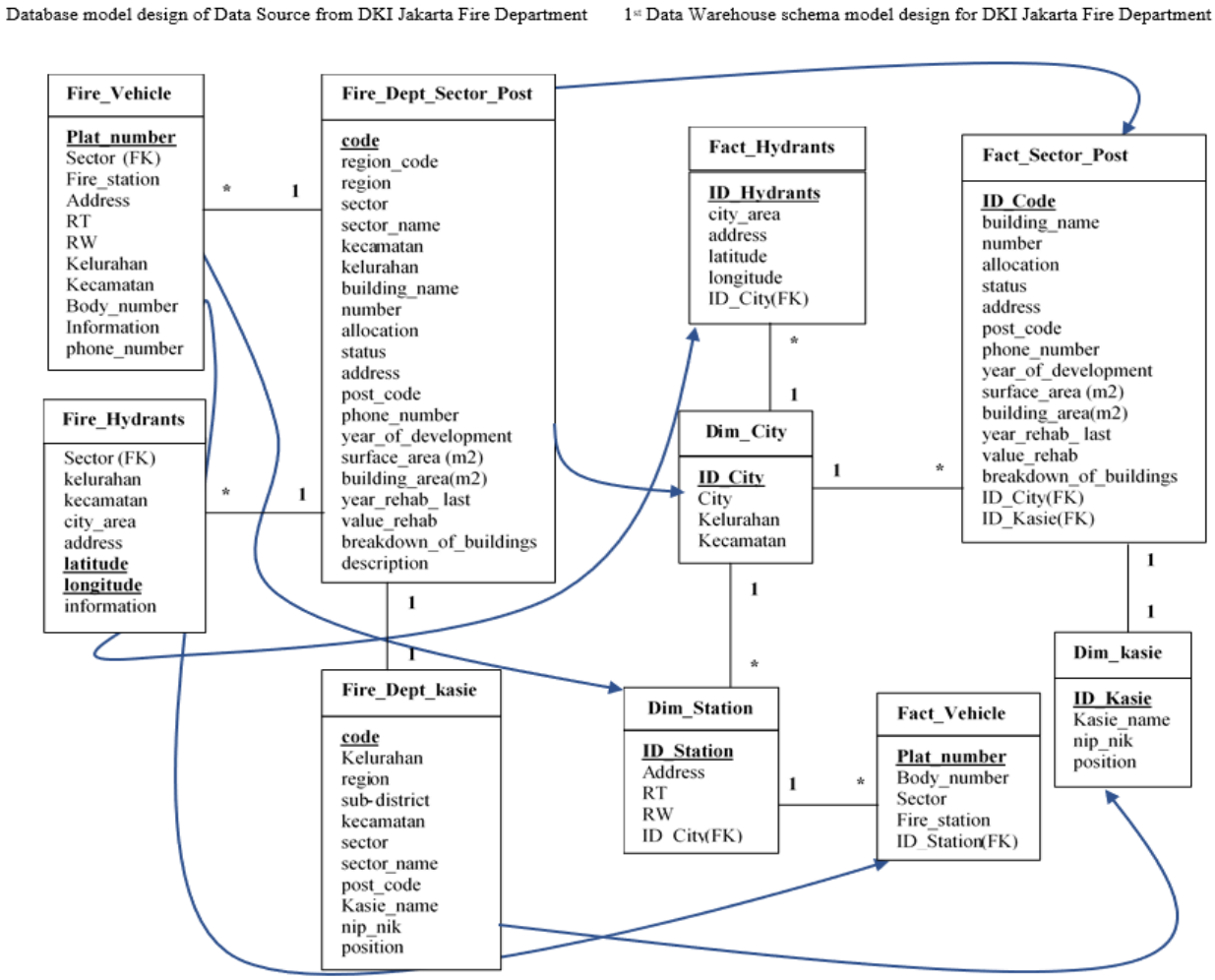

Figure 8. A transformation from database data source DKI Jakarta Fire Department to 1st Data Warehouse schema model design

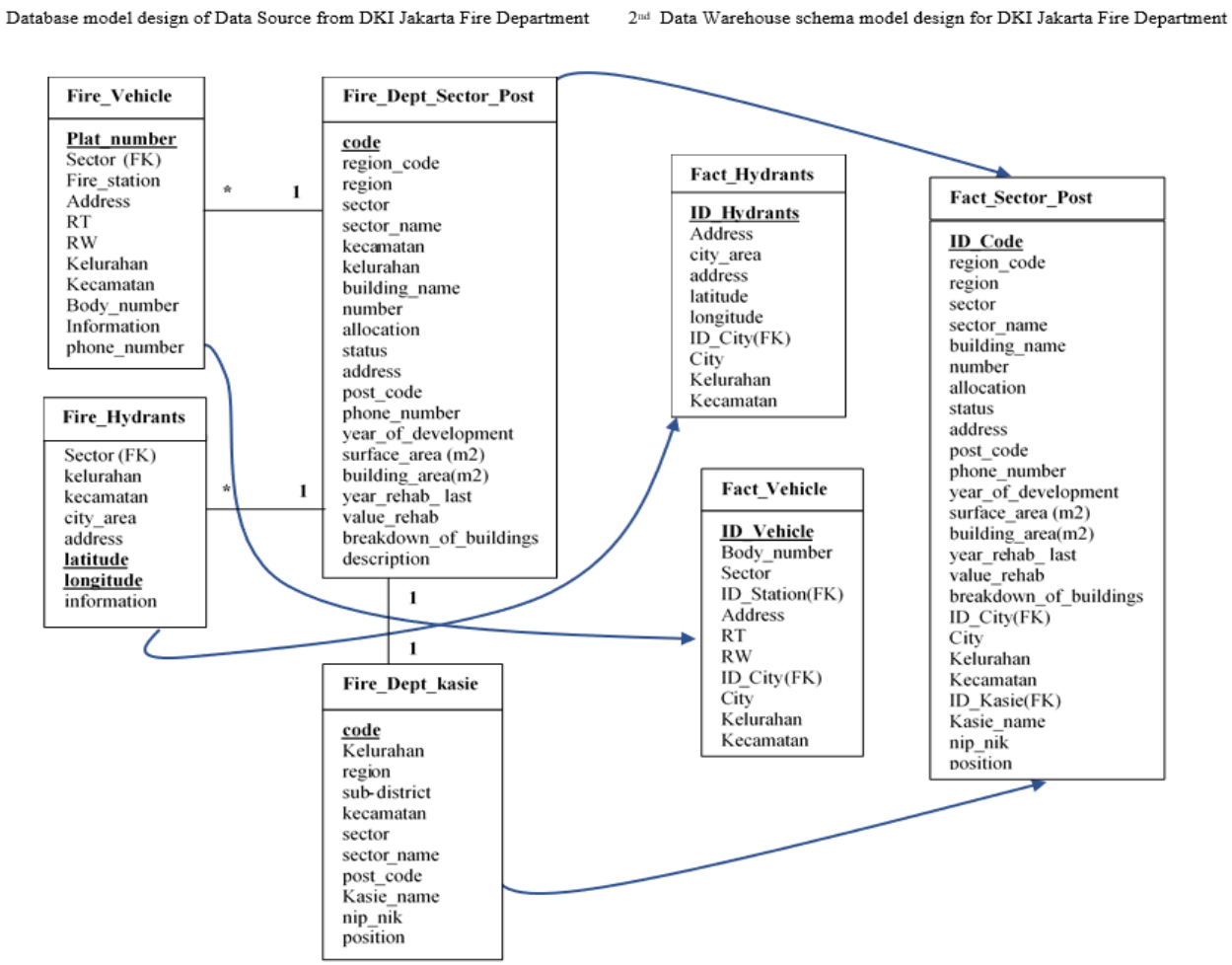

Figure 9. A transformation from database data source DKI Jakarta Fire Department to 2nd Data Warehouse schema model design

a. Tables Dim_City and Dim_Kasie in Figure 6 are merged into table Fact_Sector_Post.
b. Tables Dim_City in Figure 6 are merged into table Fact_Hydrants.
c. Tables Dim_City and Dim_Station in Figure 6 are merged into table Fact_Vehicle.

The constellation data warehouse schema model in Figure 7 will further speed up the process of making reports commonly carried out by the data warehouse where the report creation process occurs. Moreover, the query process is faster because of a reduced number of join tables in the data warehouse table, ultimately speeding up the process of making. Furthermore, the data warehouse in Figure 6 has undergone denormalisation, becoming an abnormal data warehouse model. Still, using an unusual data warehouse model speeds up the query process, where only the minimum data warehouse tables are used to generate reports faster.

Table 2. A transformation from database data source DKI Jakarta Fire Department to 1st Data Warehouse schema model design

A table in the 1st Data Warehouse Schema model	Table source from Database data source model design at DKI Jakarta Fire Department
Fact_Hydrants	Fire_Hydrants
Fact_Vehicle	Fire_Vehicle
Fact_Sector_Post	Fire_Dept_Sector_Post
Dim_City	Fire_Dept_Sector_Post
Dim_Station	Fire_Vehicle
Dim_kasie	Fire_Dept_Kasie

Table 3. The transformation from database data source DKI Jakarta Fire Department to 2nd Data Warehouse schema model design

A table in the 2nd Data Warehouse Schema model	Table source from Database data source model design at DKI Jakarta Fire Department
Fact_Hydrants	Fire_Hydrants
Fact_Vehicle	Fire_Vehicle
Fact_Sector_Post	Fire_Dept_Sector_Post Fire_Dept_Kasie

Figure 8 shows the transformation from a database data source at DKI Jakarta Fire Department to 1st data warehouse (DW) schema model design at DKI Jakarta Fire Department as shown in Table 2 where:

a. Table DW Fact_Hydrants is transformed from table Fire_Hydrants.
b. Table DW Fact_Vehicle is transformed from table Fire_Vehicle.
c. Table DW Fact_Sector_Post is transformed from table Fire_Dept_Sector_Post.
d. Table DW Dim_City is transformed from table Fire_Dept_Sector_Post.
e. Table DW Dim_Station is transformed from table Fire_Vehicle.
f. Table DW Dim_Kasie is transformed from table Fire_Dept_Kasie.

Meanwhile, Figure 9 shows the transformation from a database data source at DKI Jakarta Fire Department to 2nd data warehouse (DW) schema model design at DKI Jakarta Fire Department, as shown in Table 3:

a. Table DW Fact_Hydrants is transformed from table Fire_Hydrants.
b. Table DW Fact_Vehicle is transformed from table Fire_Vehicle.
c. Table DW Fact_Sector_Post is transformed from tables Fire_Dept_Sector_Post and Fire_Dept_Kasie.

Below is an explanation of how all three reports were developed using the two DW models mentioned above. The following describes the Structured Query Language (SQL) statement commands required to retrieve data from the table specified in the SQL command and applied to the two DW models above:

a. Report sector list.

If the sector listing report is made with the first DW model in Figure 6, it uses three tables, Fact_Sector_Post, Dim_City, and Dim_Kasie, which will be linked in the SQL statement command a report creation query. Following is the SQL statement for making the report:

```
Select A.ID_code, A.building_name, B.City,
B.kelurahan, A.ID_kasie, C.kasie_name.
From Fact_Sector_Post A, Dim_City B,
Dim_Kasie C
where A.ID_City=B.ID_City and
A.ID_Kasie=C.ID_Kasie
```

Meanwhile, if the list of sectors is made with the second model in Figure 7, it only uses 1 table about Fact_Sector_Post. Following is the SQL statement for making the report:

```
Select ID_code, building_name, City,
kelurahan, ID_kasie, kasie_name from
Fact_Sector_Post
```

b. Report on the Hydrant list.

If made with the first model in Figure 6, the hydrant list report uses two tables, Fact_Hydrants and Dim_City, linked in the SQL statement command as a report creation query. Following is the SQL statement for making the report:

```
Select A.ID_Hydrants, A.City_area,
A.latitude, A.longitude, B.City, B.Kecamatan
From Fact_Hydrants A, Dim_City B Where
A.ID_City=B.ID_City
```

Meanwhile, if the list of sectors is made with the second model in Figure 7, only use 1 table Fact_Hydrants. Following is the SQL statement for making the report:

```
Select ID_Hydrants, City_area, latitude,
longitude, City, Kecamata From
Fact_Hydrants
```

c. Vehicle Register Report.

If made with the first model in Figure 6, the vehicle register listing report uses three tables, Fact_Vehicle, Dim_Station, and Dim_City, linked in the SQL statement command as a report creation query. Following is the SQL statement for making the report:

```
Select A.Plat_Number, A.body_number,
A.ID_Station, B.Address, B.ID_City, C.City
From Fact_Vehicle A, Dim_Station B,
Dim_City C
where A.ID_Station=B.ID_Station and
B.ID_City=C.ID_City
```

Meanwhile, if the list of sectors is made with the second model in Figure 7, it only uses 1 table about Fact_Vehicle. Following is the SQL statement for making the report:

```
Select Plat_Number, body_number,
ID_Station, Address, ID_City, City from
Fact_Vehicle
```

5. Conclusion

From the two schema models formulated, namely the Fact Constellation data warehouse model in Figures 6 and 7, it can be concluded that the second data warehouse schema in Figure 7 will further speed up the report creation process usually carried out by data warehouses. Meanwhile, the Fact Constellation data warehouse model in Figure 6, which is denormalised into an abnormal data warehouse model, is the second choice as an alternative for making reports based on the data warehouse.

Of course, using an eccentric data warehouse model will speed up the query process. In contrast, a minimal data warehouse table, like the data warehouse model in Figure 7, will speed up the report creation process. The speed of the report creation process occurs due to the reduction in the number of join tables in the data warehouse tables so that the query process becomes faster, ultimately speeding up the report creation process.

Meanwhile, the extract transformation and loading (ETL) process for withdrawing data from a transactional database will be more efficient in pulling data into Figure 7 as a data warehouse fact table. In this case, there are 4 processes for withdrawing data from the transactional database to the data warehouse. Furthermore, withdrawing data from the transactional database to the data warehouse model in Figure 6 is more complex than withdrawing data from the data warehouse model in Figure 7, where there are 6 data withdrawal processes.

Regarding the application of automatic identification system (AIS) research using a data warehouse, the data warehouse will be used to design a data warehouse model for AIS. AIS data is formulated and designed into a fact table. It is hoped that there will be no merging of many tables in its management so the preparation of reports related to AIS data can be more optimal and measurable. AIS data can be organised by differentiating the month and year in a separate fact table. Of course, the data organisation refers to the month and year data from which the AIS data is withdrawn. Organising AIS data separately into months and years will speed up the creation of the search and report.

By creating a data warehouse schema in this research, further research can be carried out by applying several machine learning algorithms that look for patterns from the data warehouse schema. Searching for patterns originating from the data warehouse schema will help search for data based on pattern search activities such as prediction patterns and classification as supervised pattern search activities. Apart from that, unsupervised pattern search activities can be done by looking for clustering and association data patterns. In addition, it is possible to explore the possibility of applying reinforcement learning based on providing rewards and punishments to learning behaviour.

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