

IFC-Bank of Italy Workshop on "Data science in central banking: enhancing the access to and sharing of data"

17-19 October 2023

Big data platform (FinPulse) initiative¹

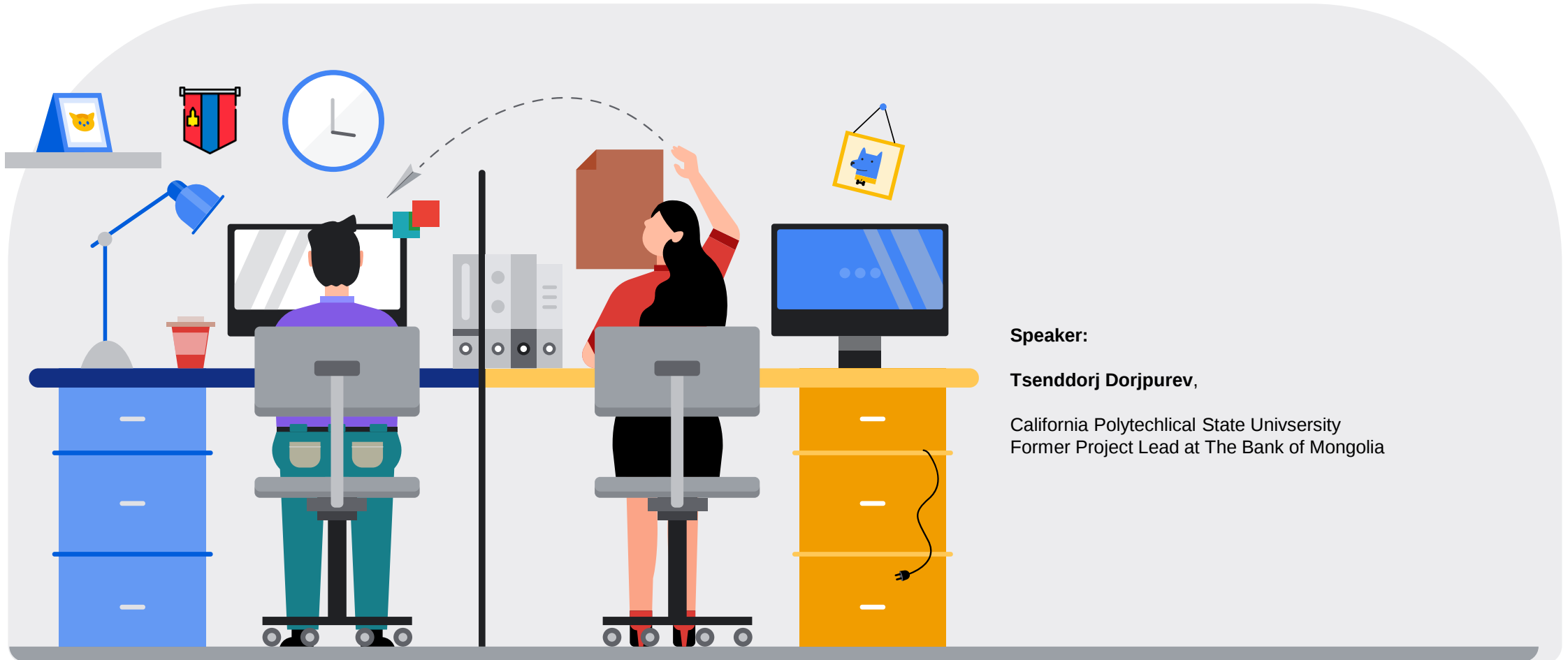
Tsenddorj Dorjpurev,
California Polytechnical State University

¹ This contribution was prepared for the workshop. The views expressed are those of the authors and do not necessarily reflect the views of the Bank of Italy, the BIS, the IFC or the other central banks and institutions represented at the event.



Big Data Platform (FinPulse) Initiative

“Reimagining regulatory data collection and analysis”



Speaker:

Tsenddorj Dorjpurev,

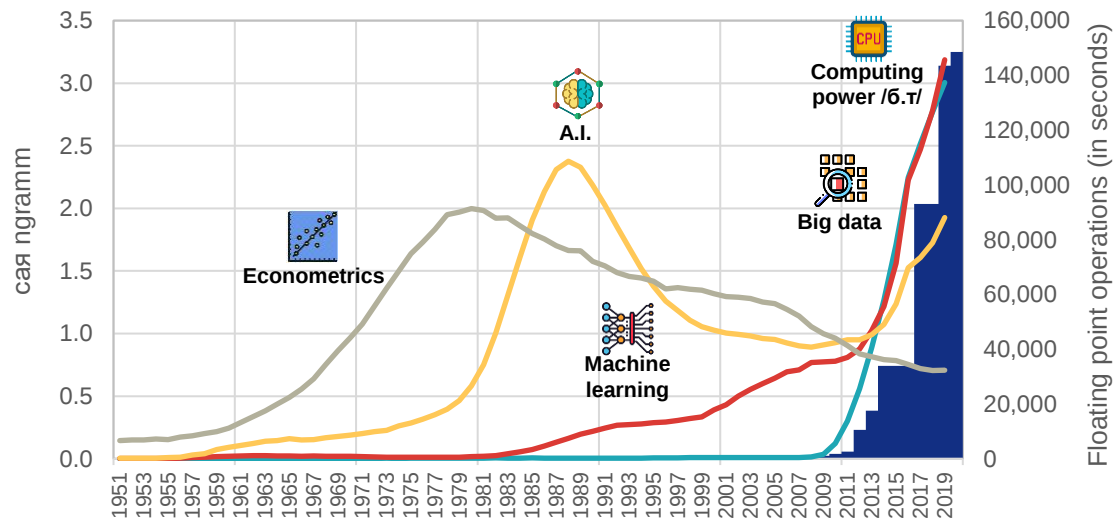
California Polytechnical State University
Former Project Lead at The Bank of Mongolia

17 OCT 2023



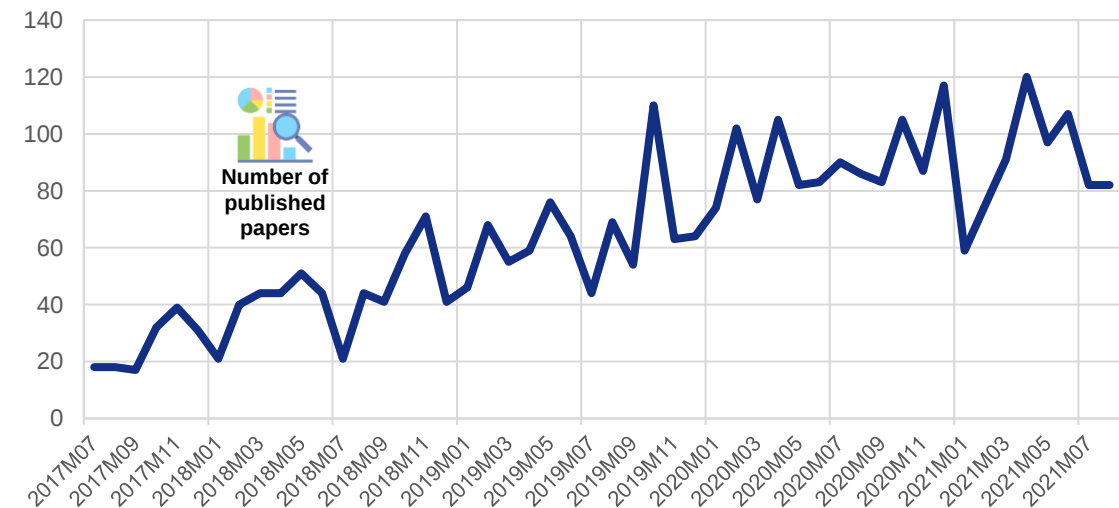
General interest

A strong interest in big data can be seen after 2010, where the term machine learning took up in the second half of the '80s and artificial intelligence has measurable volume as early as the '60s, and it has shown a decline through the '90s 2000s and the first half of 2010s as well



Academic interest

The field of Big Data has **3,315 papers (310 authors)** compared with 22,500 articles published in the field of central banking, from a total of 1,001,932 articles in the archive. In the following figure, we can see that **around 100 articles** are being published in this field every month.




МОНГОЛБАНК
 БАНКНЫ ТАЙЛАНГИЙН СИСТЕМ

Хэрэглэгчийн нэр: Статистик (mbrsd01) Тусламж Гарах

Нүүр хуудас > Тайлан хайлтын цонх

Тайлан хайх

Хайх Буцах

Хайх нөхцөлүүд

Тайлангийн төрөл

Бүгд
 ССГ - 02. Ипотекийн зээлийн сарын тайлан
 ССГ - 07. Гадаад гүйлгээний сарын тайлан
 ССГ - 08. Гадаад гүйлгээний сарын нэгтгэл /Г
 ССГ - 09. Гадаад гүйлгээний сарын нэгтгэл /Д
 ССГ - 10. Гадаад гүйлгээний сарын нэгтгэл /Д
 ССГ - 14.ӨОХАИХ - ний зээлийн сарын мэдэ
 ССГ - 15. Орон нутгийн ипотекийн тайлан /са
 ССГ - 16. Төлбөрийн тэнцлийн мэдээ
 ССГ - 17. Шинээр татсан харилцах, хадгалам

Эхлэх огноо 2021/08/01

Дуусах огноо 2021/08/18

Тайлангийн төлөв Бүгд

Банкны нэр

Бүгд
 Ардкредит ББСБ ХК
 Ариг банк
 Архангай
 Баян-Өлгий
 Баянхонгор
 Богд банк
 Булган
 Бусад
 Говь-алтай

Нүүр хуудас
 Тайлан
 Тайлангийн загвар татах
 Тайлан хайх
 Дүгнэлтийн тайлан оруулах
 Дүгнэлтийн тайлан хайх
 Олон тайлан оруулах
 Банкны лавлагаа
 Байгууллага хайх
 Лавлагаа
 Валютын ханш
 Хэрэглэгчдийн жагсаалт
 Банкны хэрэглэгчийн эрх
 Тусгай зөвшөөрлийн жагсаалт
 Хэрэглэгч хайх
 Дансны төлөвлөгөө
 Тайлан ирүүлдэггүй өдөр
 Лог татах
 ААН-н нэрсийн жагсаалт
 Хэрэглэгчийн мэдээлэл
 Нууц үг солих

+250



+70 templates are received by 5 departments:

RSD
PSD
RMFMD
BRPD
SD

- Duplicated information => Cross check validation
- Increasing frequency of changes in the templates and ad hoc data collection
- Increased fatigue at bank employees due to increasing regulatory data demand
- Demand for higher frequency, cohesive data collection

Project Impact



Creation of a standard, unified database



Reduced time-lag of official statistics



Data collection frequency



Data volume



Increased labor efficiency
(cost reduction and human error)



In Numbers

Condensed **70+ reports** and **250+ sheets** of data templates into a **single standardized data acquisition model**.



Reduced the time between data collection and data dissemination from **t+17 days** to **t+1 day**.



Increased average data collection frequency from **monthly** to **daily**.



Increased recorded annual data volume **x425**, from **40GB** to **17TB** (26GB when data mirroring and more with backup).



Enabled **200+ workers** in the banking sector to focus on higher-value tasks such as problem solving and analytics.



Improvements of the Entire Central Bank and Partners

- Increased analytical capabilities that supervisors can use to provide policymakers and upper management with instant access to reports and key indicators.
- The standardized data model and staging database setup allow banks to change systems without disrupting the data-sharing connection.

Current Data Collection System

Reserve Management Financial Markets Department	Research and Statistics Department									
Mortgage Soft Loan Program (by daily news)	Foreign Trade Statistics	Mongolian Embassy's Abroad Expenditure Report	Total Current and Savings Report (by soum and district)	Balance of Payments	Interest Rate Lending Report (Outstanding)	Nominal and Real Effective Exchange Rate of MNT (NEER, REER)				
Mortgage bonds held by the Bank of Mongolia	Oyun Tolgoi Monthly News	Government Foreign Loan Report	Sex Disaggregated Childrens Savings Report (by soum and district)	Loan Report of Banks (by economic activity)	Interest Rate Lending Report (New)	International Reserves and Foreign Currency Liquidity Report				
Mortgage Soft Loan Program (by resource allocation)	Oyun Tolgoi Monthly Export Forecast	Monthly Sales and Transportation Data of Coal Exporting Mongolian Enterprises	Loan information for changes in loan contracts due to the COVID-19 pandemic	Rural-Area Loan Report	Interest Rate Deposit Report (Outstanding)	Bank of Mongolia Balance				
Bank Reserve Requirement Statement Information	State Budget News	Cross-Border Passenger Survey	Cash Replenishment News	SME Loan Report	Monthly International Transactions News	Bank of Mongolia Net Domestic Asset News				
Mortgage Soft Loan Program (by demand news)	Sex Disaggregated Loan Report (by soum and district)	Diplomatic Mission Expenditure Report	Bank Branch and Personnel Gender Report (by soum and district)	Bank Branch and Personnel Report	Balance of Payments (by banks)	Foreign and Domestic Ownership Concentration Survey				
Loan Outstanding Report (by banks)	Total Loan Report (by soum and district)	Consumer Loan Report (by debt-to-income ratio)	M2 Money Supply (by banks)	Consolidated Balance Sheet (by banks)	Interest Rate Deposit Report (New)	Official Reserve Assets Report				
Daily Current and Deposit Balance Information	Sex Disaggregated Individuals Current Account and Savings Report (by soum and district)	Green Loan Report	Mortgage Loan Report		Declared Loan Rates Information (by banks)					
Liquidity Ratio Report	Banking Resolution and Policy Department		Supervision Department		Payment Systems Department					
Daily International Transactions News	Rural-Area Banks Balance Sheet	Liquidated Banks Balance Sheet	Monthly Report on Job Support Loans	List of All Related Parties of the Bank and Report on Assets Related to Them	Settlement Representative Report	Remote Banking Report				
Foreign Currency Risk Report (by banks)	Agricultural Support Loan Interest Rate /subsidies/	Repo Weekly News	Mortgage Daily News /6% interest rate/	Financial Derivatives Report	E-Money Report	Payment Card Clearing Report				
Monthly Interbank Transaction Report	Detailed Loan Report	Weekly Banks Balance Sheet	Calculation of Interest Rate Support from the Government	Calculation of Job Support Loan Interest Rate /subsidies/	Payment Card Report	Continuity Report				
Foreign Currency Trading Report (by banks)										

28

Email

14

BRMS

16

FINA

13

Others

Regulatory Reports

The New System in Development

Reserve Management Financial Markets Department	Research and Statistics Department									
Mortgage Soft Loan Program (by daily news)	Foreign Trade Statistics	Mongolian Embassy's Abroad Expenditure Report	Total Current and Savings Report (by soum and district)	Balance of Payments	Interest Rate Lending Report (Outstanding)	Nominal and Real Effective Exchange Rate of MNT (NEER, REER)				
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Liquidity Ratio Report	Banking Resolution and Policy Department		Supervision Department		Payment Systems Department					
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Foreign Currency Trading Report (by banks)										

53

DAM

18

Dynamic Form



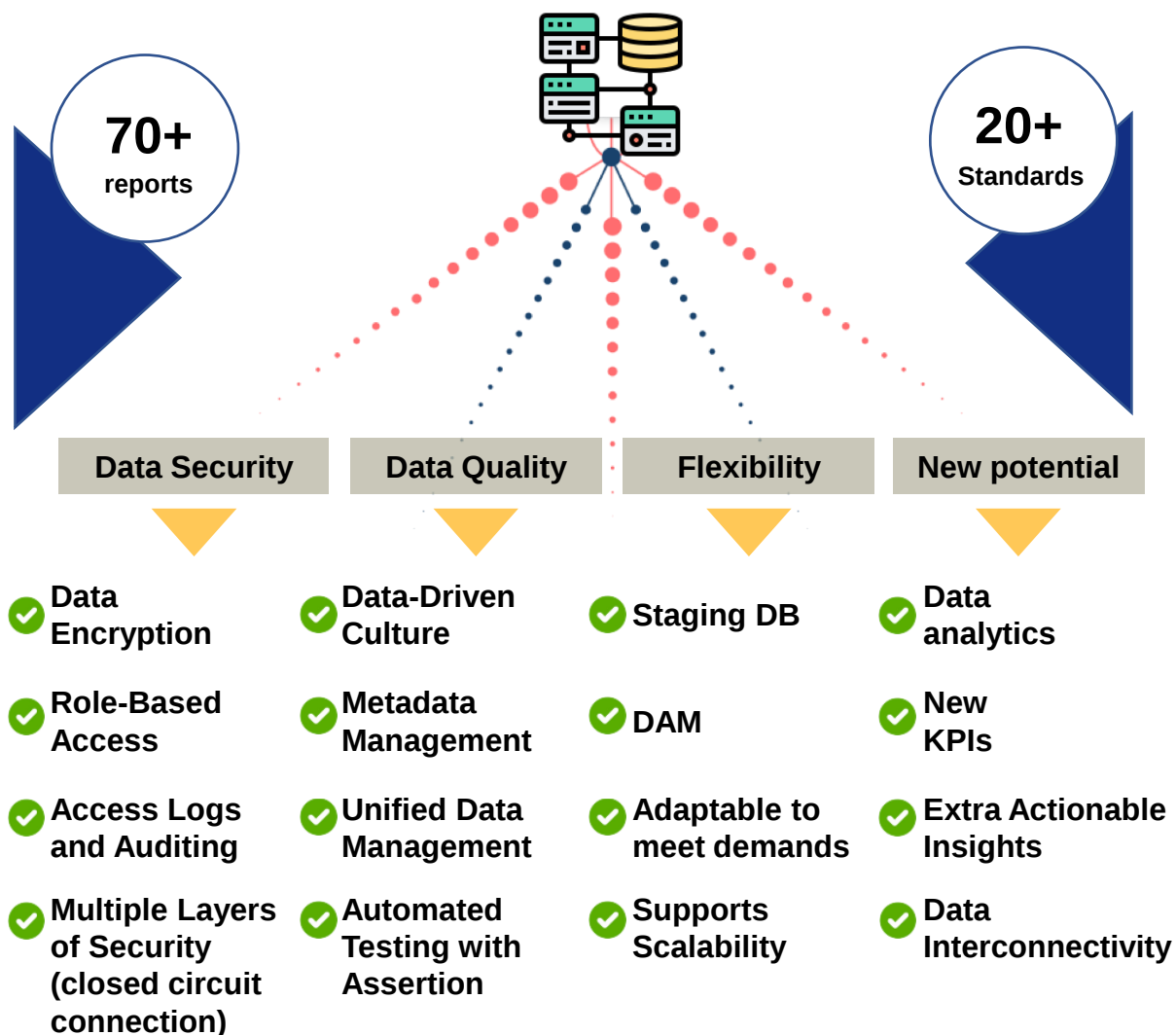
Regulatory reports

- ☐ Loan Report of Banks
- ☐ SME Loan Report
- ☐ Rural-Area Loan Report
- ☐ Mortgage Loan Report
- ☐ Consolidated Balance Sheet
- ☐ Interest Rate Lending Report
- ☐ Balance of Payments
- ☐ Liquidity Ratio Report

...



Data Acquisition Model of Big Data (FinPulse) System



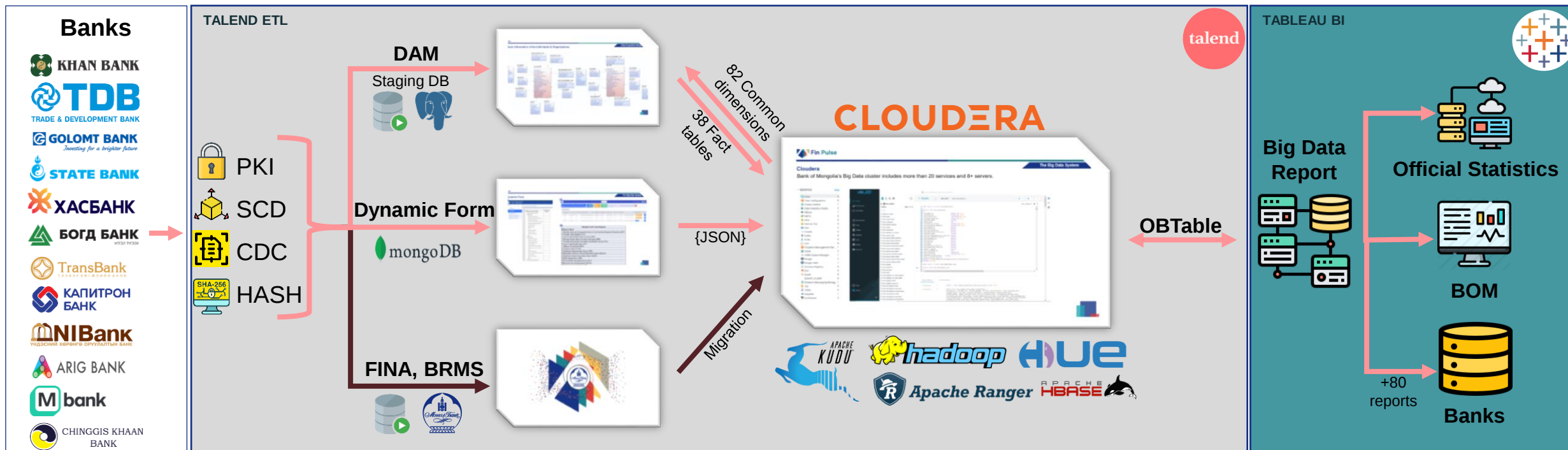
Data Acquisition Model

Official statistics standards & guidelines



- ☐ IFRS
- ☐ IMF SDDS
 - ☐ Monetary and Financial Statistics Guidelines
 - ☐ Balance of Payments Manual
- ☐ The System of National Accounts
- ☐ Green Taxonomy
- ☐ AFI Sex-disaggregated data guidelines
- ☐ The International standard industrial classification of all economic activities ISIC
- ☐ Merchant Category codes
- ☐ Zip postal code

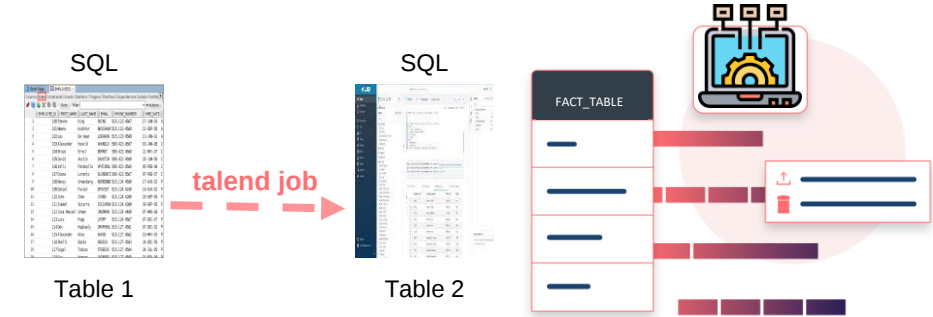
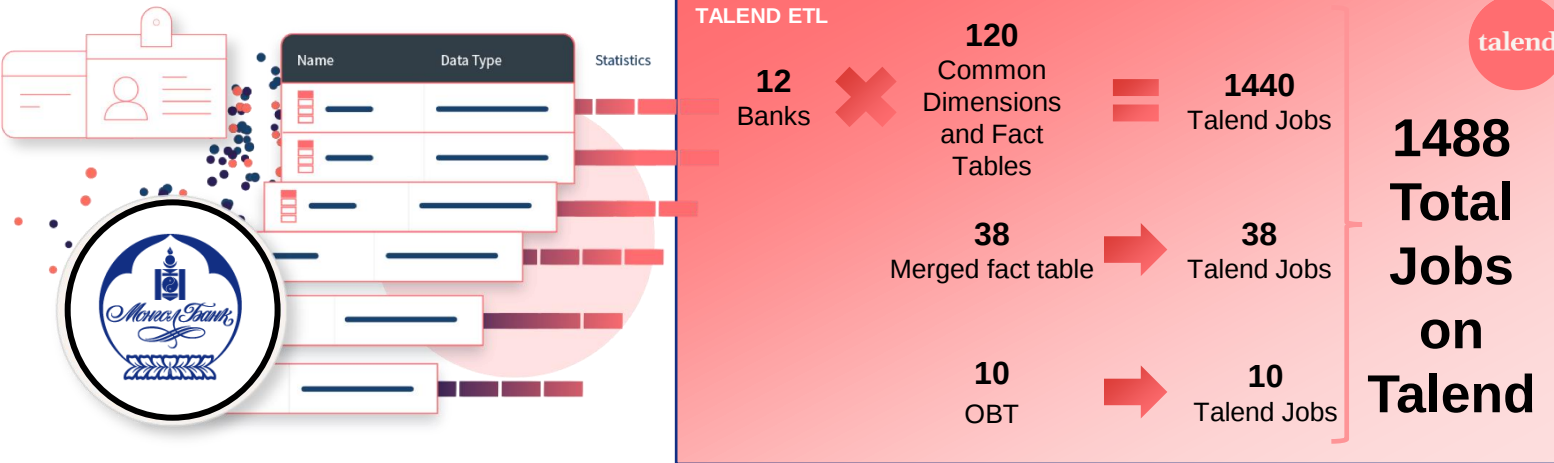
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The Big Data platform uses staging databases (i.e., parallel warehouse) that are kept on the bank's premises to hold raw, granular-level data using the BoM's Data Acquisition Model (DAM) format which is encrypted and transmitted to the BoM through a closed-circuit connection, and offers a single, unified source of information for both supervisors and banks to access in near real-time. Besides DAM, the platform also collects data from commercial banks and licensed institutions through manually filled Dynamic form.

- 1. Data Acquisition Model (DAM):** The DAM generates an automated report daily with access in near real-time, eliminates data redundancy and inconsistency both interdepartmentally and system-wide, and can acquire and assimilate more forms of data.
- 2. Dynamic Form:** Data that is not readily available through DAM will be collected using a web-based dynamic questionnaire management solution connected to the big data system. Dynamic form uses customizable data templates at a fixed frequency and is easy to make additional changes and updates to the reports.

ETL "job"



STAGING DB SQL



$$38 \times 12 = 456 \text{ CDC SQL tables}$$

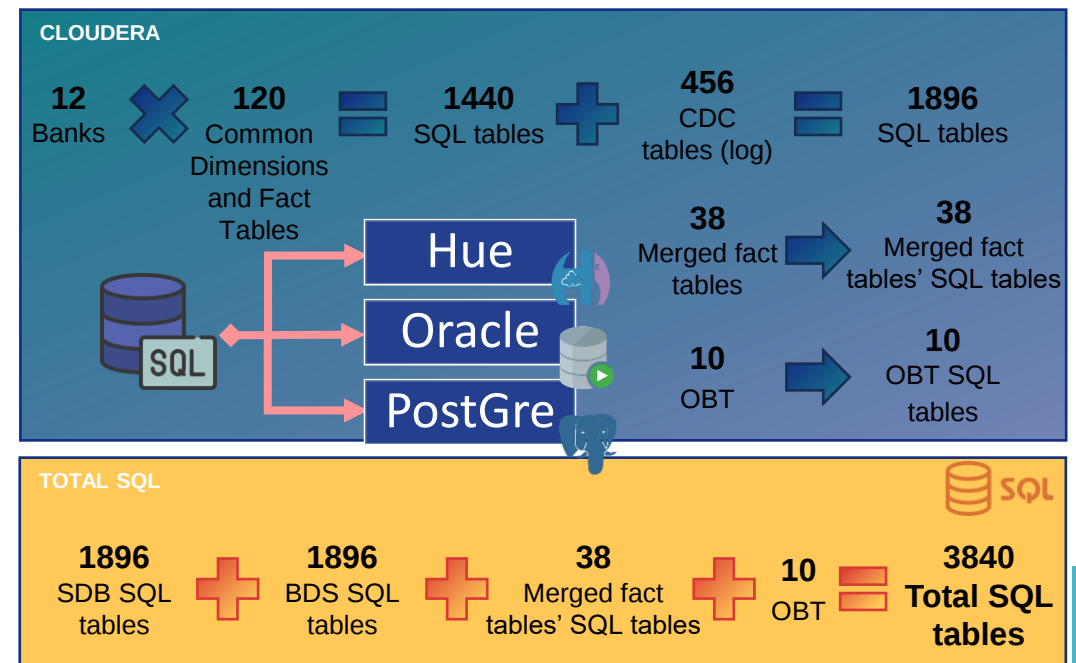


$$12 \text{ Banks} \times 120 \text{ Common Dimensions and Fact Tables} = 1440 \text{ SQL tables}$$

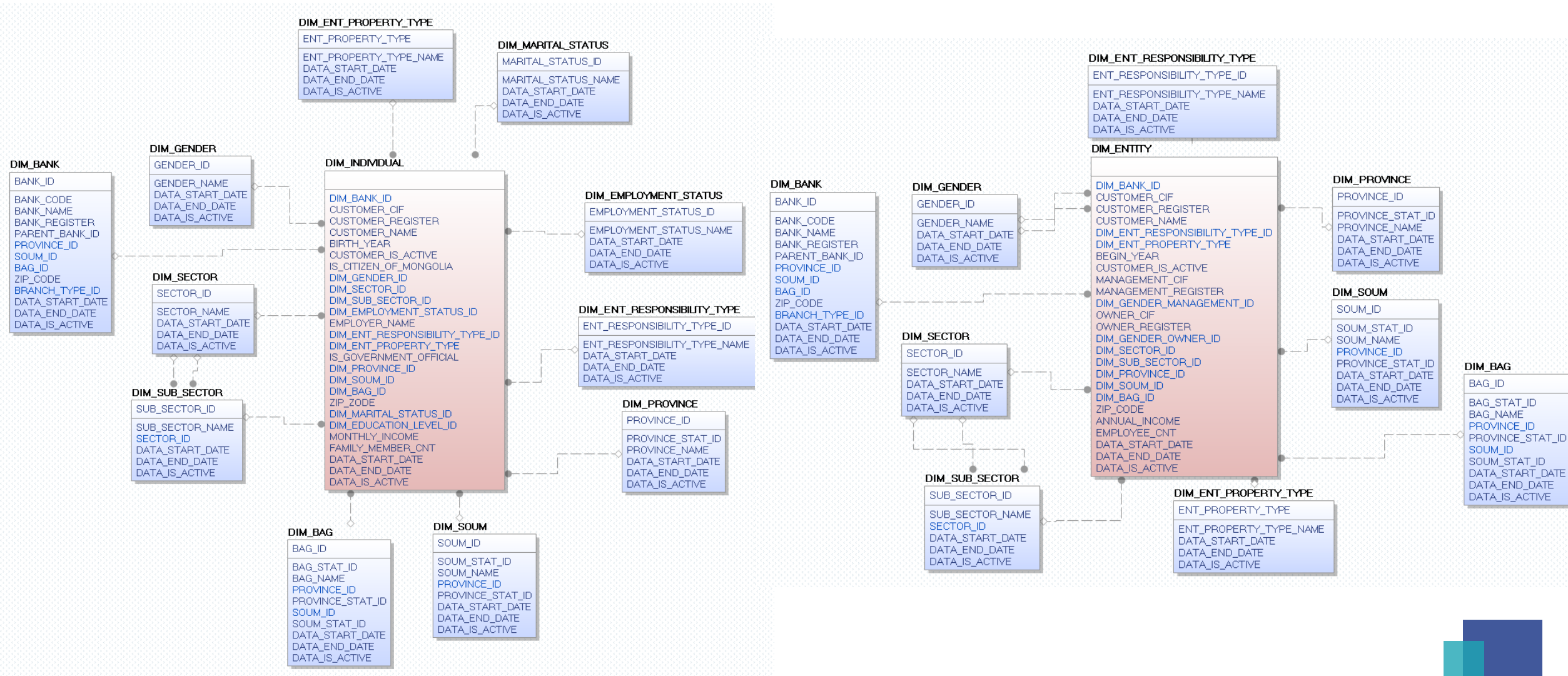


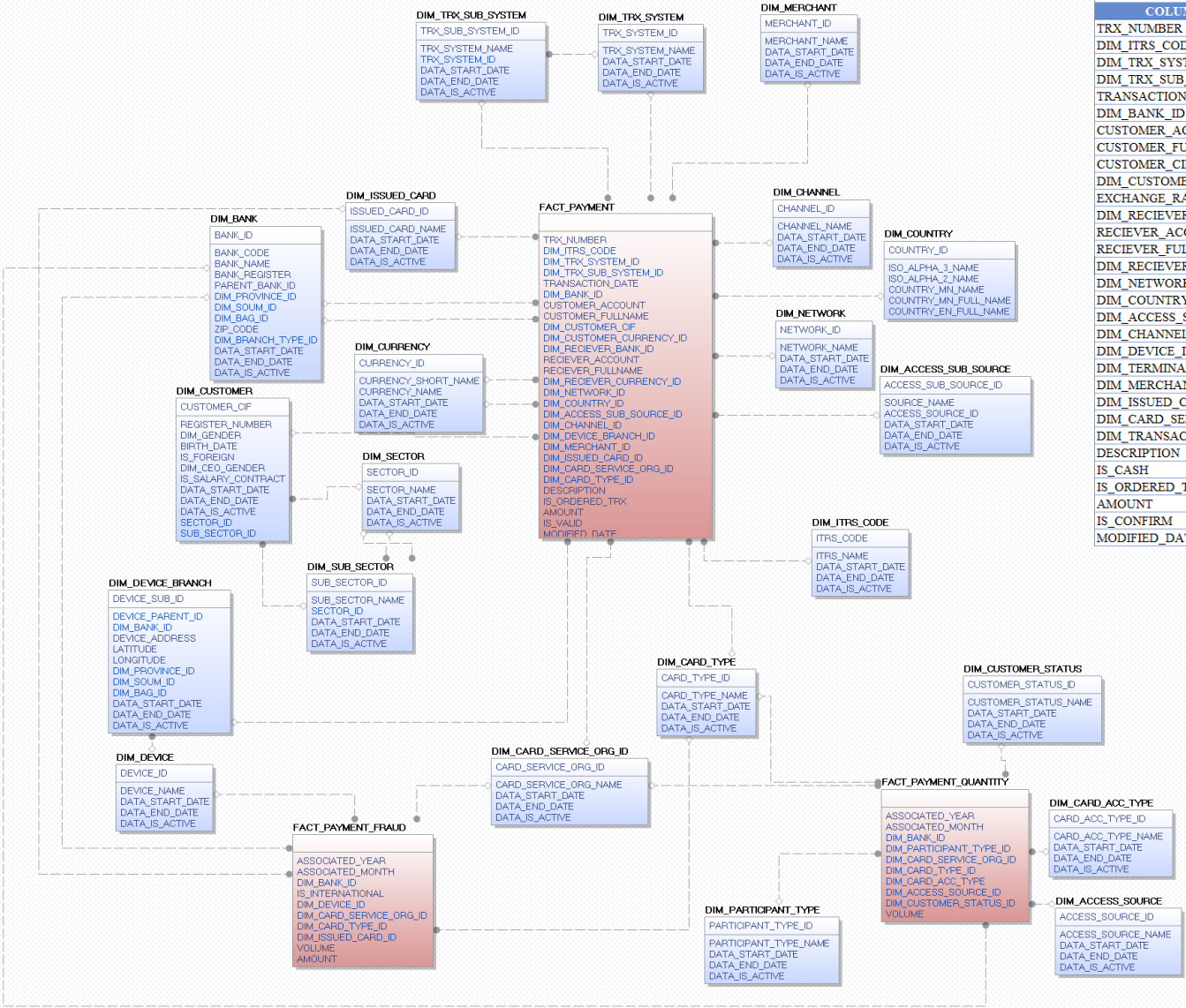
$$1896 \text{ SQL tables}$$

talend



Basic Information of the Individuals & Organizations





COLUMN_NAME	NAME	DESCRIPTION
TRX_NUMBER	Гүйлгээний дугаар	Банкуудын гүйлгээ бүрийг тодорхойлсон давтагдашгүй ID дугаар
DIM_ITRS_CODE	ITRS дугаар	Гадаад гүйлгээ хийсэн тохиолдолд DIM_ITRS table-н харгалзах ITRS_CODE оруулна.
DIM_TRX_SYSTEM_ID	Төлбөр тооцооны системийн төрөл	Банк доторхи гүйлгээ бол банкууд Inner-bank, Гадаад гүйлгээ Foreign transaction төрлөөр тус тус оруулна.
DIM_TRX_SUB_SYSTEM_ID	Төлбөр тооцооны системийн дэд төрөл	Банк доторхи гүйлгээ бол банкууд Inner-bank, Гадаад гүйлгээ Foreign transaction төрлөөр тус тус оруулна.
TRANSACTION_DATE	Гүйлгээ хийгдсэн өдөр, цаг, минут	YYYY-MM-DD HH:MM:SS форматаар байна
DIM_BANK_ID	Банк, салбар	Харишлагч салбар дээр хийгдсэн гүйлгээ бол салбарын кодоор авна.
CUSTOMER_ACCOUNT	Харишлагчийн дансны дугаар	Илгээгчийн данс ихдээ 12 оронтой тоо оруулна.
CUSTOMER_FULLNAME	Харишлагчийн нэр	Гадаад гүйлгээ хийсэн тохиолдолд илгээгчийн дансны нэрийг текстээр оруулна.
CUSTOMER_CIF	Харишлагчийн CIF	Банканд бүртгэлтэй харишлагчийн дахин давтагшгүй CIF дугаарыг оруулна.
DIM_CUSTOMER_CURRENCY_ID	Харишлагчийн дансны валют	DIM_CURRENCY table-н харгалзах CURRENCY_ID оруулна
EXCHANGE_RATE	Харишлагчийн валютын ханш	Валютын ханшын дүнг оруулна
DIM_RECIEVER_BANK_ID	Хүлээн авагчийн банк	DIM_BANK table-н харгалзах BANK_ID оруулна
RECIEVER_ACCOUNT	Хүлээн авагчийн дансны дугаар	Хүлээн авагчийн данс ихдээ 12 оронтой тоо оруулна.
RECIEVER_FULLNAME	Хүлээн авагчийн нэр	Гадаад гүйлгээ хийсэн тохиолдолд илгээгчийн дансны нэрийг текстээр оруулна.
DIM_RECIEVER_CURRENCY_ID	Хүлээн авагчийн дансны валют	DIM_CURRENCY table-н харгалзах CURRENCY_ID оруулна
DIM_NETWORK_ID	Нэгдсэн болон гадаад сүлжээний төрөл	DIM_NETWORK table-н харгалзах NETWORK_ID оруулна
DIM_COUNTRY_ID	Хүлээн авагчийн улсын дугаар	DIM_COUNTRY table-ийн COUNTRY_ID оруулна.
DIM_ACCESS_SUB_SOURCE_ID	Хандалтын эх үүсвэр	DIM_ACCESS_SUB_SOURCE table-н харгалзах ACCESS_SUB_SOURCE_ID оруулна
DIM_CHANNEL_ID	Гүйлгээний төрөл	DIM_CHANNEL table-н харгалзах CHANNEL_ID оруулна
DIM_DEVICE_ID	Төхөөрөмжийн төрөл	DIM_DEVICE table-ийн харгалзах DEVICE_ID оруулна
DIM_TERMINAL_ID	Төхөөрөмжийн терминал дугаар	DIM_DEVICE_BRANCH table-ийн харгалзах TERMINAL_ID оруулна
DIM_MERCHANT_CODE	Мерчантайн төрөл	DIM_MERCHANT table-н харгалзах MERCHANT_CODE оруулна
DIM_ISSUED_CARD_ID	Банкны картын эзэмшилийн төрөл	DIM_ISSUED_CARD table-н харгалзах ISSUED_CARD_ID оруулна
DIM_CARD_SERVICE_ORG_ID	Картын төрөл	DIM_CARD_SERVICE_ORG table-н харгалзах CARD_SERVICE_ORG_ID оруулна
DIM_TRANSACTION_TYPE_ID	Картын дэд төрөл	DIM_CARD_TYPE table-н харгалзах CARD_TYPE_ID оруулна
DESCRIPTION	Гүйлгээний утга	Текст утгаар оруулна
IS_CASH	Бэлн мөнгөний гүйлгээ эсэх	1 = Тийм, 0 = Үгүй
IS_ORDERED_TRX	Захиалгат гүйлгээ эсэх	1 = Тийм, 0 = Үгүй
AMOUNT	Гүйлгээний дүн	Тоон утгаар оруулна
IS_CONFIRM	Хуучилт эсэх	Банкууд ИТРС кодыг зассан тохиолдолд 1 гэж дугаарлана. Өмнөх буруу утгатай гүйлгээг 0 болгож өөрчилнө.
MODIFIED_DATE	Өөрчилсөн өдөр, цаг, минут, секунд	YYYY-MM-DD HH:MM:SS форматаар байна. Гүйлгээний мэдээллийг зассан өдөр цагийг оруулна.

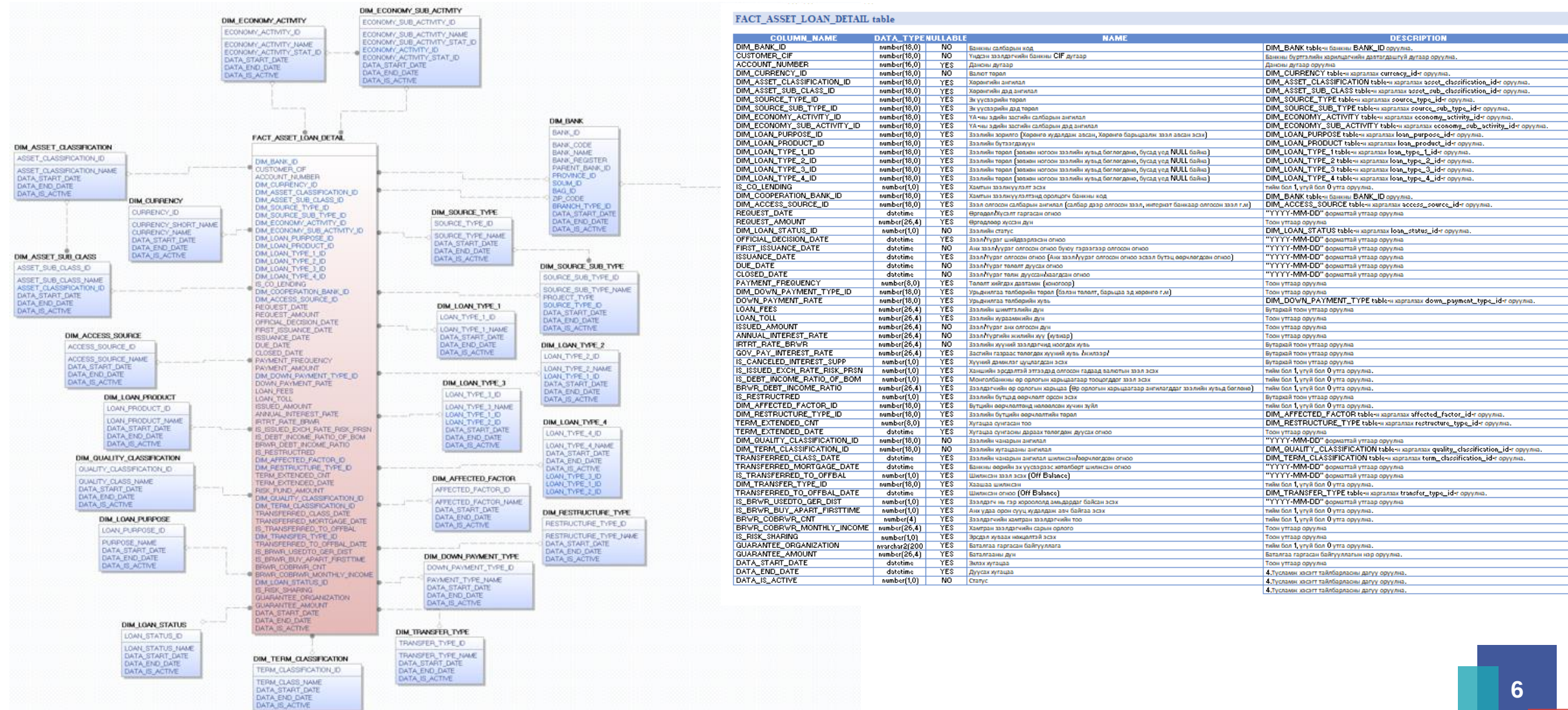
FACT PAYMENT QUANTITY table

Хөдөлгөөнт банкны хэрэглэгч, картын тоо болон Гэрээт хамтрагчдийн тоон мэдээллийг FACT_PAYMENT_QUANTITY table-руу оруулна.

COLUMN_NAME	NAME	DESCRIPTION
ASSOCIATED_YEAR	Тайлант жил	Сар бүр нэгдсэн тоогоор татах гул гухайн жилийн тоог оруулна
ASSOCIATED_MONTH	Тайлант сар	Сар бүр нэгдсэн тоогоор татах гул гухайн сарын тоог оруулна
DIM_BANK_ID	Банк, салбар	Хэрэглэгчийн бүртгүүлсэн салбар нэгж
DIM_PARTICIPANT_TYPE_ID	Оршогчидийн хандах төрөл	Карт, хөдөлгөөнт банк, гэрээт хамтрагч гэсэн ангилал бий
DIM_CARD_SERVICE_ORG_ID	Картын үйлчилгээ үзүүлэгчийн карт	DIM_CARD_SERVICE_ORG table-ийн CARD_SERVICE_ORG_ID оруулна
DIM_TRANSACTION_TYPE_ID	Картын төрөл	Зөвхөн картын хэрэглэгчийн тоон дээр нөхөгдөнө
DIM_CARD_ACC_TYPE_ID	Картын дэд төрөл	Зөвхөн картын хэрэглэгчийн тоон дээр нөхөгдөнө
DIM_ACCESS_SOURCE_ID	Хандалтын эх үүсвэр	Зөвхөн хөдөлгөөнт банкны ангилалын ID авч ашиглана
DIM_CUSTOMER_STATUS_ID	Нийт хэрэглэгчийн төлөв	Илэвхитэй, болон нийт, тайлант сард г.м ангилалыг оруулна
VOLUME	Тоо хэмжээ	Тоон утгаар оруулна

Asset Loan Balance

Data Acquisition Model



Cloudera

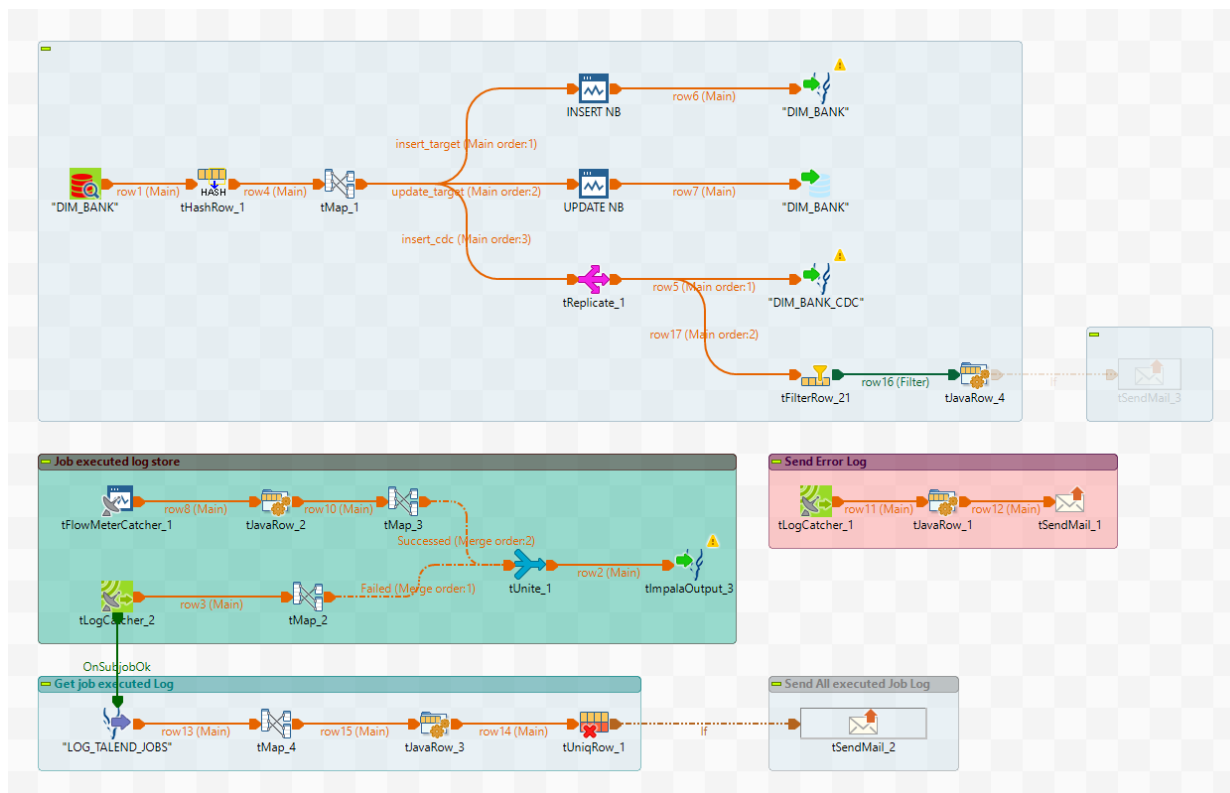
Bank of Mongolia's Big Data cluster includes more than 20 services and 8+ servers.

The screenshot displays the Apache Hue web interface. On the left is a vertical sidebar with a dark blue background containing icons and names for various services like Atlas, Core Configuration, Cruise Control, Data Analytics Studio, HBase, HDFS, Hive, Hive on Tez, Hue, Impala, Kafka, Kudu, Livy, Cloudera Management Services, Oozie, YARN Queue Manager, Ranger, Ranger KMS, Schema Registry, Solr, Spark, SQOOP_CLIENT, Streams Messaging Manager, Tez, YARN, Zeppelin, and ZooKeeper. The main area is divided into two panes. The top pane shows a search bar at the top right and a dropdown menu labeled 'fact_tables'. Below this is a list of tables under the heading 'Tables (42) + ↻', with a filter input field. The bottom pane is the SQL editor, titled 'DDL_FACT' with a subtitle 'Add a description...'. It contains SQL code for creating and dropping tables. The code includes comments and table definitions for 'DIM_INDIVIDUAL' and 'DIM_INDIVIDUAL_CDC'. At the bottom of the editor, there are tabs for 'Query History' and 'Saved Queries', each showing recent queries with timestamps.

Talend Big Data

Big data system of the Bank of Mongolia has installed the TAC with 4 servers and 10 cores.

The Big Data System



JOB CONDUCTOR

Refresh Add Duplicate Deploy Run Kill
Enable auto refresh Delete Pause task(s) Resume task(s) Recover last execution Show

State	Status	Error status	Label	Trigg...	Actions	Time left ...	Last run	Project
Project: BOM (6 items)								
Ready to run			SERV1-KERBEROS-AU...			4h 49min ~	2022-11-23 08:5...	BOM
Ready to run			SERV2-KERBEROS-AU...			4h 42min ~	2022-11-23 08:5...	BOM
Ready to run	Connection t...		SERV3-KERBEROS-AU...				2022-11-20 16:3...	BOM
Ready to run	Connection t...		SERV4-KERBEROS-AU...				2022-11-19 16:5...	BOM
Ready to depl...			AB_DIM_ACCESS_SOU...				2022-11-18 16:5...	BOM
Ready to run			DIM_AB_ALL					BOM

Page 1 of 1 10

Triggers Context parameters JVM parameters

Refresh Add trigger... Duplicate Delete Pause trigger Resume trigger

Label	Type	Status	Previous trig...	Time left befo...	Next triggerin...	Next Triggeri...	Number of t
Add a CRON-based trigger							

Dynamic Form

Оюунтолгойн сарын мэдээ (OT)

Нэр:

Тайлант огноо: 1

Хайх

Гадаад дах дансны мэдээлэл

I. Хаягийн хэсэг

II. Үндсэн хэсэг

Экспортын үзүүлэлт

Гадаад дах дансны мэдээлэл

Худалдааны зээл /Экспорт/

	A	B	C	D
1	2.	Гадаад дахь данс /бэлэн мөнгө, харилцах/	Мөнгөн дүн (ман. ам доллар)	
2	2.1	Тайлант хугацааны эхний үлдэгдэл		
3	2.2	Дансны орлого		
4		Эдийн засгийн харьяат бусаас		
5		Хувьцаат капиталд оруулсан хөрөнгө оруулалт		
6		Хөрөнгө оруулагчаас авсан зээл		
7		Монголын банкин дэх өөрийн данснаас зузаатгал		
8		Экспортын орлого (зардлын нөхөн төлбөр)		
9		Экспортын урьдчилгаа		
10		Гадаадаас авсан зээл		
11		Бусад		
12		Эдийн засгийн харьяатаас		
13		Үйлчилгээний төлбөр		
14		Бараа бүтээгдүүний төлбөр		
15		Бусад		
16	2.3	Дансны зарлага		
17		Эдийн засгийн харьяат бус руу		
18		Импортын төлбөр (барааны)		
19		Импортын төлбөр (цахилгааны)		
20		Үйлчилгээний төлбөр		
21		Хөрөнгө оруулагчаас авсан зээлийн төлбөр		
22		Гадаадаас авсан зээл, түүний хүүгийн төлбөр		
23		Бусад		
24		Эдийн засгийн харьяат руу		
25		Монголын банкин дэх өөрийн данс руу зузаатгал		
26		Үйлчилгээний төлбөр		
27		Бараа бүтээгдүүний төлбөр		
28		Бусад		
29	2.4	Тайлант хугацааны эцсийн үлдэгдэл		

The Big Data System

СУДАЛГАА

Аж ахуй нэгжийн үзүүлэлт /Төлбөрийн тэнцэлийн мэдээ/ (BOP)

2022-11-032022-11-08

1Эхлээгүй

2Үргэлжилж байгаа

0Дууссан

3Үйл ажиллагаа явуулж байгаа

00000000

Хайлтыг цэвэрлэх

Дугаар	Нэр	ISIC	Үйл ажиллагааны төрөл	Аймаг/Хот	Сум/Дүүрэг	Мэргэжилтэн	Эхлэх	Дуусах	Үйл ажиллагаа явуулж байг	Мэдээний төлөв	Үйлдэл
2075377	Голомт банк	6419	Мөнгөний зуучлалын бусад үйл ажиллагаа	Улаанбаатар	Чингэлтэй	S.Sudlaach1, Судлаач	2022-11-03	2022-11-08	Үйл ажиллагаа явуулж байгаа	Үргэлжилж байгаа	
2693321	ХААН банк	6419	Мөнгөний зуучлалын бусад үйл ажиллагаа	Улаанбаатар	Сүхбаатар	S.Sudlaach1, Судлаач	2022-11-03	2022-11-08	Үйл ажиллагаа явуулж байгаа	Үргэлжилж байгаа	
2578697	ХАС банк төв	6419	Мөнгөний зуучлалын бусад үйл ажиллагаа	Улаанбаатар	Сүхбаатар	S.Sudlaach1, Судлаач	2022-11-03	2022-11-08	Үйл ажиллагаа явуулж байгаа	Эхлээгүй	

"Dynamic Form" List of Reports	
No	Report Name
1	Monthly Sales and Transportation Data of Coal Exporting Mongolian Enterprises (MST)
2	Foreign Trade Statistics (FTS)
3	Oyun Tolgoi Monthly Export Forecast (OME)
4	Mortgage Bonds Held by the Bank of Mongolia (MBH)
5	Foreign and Domestic Ownership Concentration Survey (FDO)
6	Oyun Tolgoi Monthly News (OT)
7	Balance of Payments (BOP)
8	E-Money Report (E-MR)
9	Settlement Representative Report (SRR)
10	Mongolian Embassy's Abroad Expenditure Report (MEAER)
11	Diplomatic Mission Expenditure Report (DMEP)
12	State Budget News (SBN)
13	Cross-Border Passenger Survey (CPS)
14	Payment Card Clearing Report (PCCR)
15	Correspondent Bank News (CBN)

