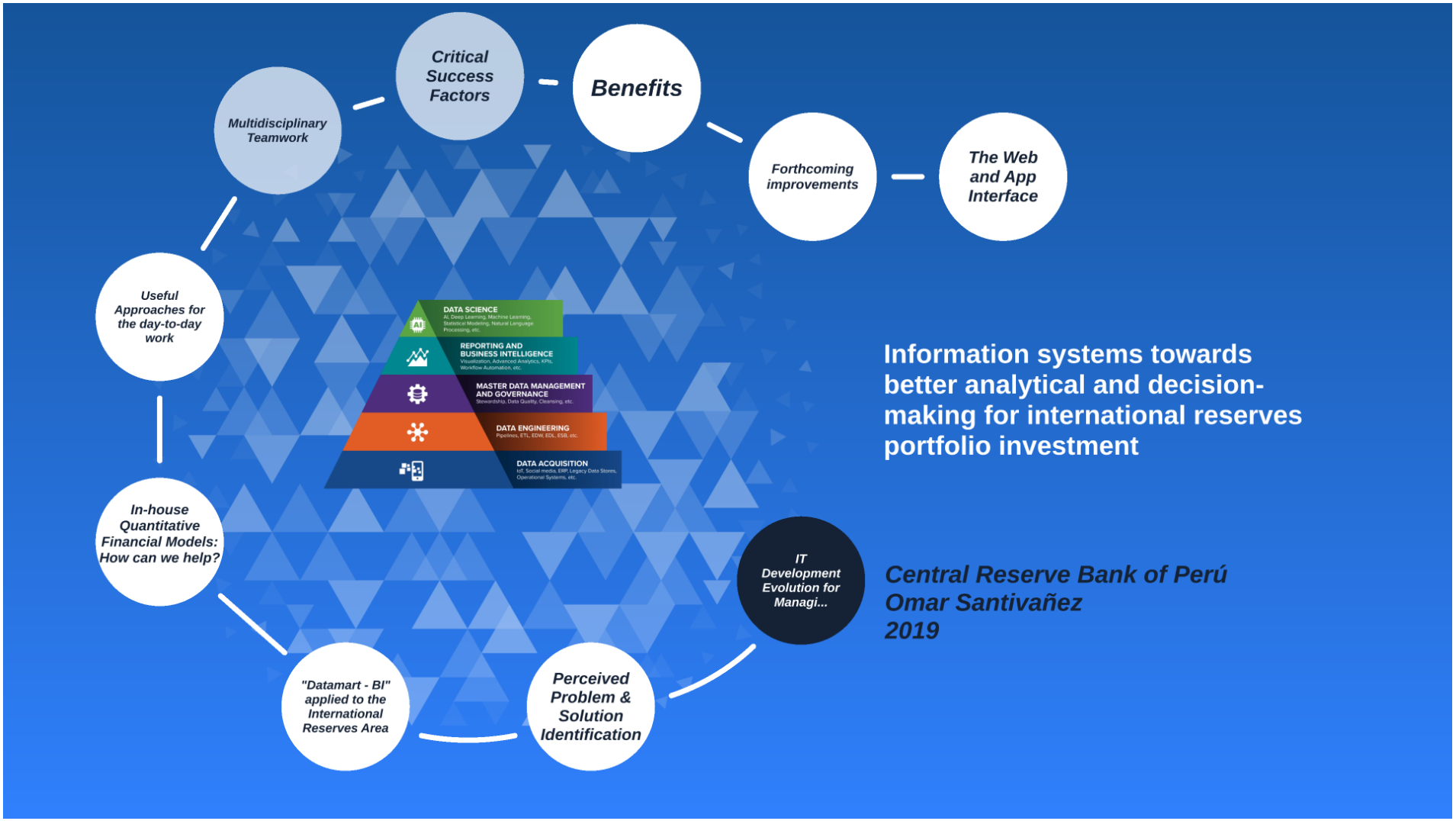
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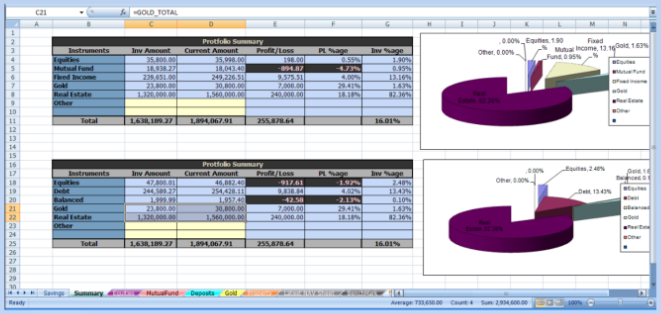
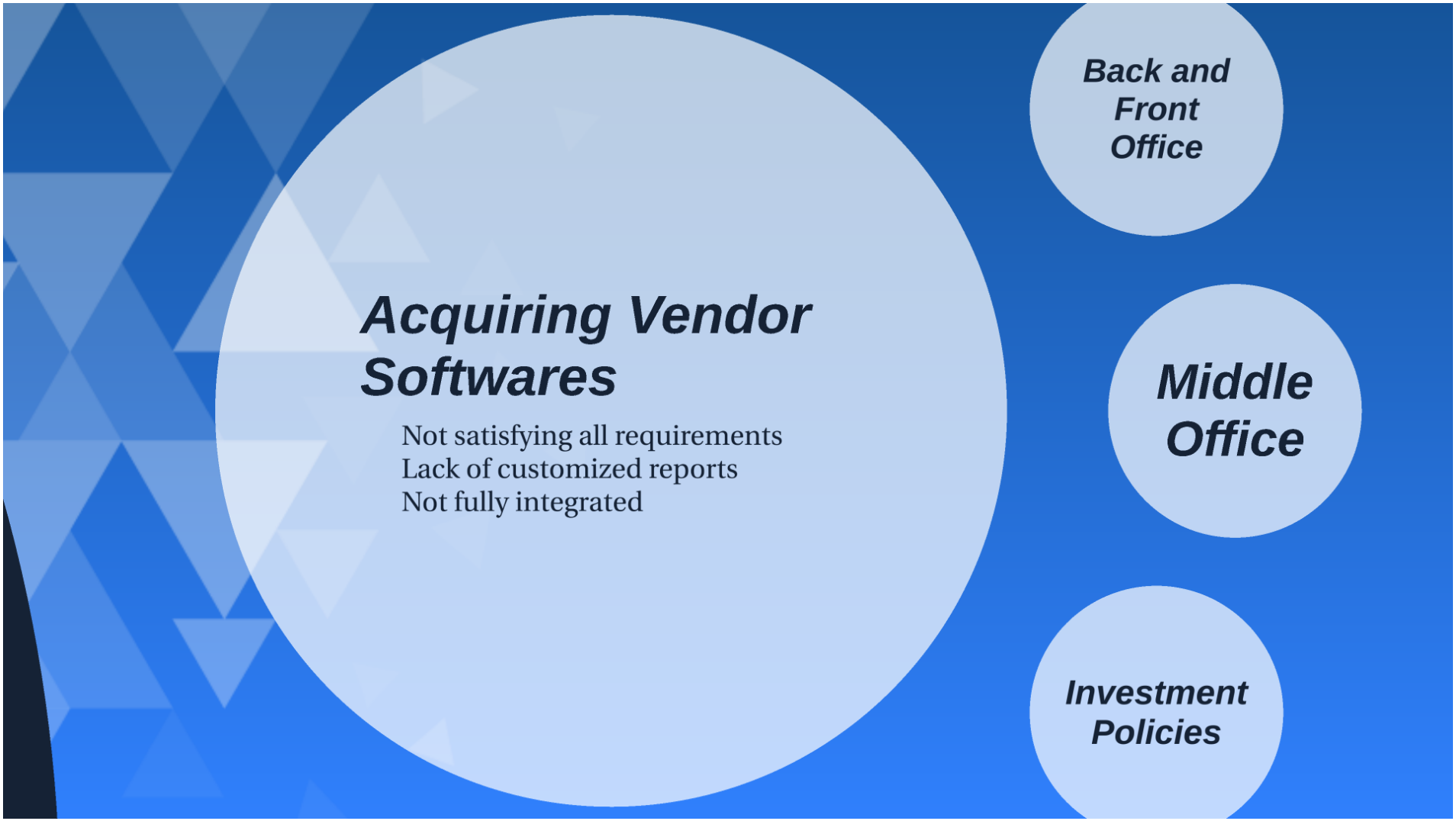
IT Development Evolution for Managing International Reserves
Excel Spreadsheets
Acquiring Vendor Softwares
IT Area Client - Server Developments
Complementing IT Developments with our o...

Excel Spreadsheets

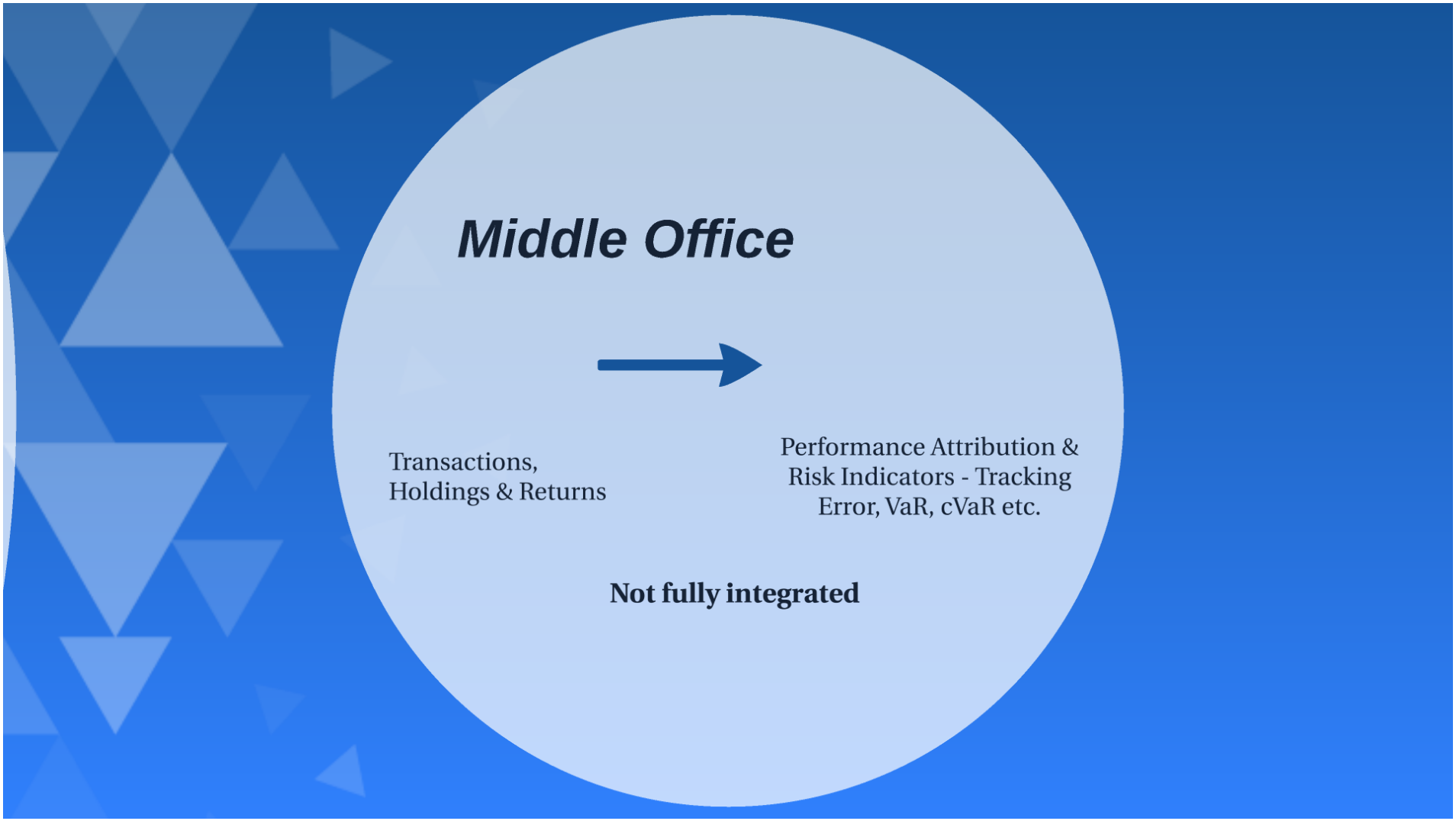
Too many formulas...
Building time series it's not easy...
Large Excel files crashing




Acquiring Vendor Softwares
Not satisfying all requirements
Lack of customized reports
Not fully integrated
Back and Front Office
Middle Office
Investment Policies

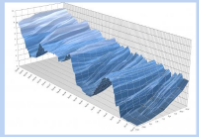
Back and Front Office

Not satisfying all reports requirements
Lack of key return and risk indicators
No native module for portfolio limits (enhancements)


Middle Office
Transactions,
Holdings & Returns
Performance Attribution &
Risk Indicators - Tracking
Error, VaR, cVaR etc.
Not fully integrated

Investment Policies

Internal Models for Yield Curves,
Asset Allocation, Risk Indicators, etc.,
in MatLab, @Risk, CrystalBall



- Gathering a large amount of data semi-manually.
- Saving output in spreadsheets.

IT Area Client - Server Developments

- Tailored Applications Power Builder and SQL - Oracle Databases.
- **Maintenance in charge of IT area.**
- New customized reports mean asking IT for new developments.

Trade Thru Transactions

Accounting Balances

Abacus Returns

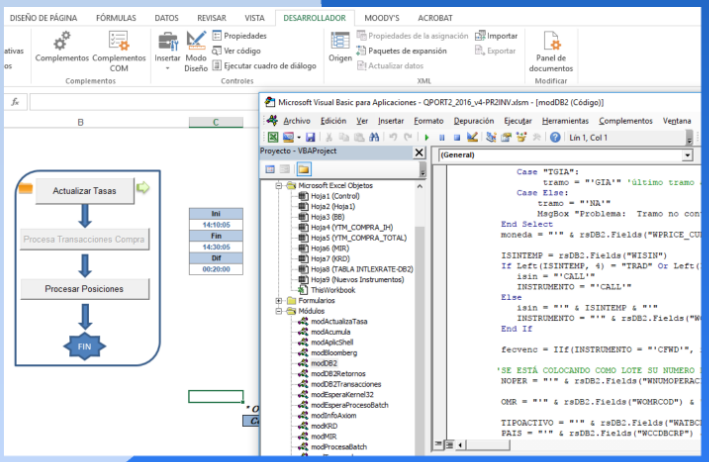
SWIFT Messages

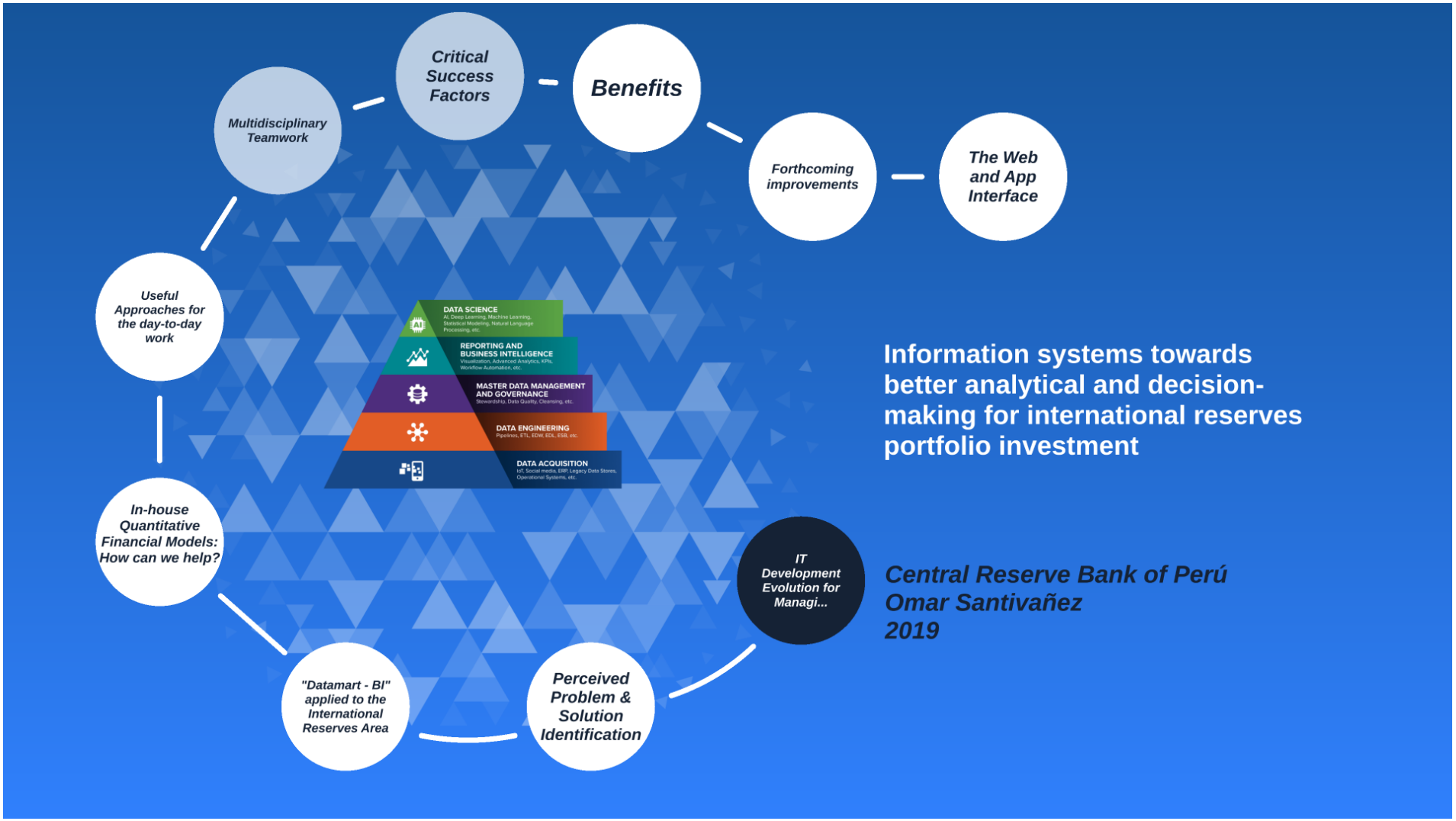
Risk Indicators

Information Islands

Complementing IT Developments with our own VBA Apps

- Extracting data from several sources with automatic procedures.
- Attempt to integrate heterogeneous data.
- Autonomy vs. programmer dependency.

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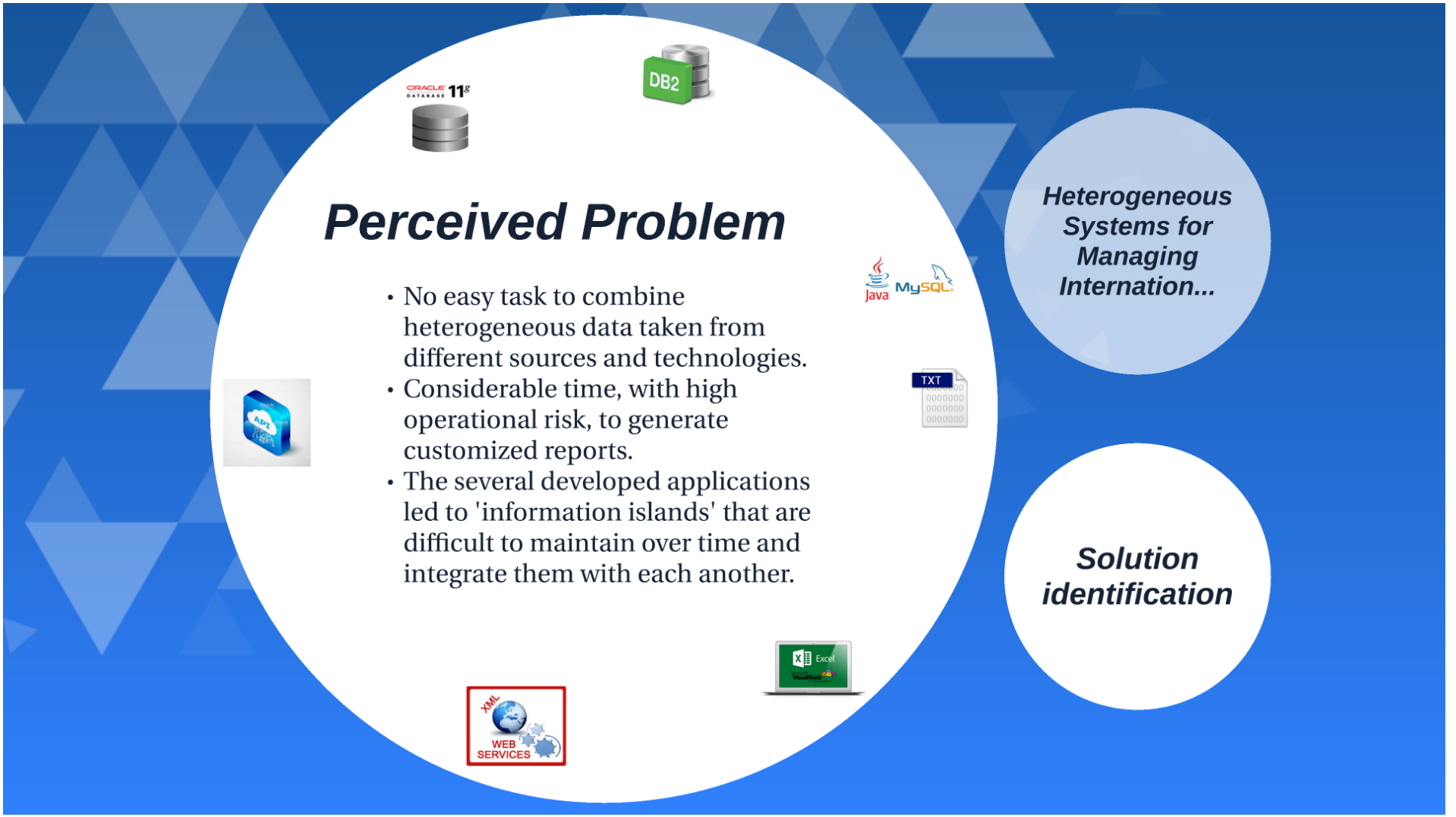
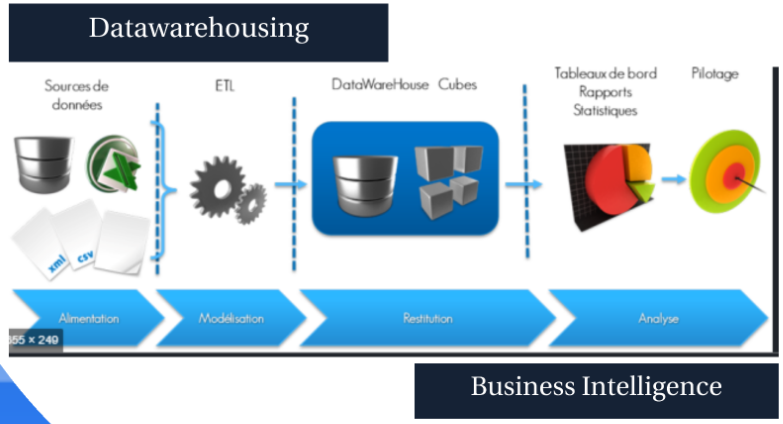

Perceived Problem
• No easy task to combine heterogeneous data taken from different sources and technologies.
• Considerable time, with high operational risk, to generate customized reports.
• The several developed applications led to 'information islands' that are difficult to maintain over time and integrate them with each another.
Heterogeneous Systems for Managing Internation...
Solution identification
DB2
Java
MySQL
TXT
Excel
XML
WEB SERVICES

Heterogeneous Systems for Managing International Reserves

Solution identification

Creation of a Centralized Database ('Datamart')
and a Business Intelligence System (BI) oriented to the multidimensional query of historical information for tactical / strategic decision making in the process of efficient management of International Reserves.

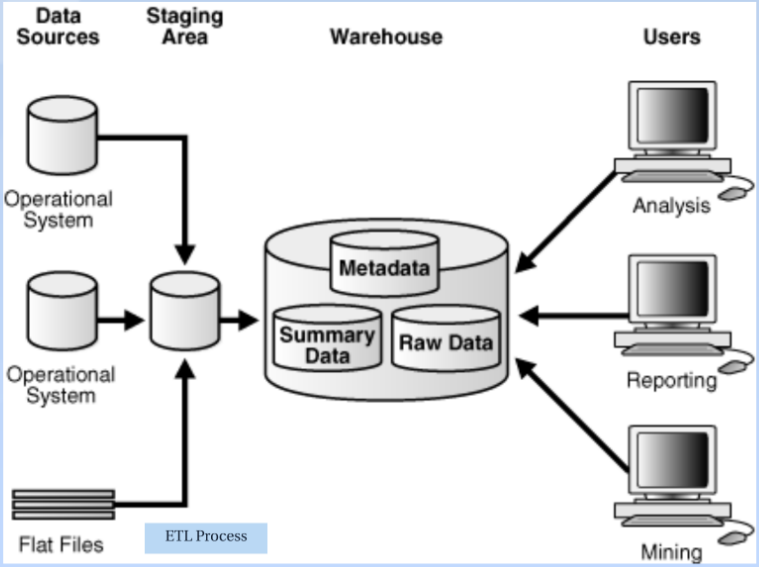


DATAMART

Business Intelligence System

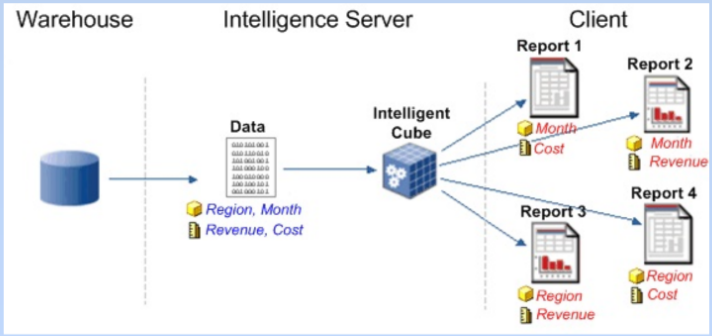
DATAMART

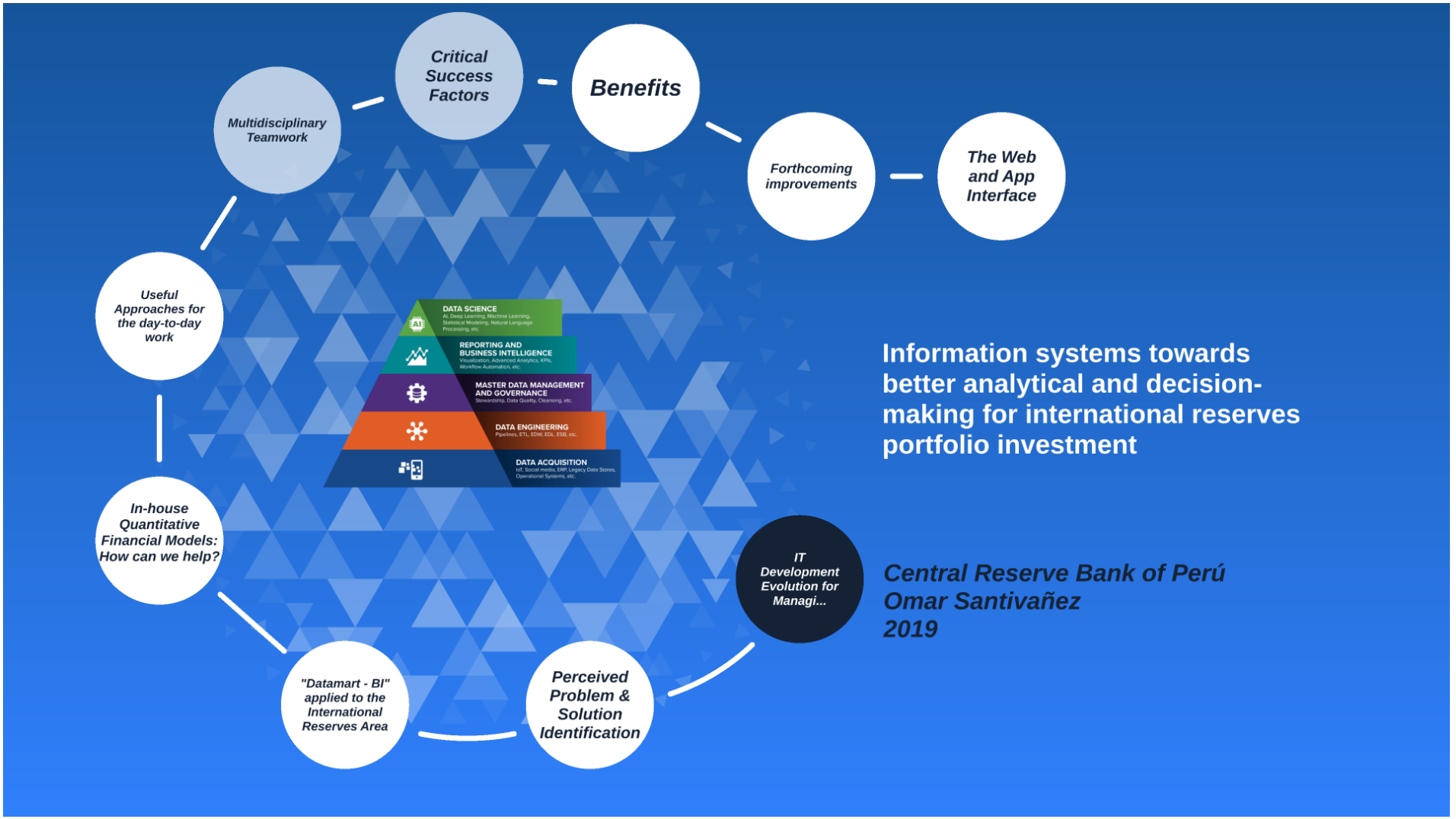
- A centralized database where mixed information is stored from around 12 heterogeneous information sources (1300 variables).
- Historical information since December 2007 which is updated daily and in some cases in nearly real-time.



Business Intelligence System

- Allows the **multidimensional exploitation** of the information stored in the Datamart through the creation of customized reports and dashboards without deep knowledge of a programming query language.
- **No classic IT dependency** for creating and modifying reports.
- The exploitation of the information is through thematic **ROLAP cubes**. ROLAP cubes are cubes whose data is gotten directly from the source database and is not kept in the cube.

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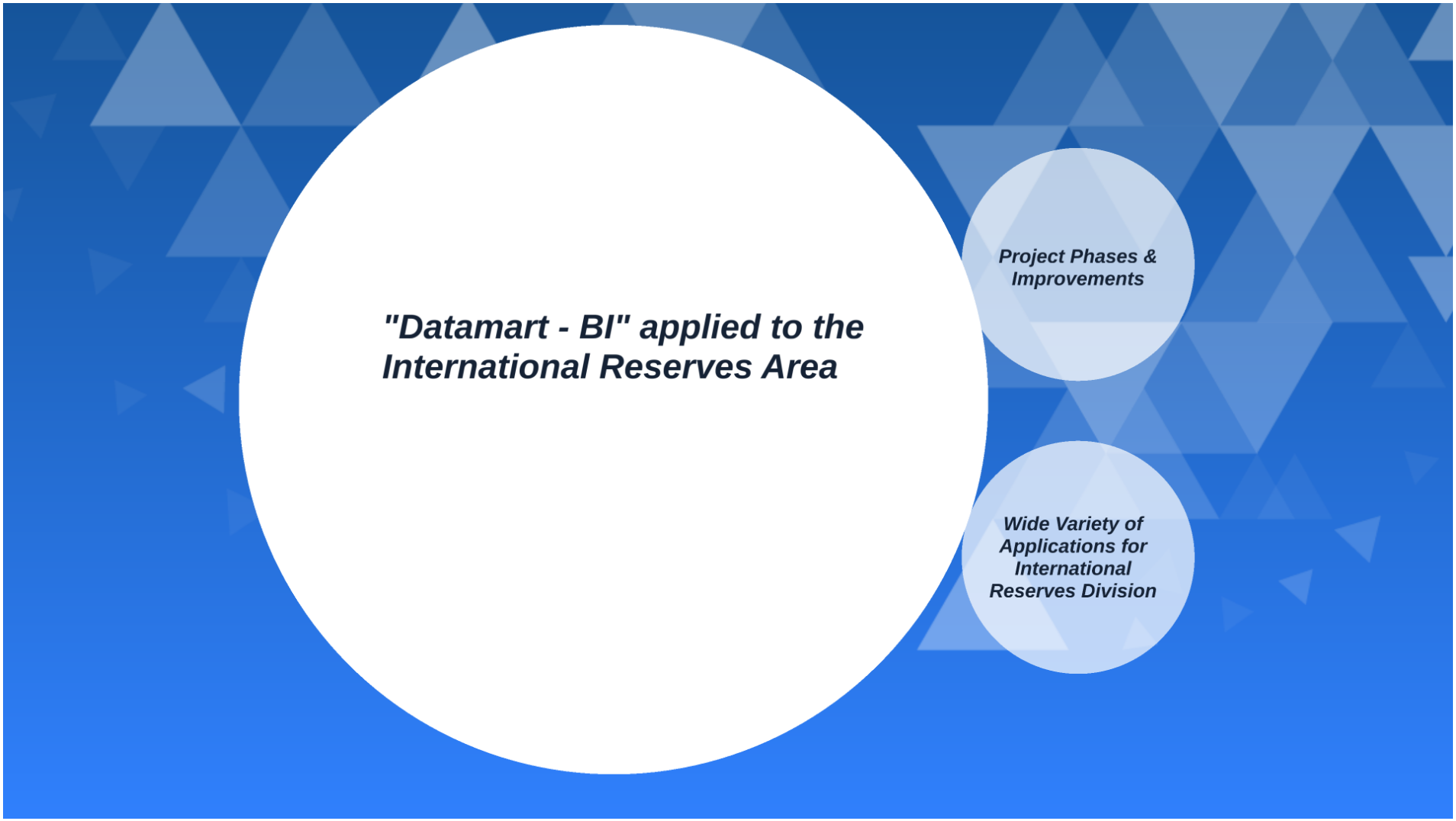

"Datamart - BI" applied to the International Reserves Area
Project Phases & Improvements
Wide Variety of Applications for International Reserves Division

Phases & Improvements

- ***2013 - "Start from Scratch"***: Data Extraction and Load Procedures, BI Database Modeling and Development, Building **Dashboards and Reports in Web and Mobile App.**
- ***2015 - "Enhacements":*** covering and adapting more data sources, building more Dashboards & Reports, defining Alerts & notifications.
- ***2018 - "Senior Management Dashboard"*** **& "Geovisualization":** more Strategic, Tactical and Operational BI Dashboards. Maps Visualization.
- **2020: "Business Analytics Capabilities" - "SaaS/APIs"**:
  - Adding BA to the BI Solution: "**R Language**"
  - Adequacy to more External Data
  - Exploring **Big Data capability connections**.

ODI

ORACLE DATA INTEGRATOR

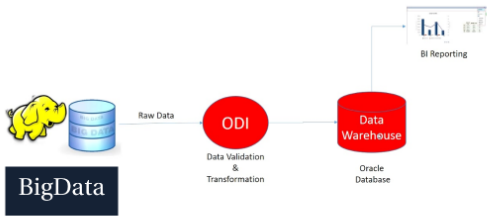
Oracle Database 12c

12c

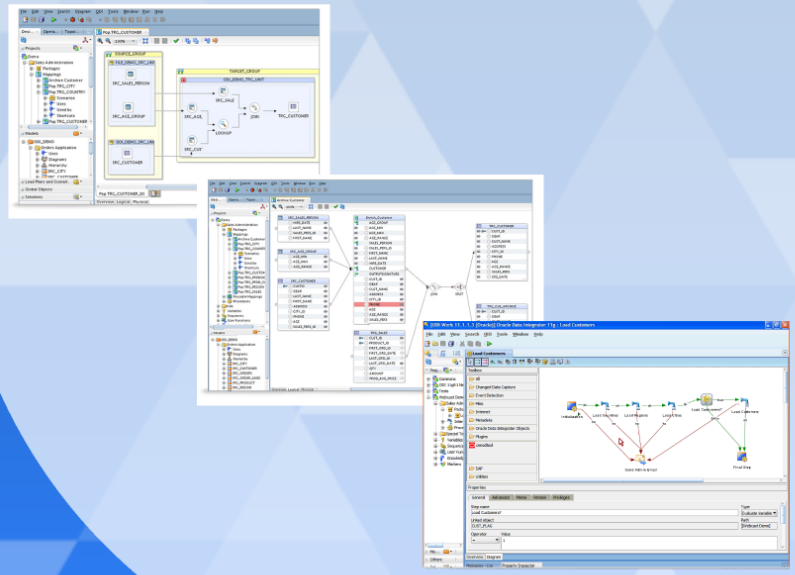
OBI

ORACLE BUSINESS INTELLIGENCE

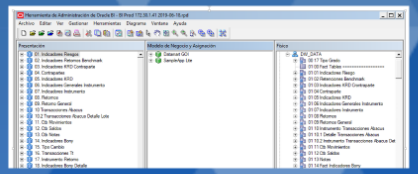
Geovisualization



Oracle Data Integrator (ODI)



Oracle Database 12c

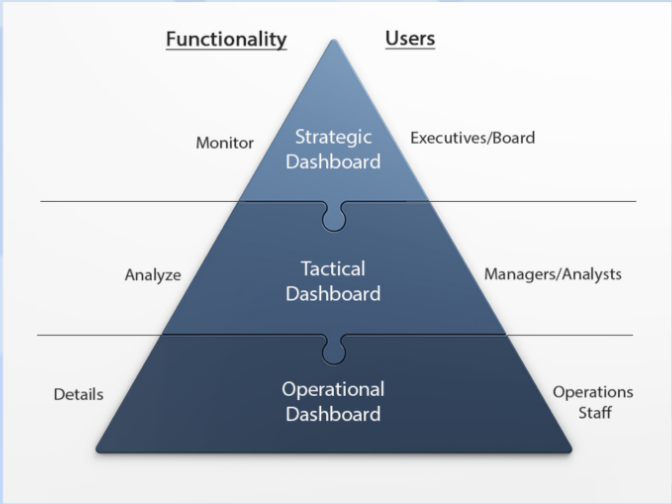


Oracle Business Intelligence (OBI)

Source: Oracle

Overview

Wide Variety of Applications for International Reserves Division



- *Investments Reports*
- *Executive Dashboards*
- *On-Demand Reports & Researches*
- *Audit Requirements*
- *External Manager Monitoring*
- *Security Lending Program*

Investments Reports

- Content
  - Transactions,Holdings & Returns (M-Mkt, Fixed Income, Forex Swaps)
  - Performance & Risk Monitoring: Returns, Stress Scenarios, VaR, cVaR, Tracking Error.
  - Limits
  - International Financial Information (USA / Eurozone, etc.)
- Uses
  - Weekly Report, Annual Report, Investments Committee
- The same information is also available daily. In some cases nearly real-time.

Executive Dashboard

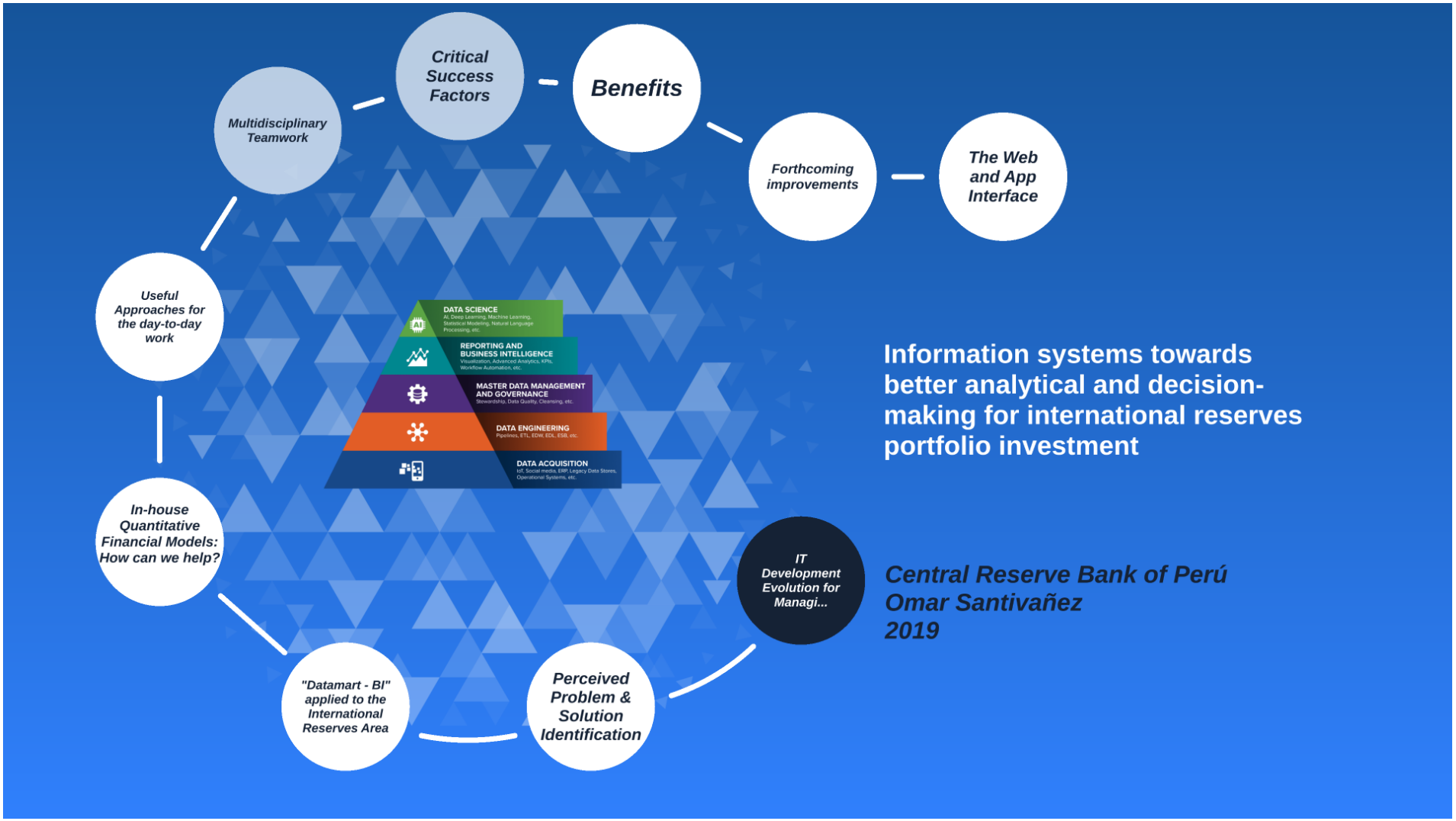
On-Demand Reports & Researches

- Historical “pick up” above LIBOR of our Arbitrage Transactions (Fx Swaps)
- Benchmark Adequacy from Historical Positions (Liquidity Branch) vs LIBOR
- Implied Ratings Accuracy to forecast Long Term Ratings
- Security Lending Performance Research
- Customized Historical Positions, Durations & Returns Requirements
- etc...

Audit Requirements

External Manager Monitoring

Security Lending Program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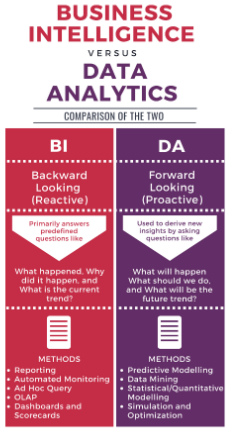
Extending the value of BI through Analytics

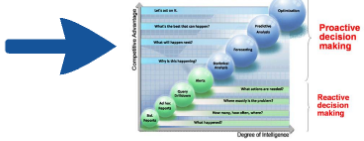


Intelligence vs. Analytics

Traditional BI
- Standard reports and dashboards
- Ad hoc reports – Current performance
- Query Drill down
- Cube analysis – Slice and dice
- Alerts

Vs.

Business Analytics
- Statistical Analysis
- Forecasting
- Predictive modeling
- Optimization



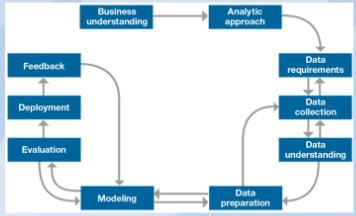
Legacy Models developed in MatLab

Incremental Developing of Legacy Models in R & Python

Exploring Native Oracle BI Capabilities for Analytics

Adding Analytics to the BI Solution: "R" Language

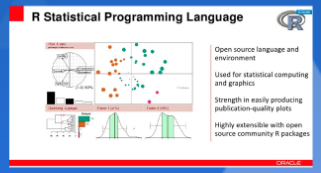
Legacy Models in MatLab

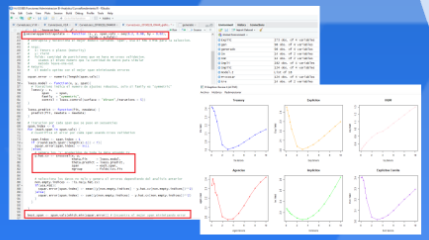


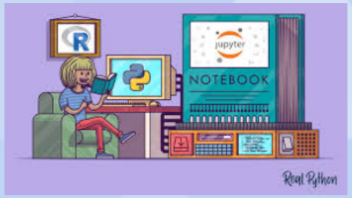
- **Pros:**
  - Main developed models:
    - Yield Curve Construction
    - Yield Curve Prediction
    - Fx Risk Neutral Distribution
    - Robust Portfolio Optimization
  - **Proven model stability for years**
  - Robust models
  - **IT independence for quick models enhancements**
- **Cons:**
  - **Not easy task to collect data in a organized manner** (csv, Excel). Too much code for "Data Collection" & "Data Preparation"
  - Code Execution in Desktop Environment (**CPU & RAM memory limitations**)
  - **Operational risk** when running every time
  - High dependency of the programmer for modifying
  - L**ack of Data Management** & Data Governance
  - **Excel/csv Output File System Storage**

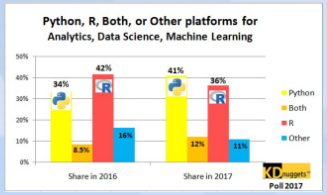
Incremental Developing of Legacy Models in R & Python

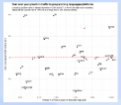
- Legacy Models Replication: trial and error approach
- Using scalable on-the-cloud Languages: **"R" & "Python"**
- **Why R Programming?** Oracle BI native capability
- **Why Python Programming?** Better to be prepared







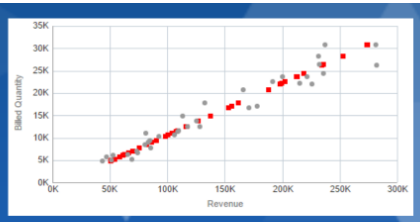




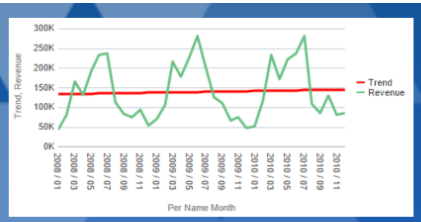
Bloomberg

Enabling R in Oracle BI 12c

- OBI 12c comes with 4 embedded R functions: Regression, TrendLine, Outliers and Cluster.
- **Possible to invoke own custom R Scripts (EVALUATE SCRIPT)**

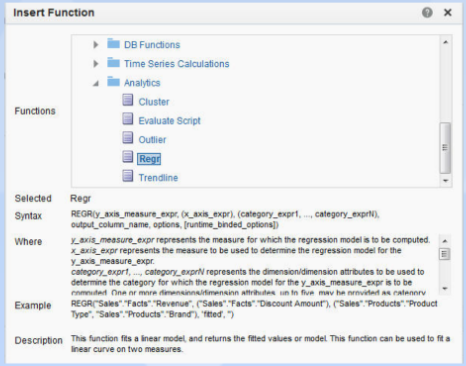


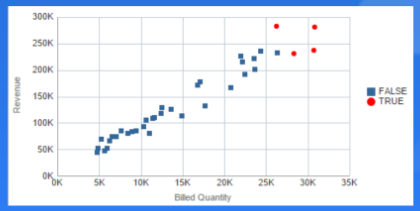
Regression



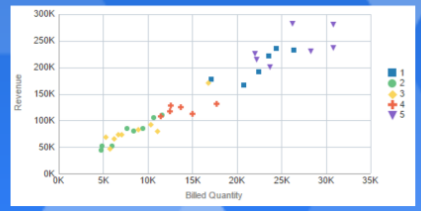
TrendLine

Own R Scripts





Outlier



Cluster

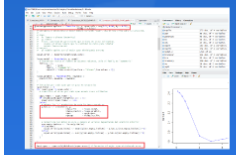
Analytics in the BI Solution using "R" Language

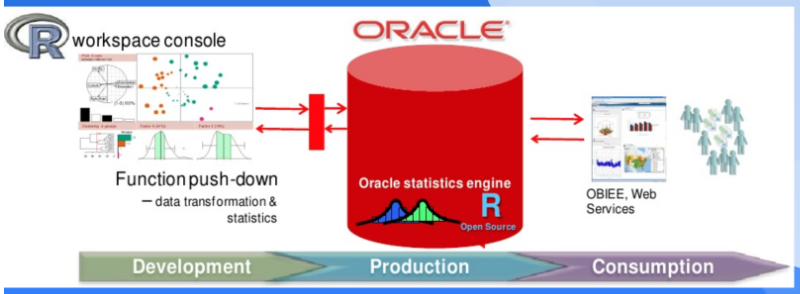
- **BI Execution Approach**
  - Parametrized Proven Models in Batch Mode (daily process)
  - On-The-Fly: Interactive What-if Dashboards
- **Taking advantage of the On-Premise Server in Data Center**
  - Sun Oracle Exalytics Appliance (Server): 72 cores and 2 TB memory = 2000 GB RAM

2TB memory = 2000 GB

Exalytics Server X5-4

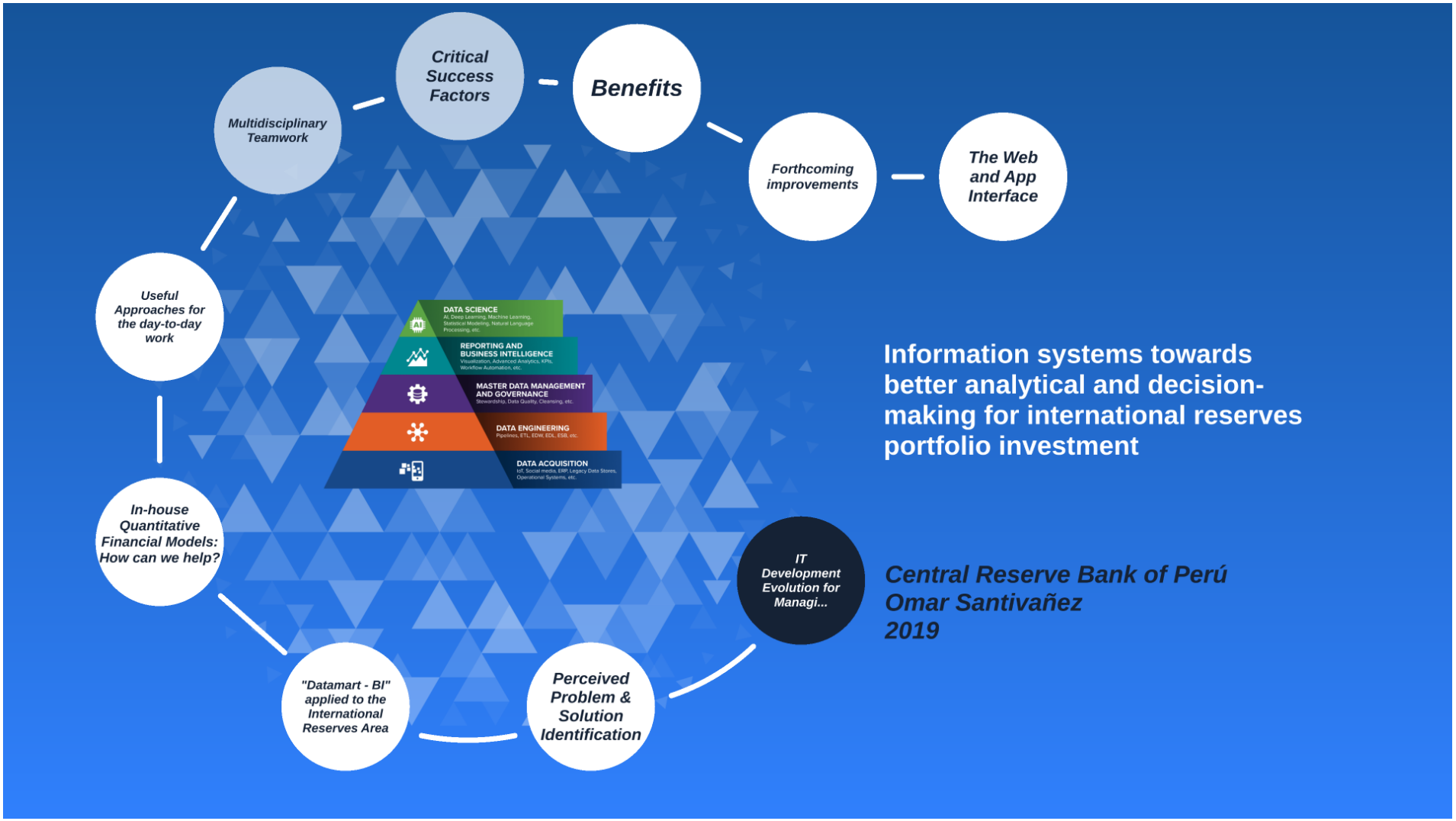
Processor	4 INTEL XEON - 72 Cores
Memory	2TB
Flash	4.8TB





Batch Mode (request data from pre-parametrized models which had run the night before)

On-the-fly Mode (running models at the moment of request considering customized parameters)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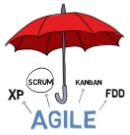
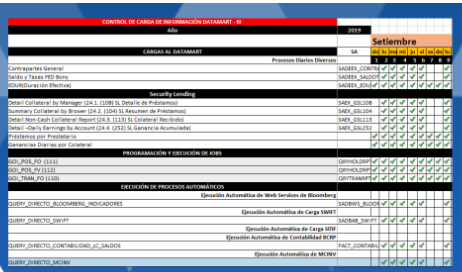
Data Governance

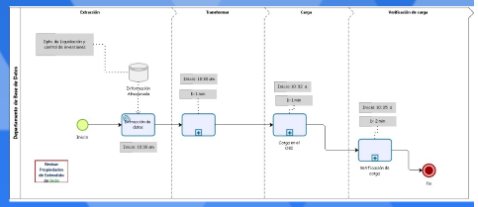
- **Data Management - Data Governance**
- **Agile Methodologies**
- Business Process Management - BPM
- Operational Risk Management



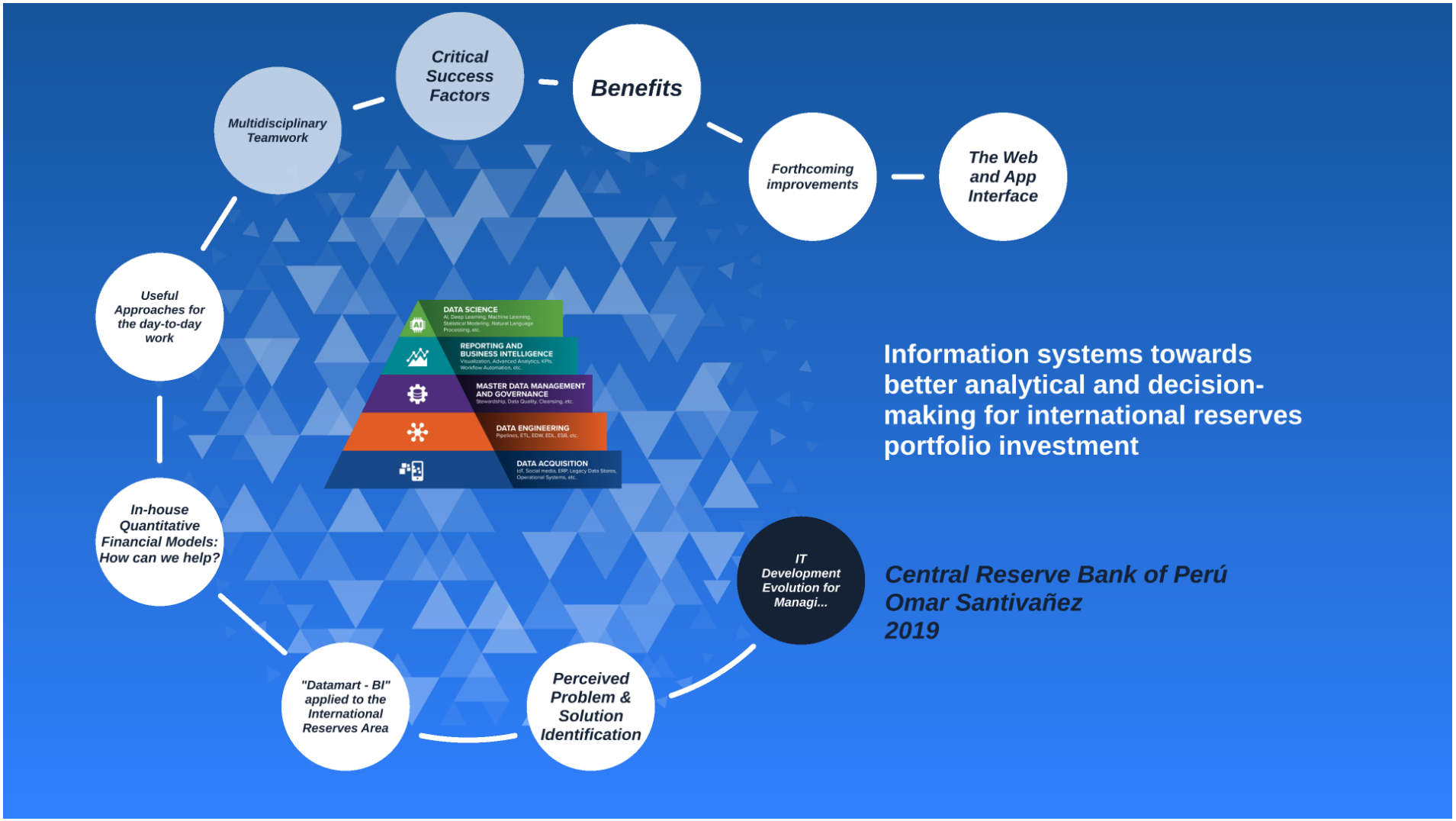
Data Governance: a process for managing and improving data for the benefit of all stakeholders.



Incidental Database



Business Process Management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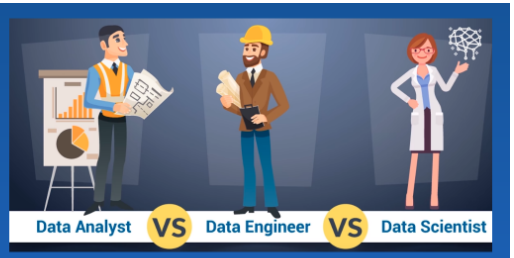
Technical skills

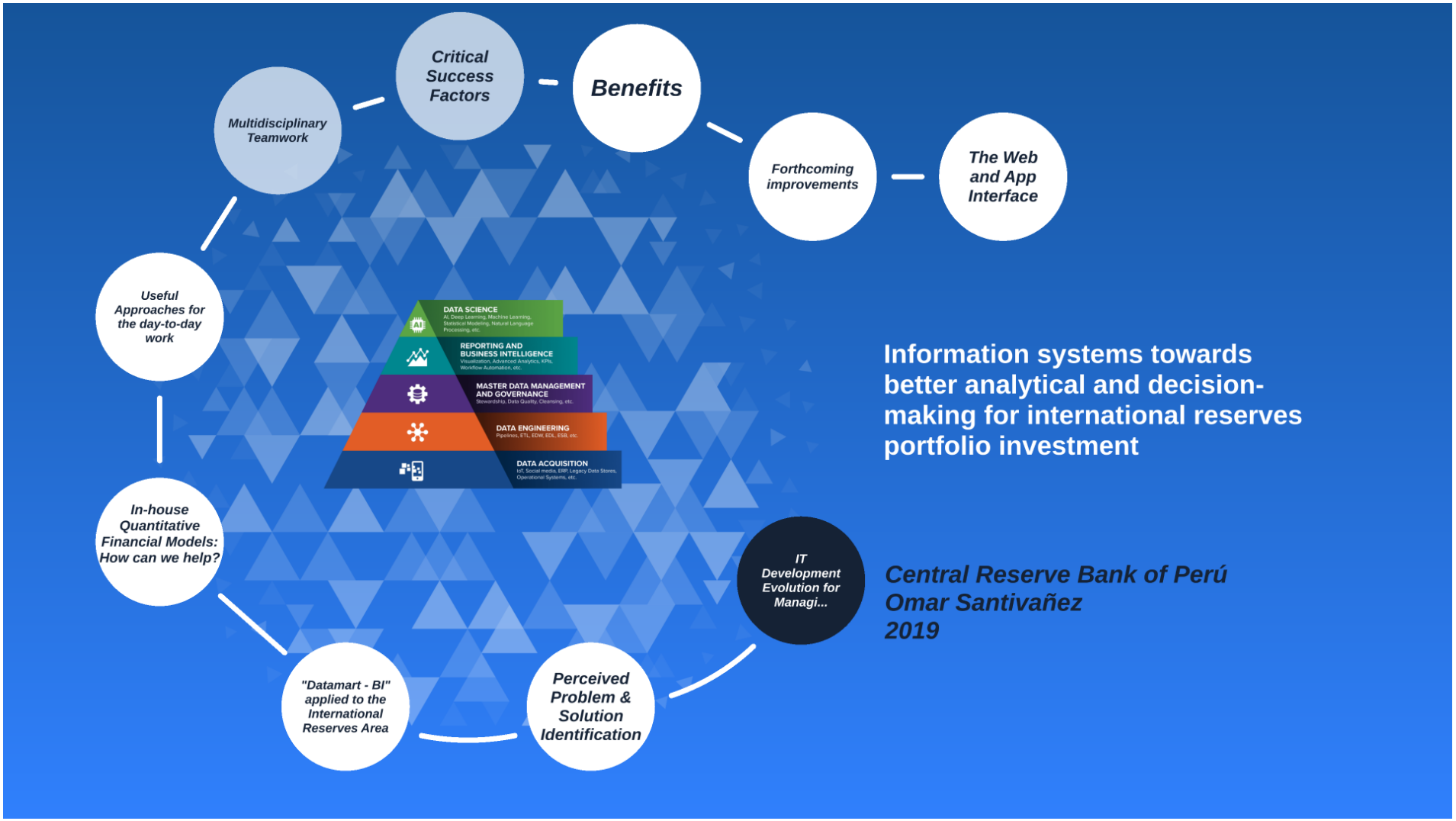
- Knowldege in:
  - Finance & Investments (basic understanding)
  - Project Management & Agile Methodologies
  - BPM (Business Process Management)
  - Programming Languages (Visual Basic, PL-SQL)
  - Operating Systems (Windows Batch, Linux)
  - Databases (SQL, Oracle, DB2, Mysql)
  - Business Intelligence & Datawarehouse Technologies
  - Scientific Popular Languages (R, Python)
- Profiles:
  - Data Analyst / Business Analyst
  - Data Engineering
  - Data Scientist
  - Business Process Management Specialist



IT Area

International Reserves Database Area

Internships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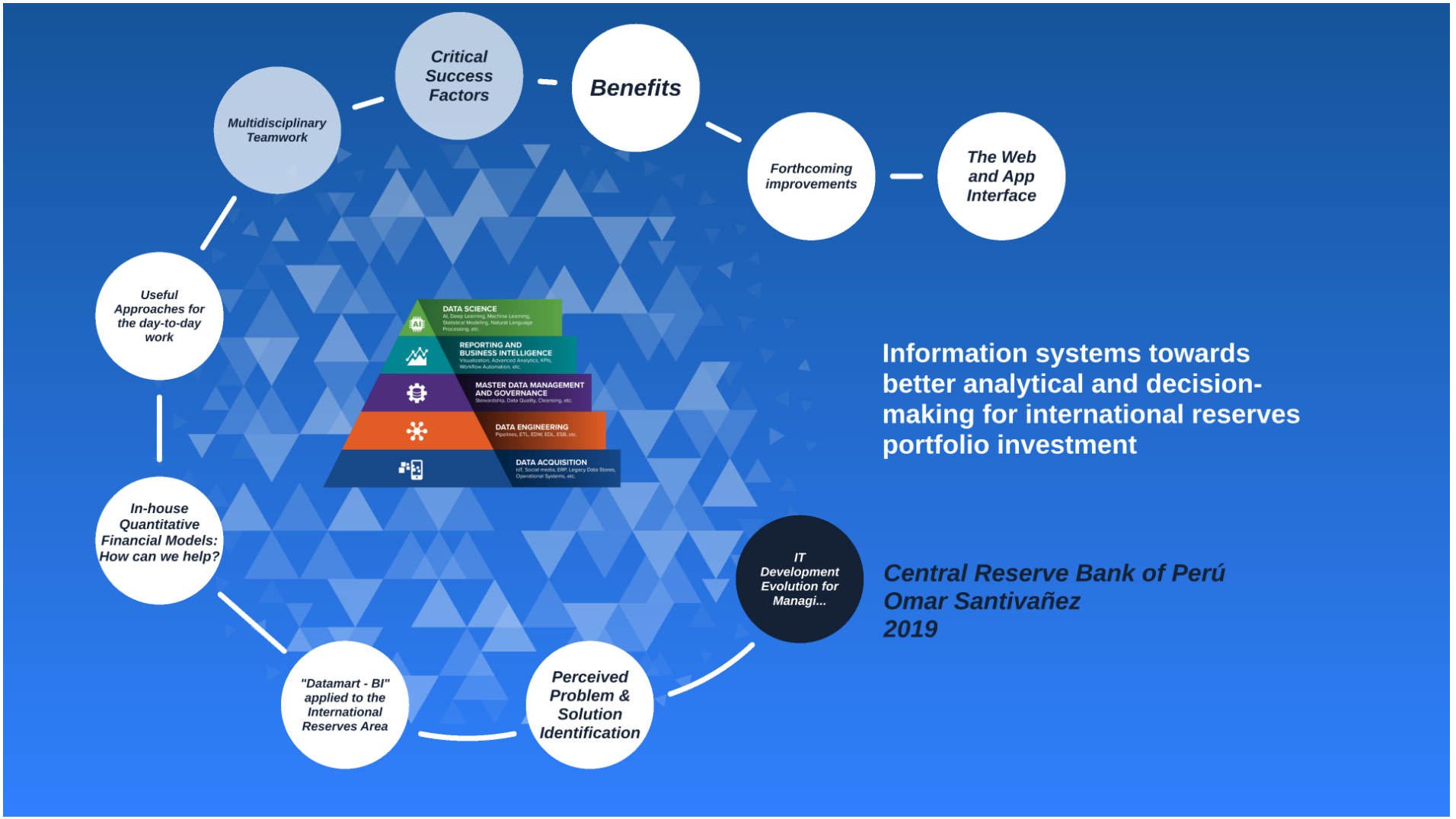
Critical Success Factors

- **Each Project Phase**
  - **Senior Management Support**
  - User area commitment for every crucial project phase
  - IT area commitment
  - **Realistic scope delimitation** (Sources, Variables and Data)
- **Daily BI Activities and Continuous Improvement**
  - **"Data Management" & "Data Governance"**
  - Operational Risk Management (Risk Assessment and Controls, Incidents Database, etc.)
  - Being Agnostic with Technologies and Languages
  - **Adopting Agile Methodologies.**
  - **Quick IT Area Response and Support for incidental issues.**

- **Team with multidisciplinary background (Portfolio & Risk Management, Financial Markets, Accounting and IT [databases, programming, networks, etc]).**
- **Incorporating a new Profile: "Data Scientist"**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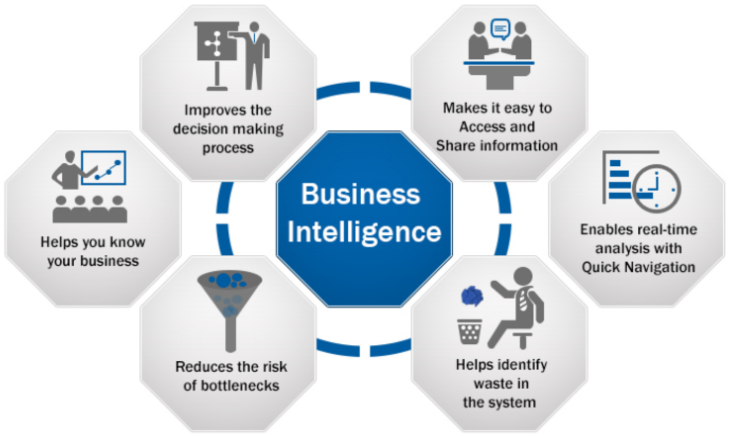
Benefits



- Information Availability in Time
- Access to a Central Repository of Information
- Friendly construction of Reports and dashboards
- New ways of information requests
- Rethinking...
- Decision Making Process
- Operational Risk Mitigation
- Web & Apps (Mobile)

Information Availability in Time

- Availability of a large amount of information in a timely manner.
- Response time improvement for inquires about the management of reserves.

Access to a Central Repository of Information

Friendly construction of Reports and dashboards

Construction of reports and dashboards in a flexible, simple and adapted to the needs of each user.

New ways of information requests

Great capacity to exploit information previously not allowed (information combined, consolidated and allowing access to the highest level of detail).

Rethinking...

Rethinking and improvement of procedures, methodologies and calculations.

Decision Making Process

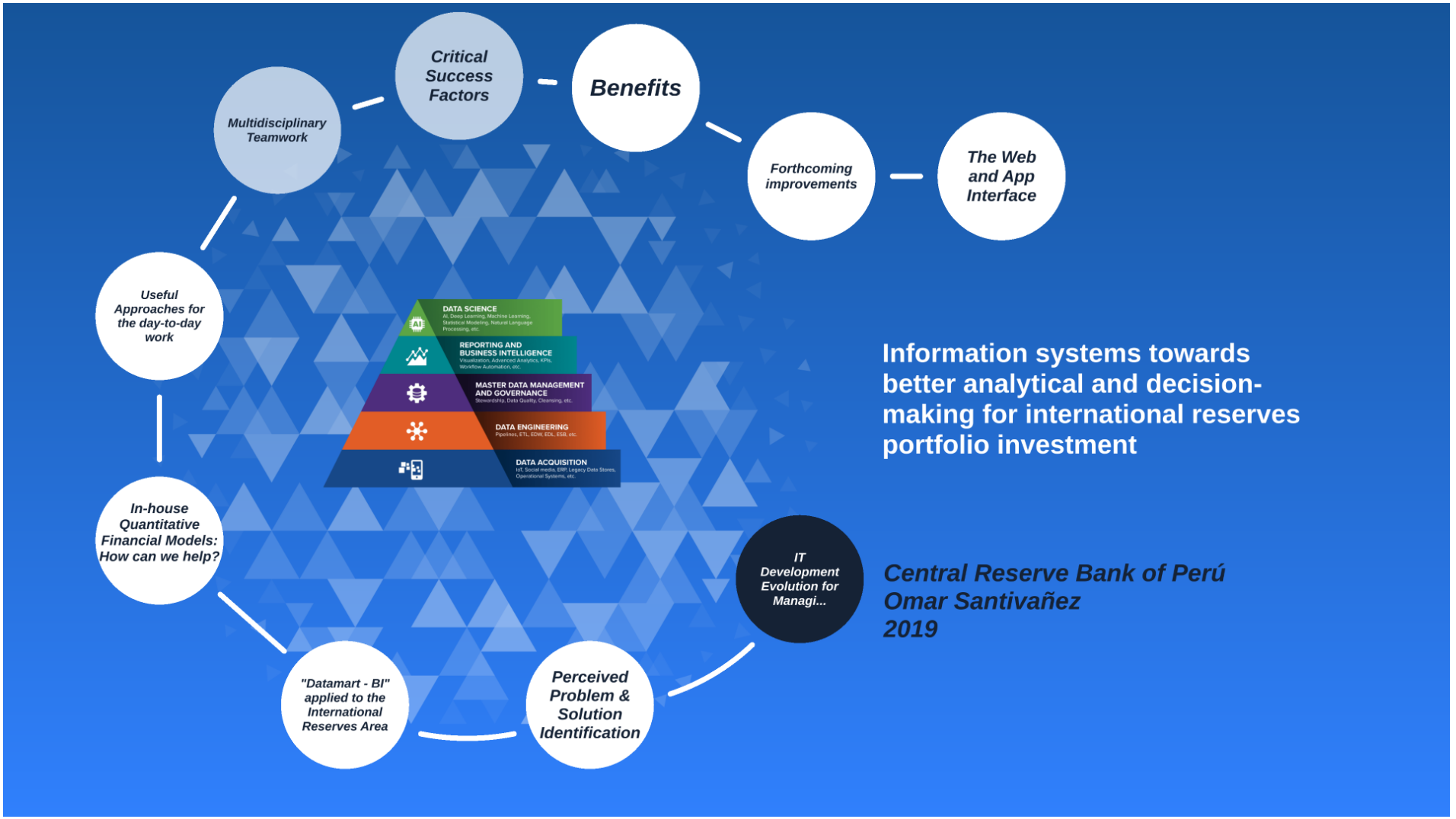
- Decision making process based on objective indicators, timely updated and with deep level of detail.
- Improved identification of opportunities and risks in the management of reserves.

Operational Risk Mitigation

- Reduction of the operational risk in the load of variables and generation of reports.
- Automation in data collection and aggregation.
- Access to variables and reports according to crucial aspects of IT Security and preventing from Cyber Attack.

Web & Apps (Mobile)

Accessible from Web and Mobile environments (Apps for iPad / Android).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Forthcoming improvements

- Rebuilding of **internal legacy models** developed in **MatLab to R/Python** languages. (Data Scientist skills development).
- Integration of more External Data: information of interest through **APIs - WebServices - SaaS**.
- **Optimization of System Response Times** (persistent cubes) & **Real Time**.
- **Exploring BigData native connectors** in case of using this kind of data sources.

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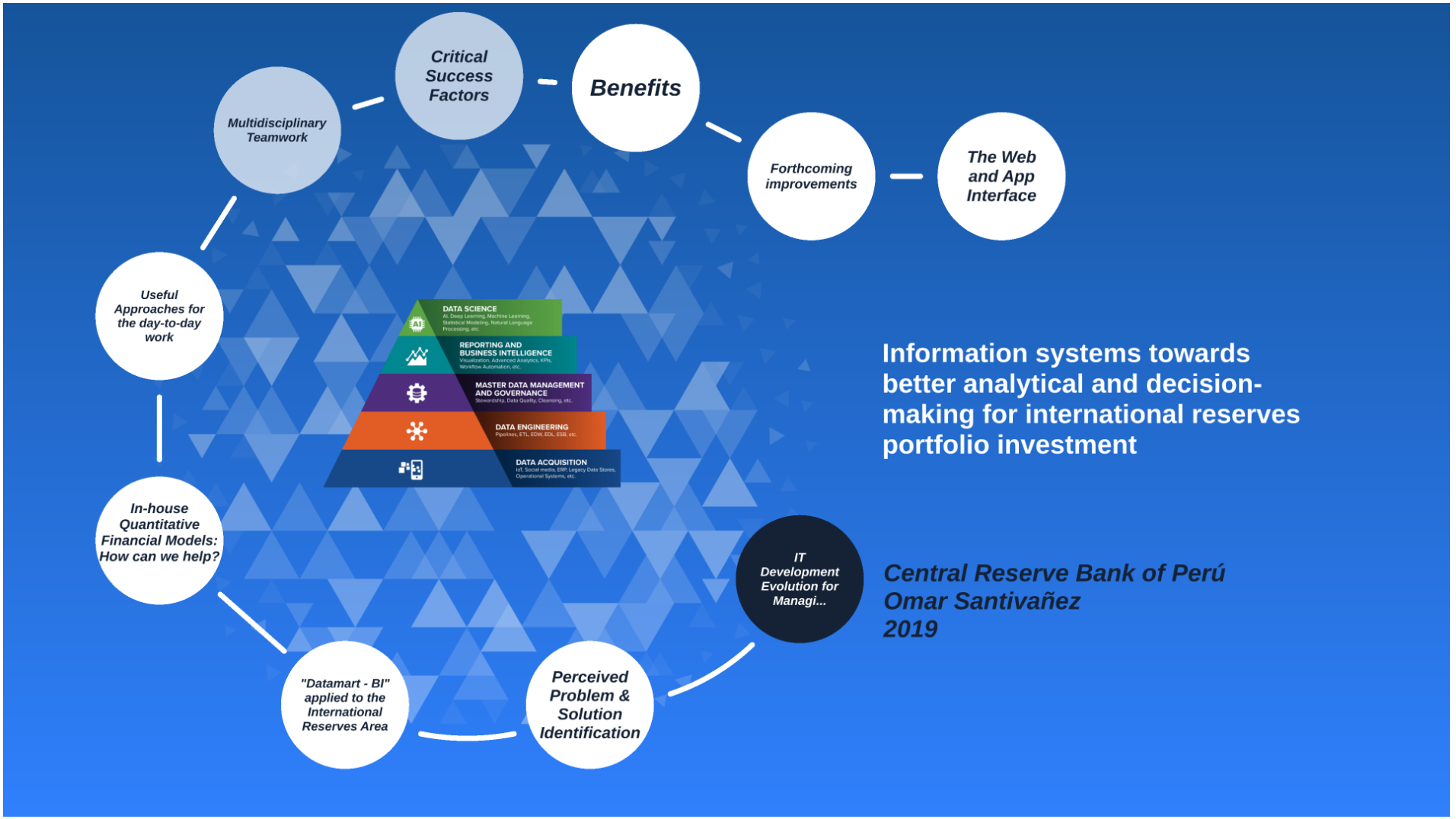
Essbase

python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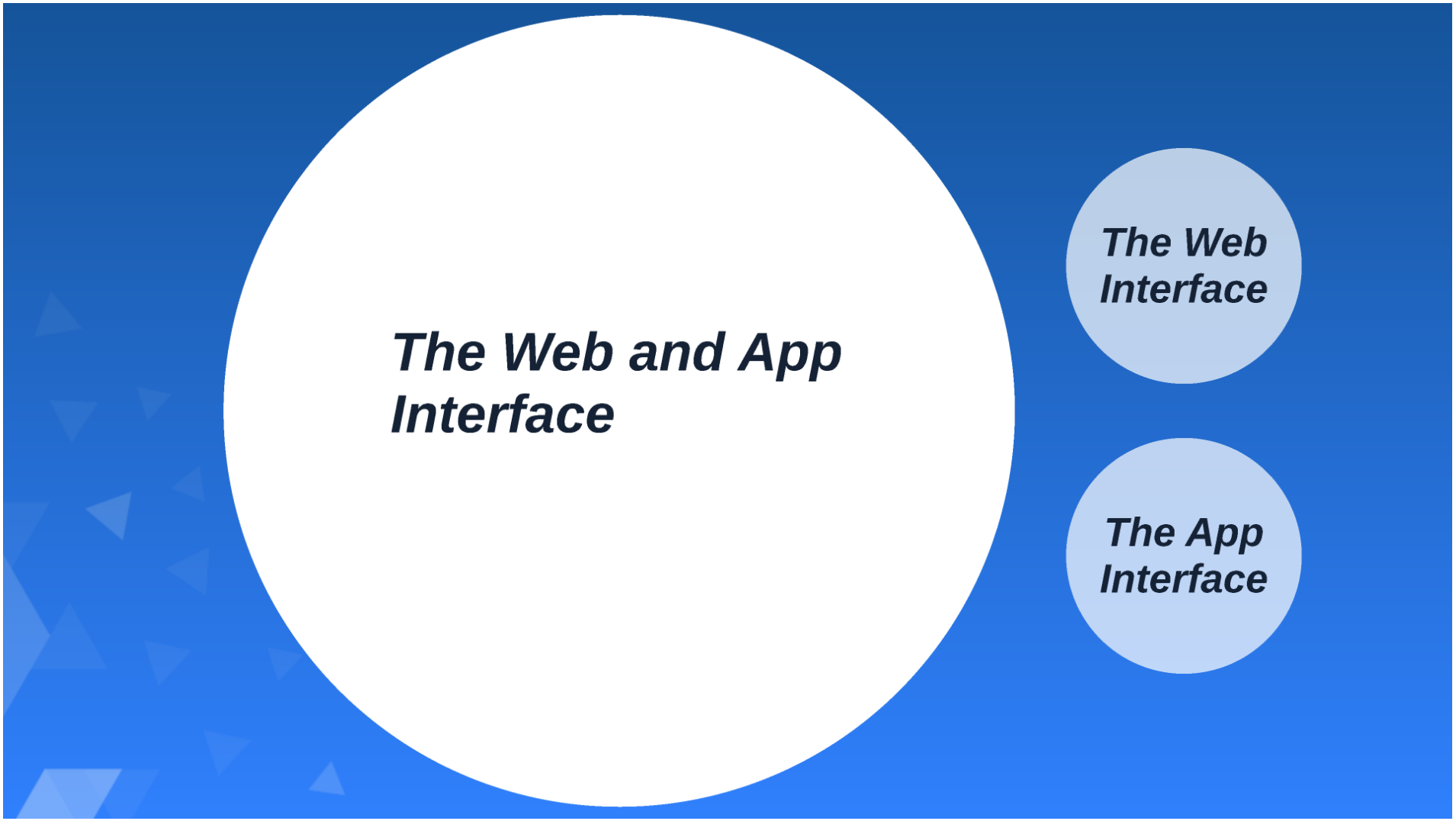
The Web and App Interface
The Web Interface
The App Interface

The Web Interface

The Overview

Simple Reports

Visual Reports

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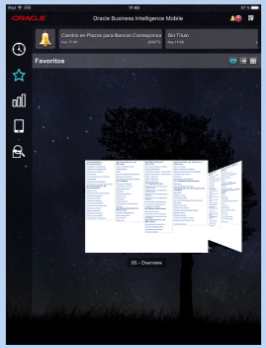
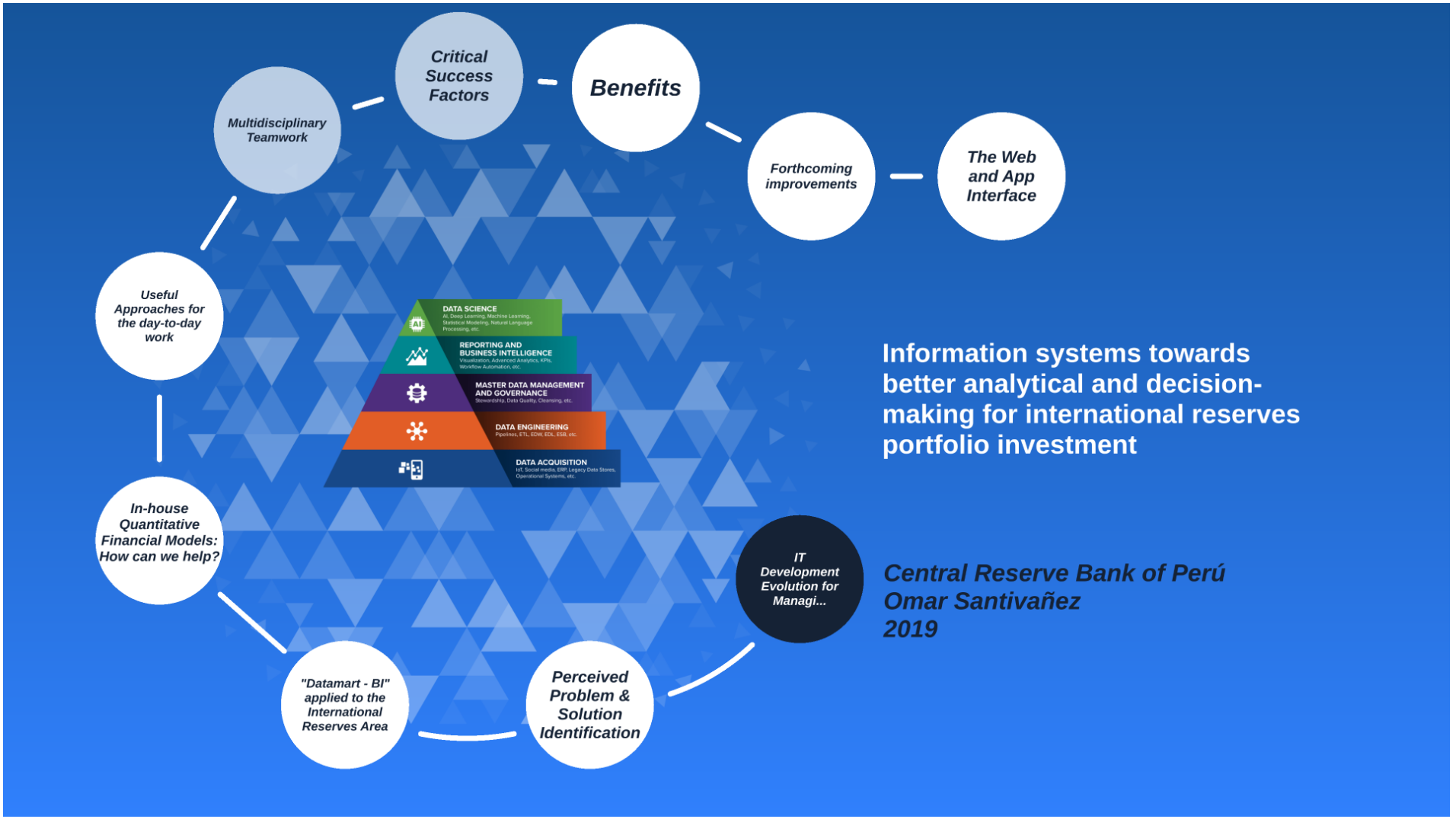
Dashboard Reports

The App Interface

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