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Visualization & Automation of Shams Dubai Report

Noora Ibrahim Alblooshi
na9365@rit.edu

RIT

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by

Noora Ibrahim Alblooshi

ID: 337007736

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Student Name: Noora Alblooshi

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Report **Graduate Paper/Capstone Committee:**

Name Dr. Sanjay Modak Date Chair of Graduate Programs and

Research

Committee Chair

Name Dr. Salameh Ahmad Date Assistant Professor of Physics

and Mathematics

Capstone Advisor

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ABSTRACT

Dubai's Smart Grid strategy includes the implementation of Distributed Energy Resources and Distribution Automation (DA) facilities to continuous monitoring and remote control from DEWA's Distribution Control Center (DCC) , and, in some cases, automatic control of electric distribution assets operated at 33kV or lower. The increase level of telemetry and automation in the field imposes a greater challenge in monitoring and live data visualization for establishing a decision support system that empowers distribution system operators and enables optimal control of existing and planned assets. This challenge can be overcome through introducing data science tools in the sector of energy. Through imposing certain reporting and visualization tool, the data generated utilization level is improved which will lead to an increase in reliability and efficiency, rise asset utilization, workforce productivity, decision making, thus, increase customer satisfaction.

The use case covered during this capstone proposal is one of the daily reports generated by distribution operation department manually on the daily bases. During this project, data science tools will be benchmarked accordingly to distribution power utility needs of reporting and anticipating certain parameters such as distribution solar generation and key performance indicators (SAIDI, SAIFI, CML, MTTR, MTBF etc.). The selected tool will be utilized to generate live reports/ dashboards and to decrease the level of manpower intervention. This proposal will highlights the background of the project, problem statement, project definition and goals and explains project methodology and evaluation followed by project deliverables & timeline.

Keywords: visualization, report, data science, Tableau, reliability, shams Dubai, Distributed Generators, solar, cloud.

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List of Symbols, Abbreviations, Nomenclature

BW Business information warehouse DED

Dubai Electricity Department

DER Distribution Energy Resources

DEWA Dubai Electricity and Water Authority DRRG

Distributed Renewable Resources Generation DWD Dubai

Water Department

ERP Enterprise Resource Planning

HANA High-performance analytic appliance IaaS

Infrastructure-as-a-Service

IoEn Internet of Energy

IoT Internet of things

MW Megawatts

NOC No objection clearance

PaaS Platform as a Service

SaaS Software as a Service

SAP Systems, Applications and Products SCADA Supervisory

Control and Data Acquisition SWOT Strengths, weaknesses,

opportunities and threats

Chapter 1: Introduction

Background of the Projects

To celebrate Golden Jubilee of the Union, the government of Dubai has launched Dubai Plan 2021 which aims to transfer the city into one of the most attractive cities in the world to live and visit. From that perspective, the government has lunched many initiatives to fulfil the vision of being a leading world city. Starting from paperless and digitalization to using robotic process automation and artificial intelligence, the Smart city of Dubai emerges technologies to

all different sectors to enhance people's experience in the city [1].

Non-surprisingly, energy sector, specially distribution, is undergoing several drastic changes as a result of various strategies such as Dubai Clean Energy Strategy 2050, Dubai's Demand Side Management Strategy, Dubai Carbon Abatement Strategy and x10 strategy [2]. Thus, ongoing automation and grid modernization projects such as emerging Distribution Energy Resources (DER) are introduced to transfer the strategies into reality. Many new equipment such as smart meter, sensors, information technology, distributed solar panels, wind turbines, mobile desal generators, electric vehicles and battery storages have been integrated already into the network resulting the bidirectional power flow or what so called smart grid. Accordingly, the customer is called prosumer instead of consumer. Smart grid is

not only connecting the prosumer to the power utility but also to the neighbours and community. The connectivity enables prosumers to feed their power excess from solar roof top, electric vehicles or any other distributed generations/ battery storages to the grid to sell it back to the utility and neighbourhood resulting in what is so called active/ dynamic network. The diverse approach in power generation adds a tremendous benefit to grid resilience, customer reliability, interdependency of single generation source, support sustainability and decreases power

interruption (outage) duration due to decentralized multiple generation options through island mode operation or even supporting micro grids. Further, electrical engineers has anticipated multiple smart grid operational challenges for instance balancing generators and frequency, forecasting necessary load, cyber security and many other challenges. However, such type of network created an opportunity for multiple initiatives such as “demand response” and “load shifting” [2].

On the other hand, the increasing level of automation and telemetry lead a significant growth in amount of data generation. Hence, it imposes greater challenge on engineers with respect to processing, visualizing and forecasting data. Proper analysis and visualization are the prime mover to enable immediate collaborative decisions making. To cope up with the evolving technology need, the utilities has to develop their infrastructure to adapt data science tools. Firstly, the platform shall support data collection from different protocols, files, servers and Enterprise Resource Planning (ERP) applications for instance Systems, Applications and Products (SAP). Once the data are stored, engineer may require to use different tool for data cleaning. Followed by analysis and reporting/ visualizing in such a way which will makes it easy for human to take accurate decision at the glace.

Problem Statement

At Dubai, the increased penetration made it tough for generation planning to accurately plan and set the schedule of upcoming customer load and hence it is difficult to plan the generators required to supply Dubai's load (electricity and water). Furthermore, it become harder for control centre dispatchers to execute the planned schedule and maintain system reliability such as frequency balancing, maintaining voltage violations and power factor violations specially for distribution network. The distribution network is not similar to transmission and generation network from size and technology development perspective

(generation plants in Dubai <10, transmission substations <300, distribution substations >37,000). The increased equipment in distribution would make it even harder to process the data and make the best decisions unless a holistic visualization is used. However, the current traditional tools and architecture are not designed to process enormous amount of data generated from distribution substations (once high level of telemetry is reached). That is due to generation of data from diverse sources which leads to produce variety of datasets such as structured, semi-structured and unstructured datasets. Moreover, another problem which distribution infrastructure may face is the speed of data generation or what is so called velocity. Smart Grid initiatives will increase the data points from the field (Advanced Metering Infrastructure, Intelligent Electronic Devices, Distribution Automation). Such a growth leads to an increase in data generation rate as well. However, due to many reasons the data transmitted may have uncertainty or inconsistencies. Furthermore, one of the main problems faced currently at distribution network is the availability of proper data analysis, reporting and visualization tools. Till date, the tools used in many utilities are Microsoft word and excel. Manpower, time, data science functions such as prediction and easiness of generating different reports are the main shortfalls in mentioned software. Thus, software in data science field are developed to handle varieties of problems for instance volume, variety,

velocity and variability. Apache Hadoop, R, Tableau, Microsoft HDInsight and NoSQL are some examples of popular data science tools which can be embedded to distribution network [3-6]. Figure 1 represents the strengths, weaknesses, along with opportunities and threats (SWOT) analysis for the project.

Figure 1: SWOT Analysis

Project Objective & Goals

Increasing level of automation in distribution automation requires an introduction of data science tools to the division. Lacking of data analysis, reporting and visualization is the main problem faced in distribution specially distribution operation department. During this project, all existing shortfalls will be tackled for Shams Dubai Project report/ dashboard which is submitted regularly to the higher management and distribution control centre of

Dubai Electricity and Water Authority (DEWA). A comprehensive solution will be used to generate live report and dashboard templates in a holistic manner through aligning data and data science tools to the organizational needs.

The gaol and objective of the project is to benchmark, suggest, share knowledge and align data science tools to the organizational needs such as organization infrastructure readiness, cyber security approvals, easiness of dashboard creation and combining of multiple data sources. Once the highlighted criteria is fulfilled and application will be selected, new templates for the report/ dashboard will be created and proposed to the business users from

Distribution Control Center. Additionally, the project will target automation of the report to reduce back office time and effort spent for routine works through enabling integrations with other systems. Finally, knowledge sharing will be presented to distribution system study and reporting team to adapt the new suggested tool, automate/ improve other reports and ensure reliability across the process.

Intended Outcomes & Deliverables

The projects intends to deliver an improved and integrated visualization of Shams Dubai report to supports easily understanding of the penetration of roof top solar generation in Dubai for management and dispatchers. Additionally, the project targets automating the process of data entry to generate accurate reports and reduce manhours spent. Furthermore, cloud technology will be used to publish the dashboard and enable easy accessing of information regardless of device and location restrictions.

Summary of Report Structure

The capstone project report is divided into five chapters; the first chapter provides

project background and sets project problem and objectives along with the intended outcomes and deliverables. While the second chapter focuses on the literature search. Solution and methodology is discussed in chapter 3 starting from data review up to testing and improvements. Chapter 4 covers capstone project management subjects such as timeline, problem faced, resources and cost. Finally, chapter 5 concludes the capstone report with a summary project solution followed by future action plan and further improvements

Chapter 2: Background Theory

Literature review

DEWA

In 1959 and 1961, Sheikh Rashid Al Maktoum has established Dubai Electricity Department and Dubai Water Department to fulfill Dubai city need of electricity and water. However, in January 1992 Sheikh Maktoum bin Rashid Al Maktoum has merged both DED and DWD under one umbrella called DEWA which stands for Dubai Electricity and Water Authority. The organization is responsible for generating, transmitting and distributing electricity and water to 880,000 customers in Dubai and Hatta. Furthermore, the vision is to be "a globally leading sustainable innovative corporation" and DEWA's mission is "we are committed and aligned to Dubai's 8 Principles and 50-Year Charter supporting the UAE's directions through the delivery of global leading services and innovative energy solutions enriching lives and ensuring the happiness of our stakeholders in a sustainable manner".

Moreover, DEWA cares about the future of Dubai and that can be seen through their motto “for generations to come”. Finally the values of the organization are Stakeholders Happiness, Sustainability, Innovation, Excellence and Good Governance.

Reflectively, DEWA has achieved multiple awards locally and internationally for instance UAE, represented by DEWA, has been ranked first in the world for Getting Electricity in 3 years consecutively as per the World Bank's Doing Business reports. DEWA also got the platinum category in Global Excellence Award from the European Foundation for Quality Management (EFQM), as the first organization outside Europe, first to win at first-time applicant. Moreover, DEWA achieved the lowest System Average Interruption Duration Index (SAIDI) or what so called Customer Minutes Lost per year (CML) in the world at 2.68 minutes

only. The record is lower by 82.1% than other leading utilities in European Union and United State of America.

DEWA operates through 8 specialized divisions (refer to Figure 2) and under each division there are supper departments (sub-divisions), departments and sections. Am currently working under Distribution Power division, Distribution Operation Super department, Distribution Control Center Department, Distribution Network and System Applications[7, 8].

Figure 2: DEWA Organization Chart

Shams Dubai

Shams Dubai is one of the projects that DEWA has lunched under the smart grid initiative and to diversify the energy mix which is the Arabic word for Dubai Sun. the project supports Distributed Renewable Resources Generation (DRRG) programme where consumers can install solar panels on the roof top of the buildings and homes with certified private companies support. The generated solar power will feed prosumers premises during daylight

hours. While the excess load will be injected to DEWA distribution network. As per latest update in DEWA website (last update 8 October 2019), there are 1,354 photovoltaic installed with total capacity of 125MW (the number is increasing daily) [9, 10].

The initiative has multiple benefits for both DEWA and the prosumer. Firstly, the generated energy is clean, accordingly there is no greenhouse gas emissions emitted to the nature and consequently reducing carbon footprint/ ecological footprint. Additionally, the total electricity bill will be reduced as the power is generated locally from a free resource "Sun".

Most importantly, the initiative ensures sustainability and supports Dubai economy through minimizing Dubai total load demand specially during peak hours.

Digital Transformation

Digital transformation can be defined as the utilization of various technologies to drastically improve the performance and the quality of service in the enterprise through enabling creativity and innovation. Digital transformation is shaped based on three laws Moore's, Metcalfe's and Bandwidth's Law through computing connecting and using cloud respectively. A good example for digital transformation can be seen in multiple Dubai organizations such as Ministry of Health and Prevention. They have placed the patient at heart of their digital transformation through investing in integrating all government hospitals and clinics medical history (cloud) and having a central database. Further, variety of services are

available on a single click such as modification of birth certification details, reviewing laboratory/ medical reports, booking an appointment and much more. Another example of digital transformation can be mentioned from the energy sector, DEWA Smart Response. The application provides a service to Dubai electricity and water customers to report, resolve all

technical interruptions, self-diagnose a problem through providing guidance and chat bot (AI) and empower the user to solve the technical issue. If the user required a technical crew, the system will automatically assign the nearest crew (data taken from GPS) and user can track the assigned crew through application map. The history of the incidents are recorded and reports/ dashboards are generated.

Disruptive technology is a ground breaking technology that creates a new industry market and business value by displacing the existing technology market. It can be analysed by studying the Porter's Model five traditional forces such as the new entry of new competitors, the threat of substitutes, the bargaining power of buyers, the bargaining power of suppliers and the rivalry among existing competitors. The first force, the new entry of new competitors introduces new digital threat to the industry through introducing an outside industry with already new digitally based business strategy that has its own value propositions. Secondly, a digital threat can be resulted due to the threat of substitutes force as it may promote the digital services by wrapping it with a pre requisite physical product. Moreover, the bargaining power of buyers may affect the customers expectation of a sets of new digital services which is the driver for digital business. On the other hand, the bargaining power of suppliers may expedite the acceleration or slow the digital transformation based on how it benefits them. Finally due to the low price of digital business models the entry and exit are going down [11,12].

To enable business models automation, digitalization and transformation, there are essential foundational building blocks disruptive technology for instance social computing ,

mobile, analytics/ big data, cloud, wearables, robotics, artificial intelligence, cyber security and internet of things (IoT).

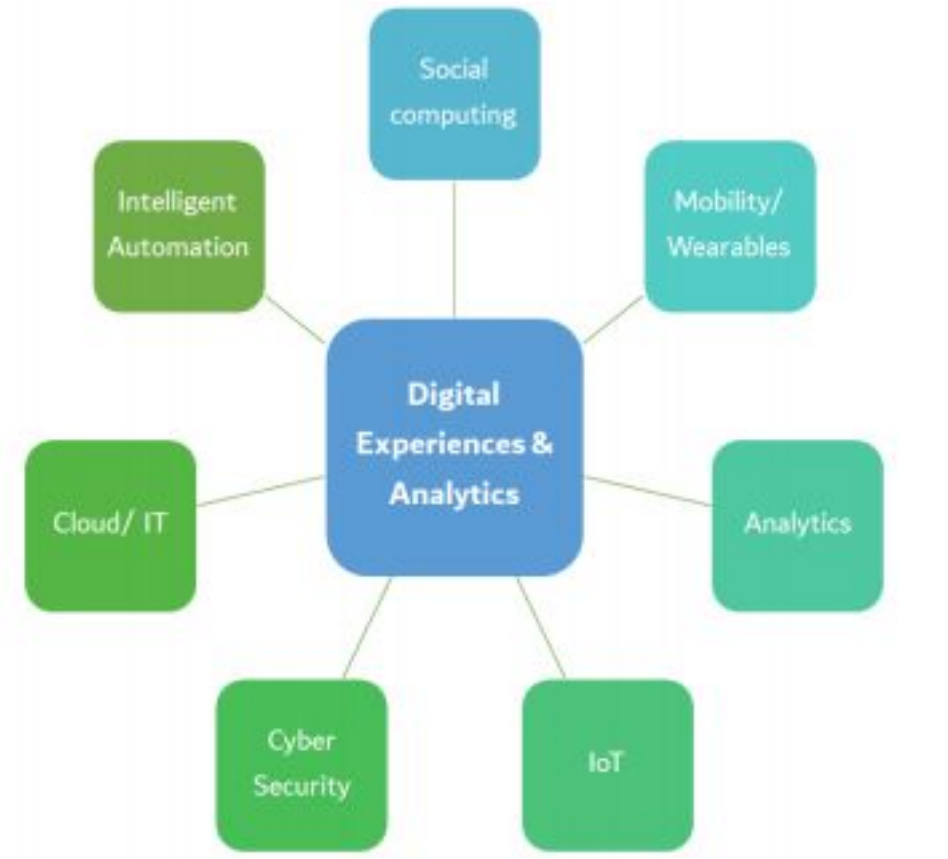


Figure 3: Digital Technologies

Social Computing

Social computing is one of the important digital transformation building blocks. It can be achieved through efficient frontier for workforce productivity for example a user friendly interface in a mobile application.

Internet of Things (IoT)

Internet of things architecture consist of all the components of data acquisition system. They are used to monitor the ecosystems with different scales and to detect unexpected phenomena. The monitored data passes through the network to an end station. The architecture

consist of certain number of nodes. Each of these nodes is connected to one or more sensors.

The output from sensor is generally a signal that is converted to human-readable display at the sensor location or transmitted electronically over a network for reading or further processing. These nodes consist of several parts such as, controllers, radio transceivers, sensors, and a circuit to interface the circuit with the power source such as battery or solar. The cost and size of the sensors node varies depending on the complexity of the individual components. So the major challenge in designing IoT are to create low cost and small sensor nodes. These nodes are scattered through the area that needs to be monitored. Different topologies exist for node communication such as star or mesh topology. The vision of mesh topology is to strengthen the interconnection of nodes by adding more nodes since it results in increase of routing opportunities. In case one of the nodes fails, a new topology can be selected and the network can continue the delivery of data. The main illustration of monitoring system architecture is shown in Figure 4.

IoT is the gateway for the organization to understand their customer's through increasing connectivity. All the field edge devices will send data through standard protocols into the control centre or clouds which will be equipped with intelligent systems for analysis. The analytical platforms will support the operators to perform studies and make right decisions. Moreover, IoT will enable operating the network more efficiently by understanding customer load pattern and predicting the load demand which will lead to a decrease in energy waste. Likewise, the efficiency will increase through assessing asset health. Monitoring and analysing asset health data, both historical and real time, and intervening at the right time, before assets go down, will support prioritizing and optimizing resources. Thus, it will lead to reduction of maintenance costs, eliminate breakdowns, reduce downtime, cut unplanned outages, reduce scheduled repairs, reduce capital investment and changing the strategy of maintenance from

reactive, preventive and condition based into predictive maintenance which will further help the optimization of asset lifecycle[13-16].

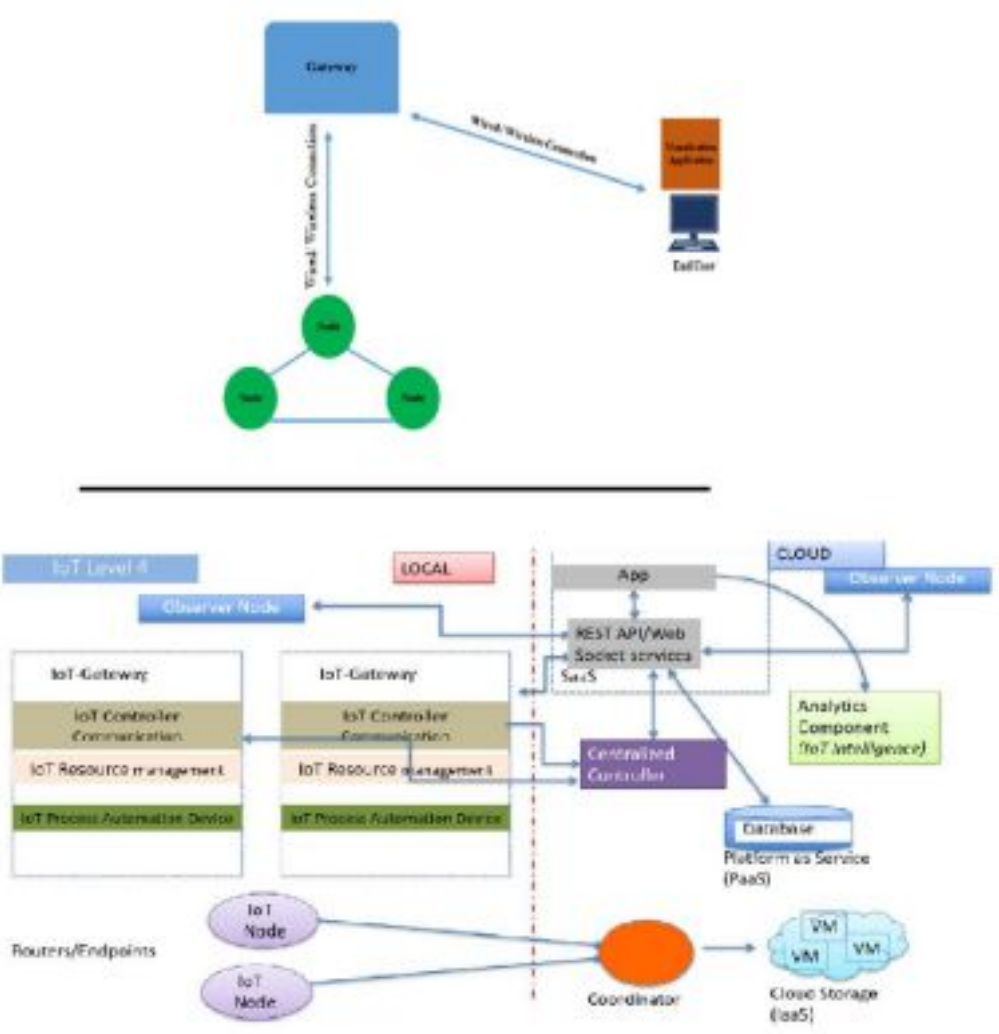


Figure 4: IoT architecture

Cloud

Cloud computing is defined by U.S. National Institute of Standards and Technology (NIST) as "a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal

management effort or service provider interaction". It enables the users to put their data on cloud without buying

expensive servers and emphasize pay per use model. Further, cloud computing has a the preference of scalability and accordingly server capacity can vary to reduce the traffic (Multi tenancy). Moreover, the cloud provider is responsible to manage the servers and hence customer doesn't have to care about understanding the infrastructure or scheduling the maintenance work [11].

Cloud computing is a key element in energy sector. Usually the data generated (sensors/ IoEn) in the energy sector can be considered as big data and managing them can be hectic. Enabling cloud technology will add benefit to the energy industry by introducing data analysis and predicting equipment failures for example. Furthermore, since the data is critical and valuable, having a digital twin on cloud will act as a redundant server for the real system and will minimizes the capital cost of procuring an extra infrastructure. Likewise, since nowadays more distribution generators are integrated to the grid, customers has been prosumers and require a computing servers to manage their distribution generators and resell it either to the utility or other residence. The best solution for such cases is cloud computing.

In cloud there are different service models for instance Software as a Service (SaaS) where only the user is renting the application/ interface through a browser which can be accessed from variety of laptops/ PCs from anywhere similar to salesforce.com, google apps, facebook, Linkedin and dropbox. This model advantages are low cost, infrastructure is not required from user side, has a seamless upgrades, Guaranteed performance, Automated backups, Easy data recovery, Secure, High adoption and On the move access. Second model is Platform as a Service (PaaS) which means that user has access to user interface that allows him to deploy his own application on cloud using specific programming language, software

libraries and developing tools. However, the user doesn't have access to the operating system or servers. This model is used in the following examples such as Google App Engine, Windows Azure Platform, Force.com, RightScale, Heroku, Github & many others. The user can achieve

many benefits from selecting this model for instance Lower upfront & operations costs, no need for IT infrastructure management costs, Improved scalability, Higher performance, Secured access, Quick & easy development and Seamless integration. Finally, Infrastructure as-a-Service (IaaS) model provides the user with virtual machine instances and virtual storage over the internet where he can access the operating system as well. Still, customer doesn't have to care about the underlying physical devices as it will be managed by cloud provided. There are many real examples of IaaS models such as Amazon Elastic Compute Cloud (EC2), RackSpace, GoGrid, Eucalyptus, Terremark, Joyent and many others. The advantages of the this model are Shifting focus from IT management to core activities, No IT infrastructure management costs, Pay-per-use pricing, Guaranteed performance, Dynamic scaling, Secure access, Enterprise grade infrastructure and Green IT adoption. For all the three models the main disadvantage is security and privacy of data. The security and privacy varies between the three models with IaaS being the safest followed by PaaS and finally SaaS is less secured model.

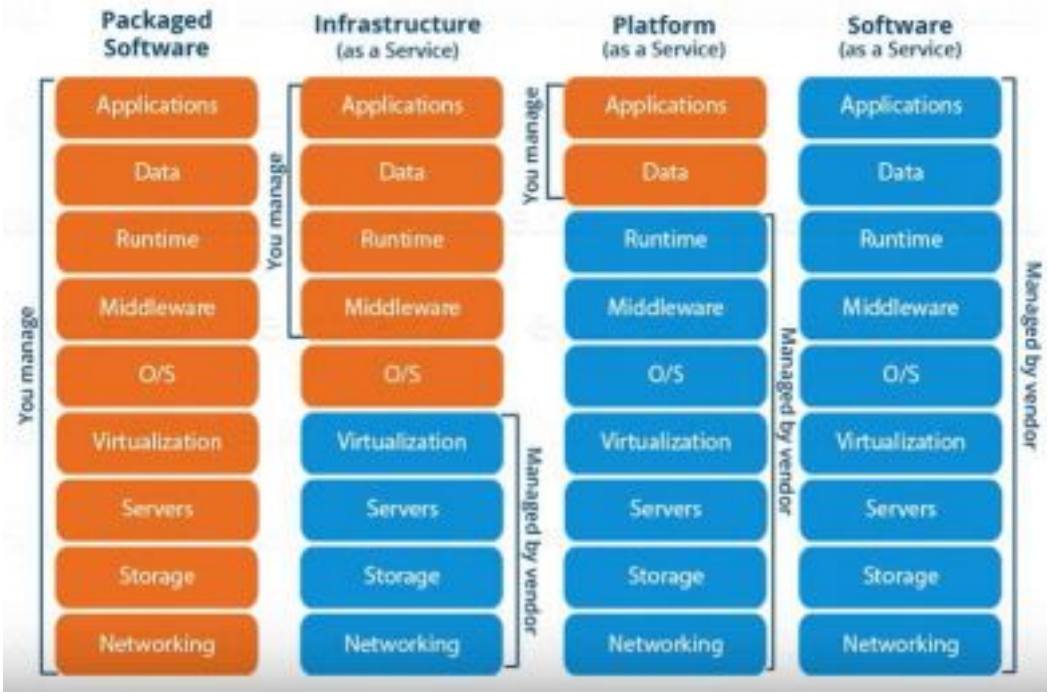


Figure 5: User/ Provider Controls for different service models

Big Data

Big data refers to a collection of extensive datasets that are large in size and complex that it become difficult to process or analyse using a traditional enterprise software. The traditional tools and architecture are not designed to process enormous amount of data. Big data is known for it is tremendously large volume (i.e., in zettabytes). That is due to generation of data from diverse sources which leads to produce variety of datasets such as structured, semi-structured and unstructured datasets. Moreover, one of the characteristics of big data is the speed of data generation or what is so called velocity. Users are increasingly using new application on their PCs, tablets and mobile phones. Such an increase leads to an increase in data generation rate as well. Accordingly, analysts develops mechanism and software to extract a value out of big data. However, due to many reasons the data transmitted may have uncertainty or inconsistencies. Thus, big data software are developed to handle the 4 Vs of big data for instance volume, variety, velocity and variability. Apache Hadoop, R,

Tableau, Microsoft HDInsight and NoSQL are some examples of popular big data tools.

Analytics & Data Visualization

With digitalization era, data went from expensive, rare, difficult to collect and find into cheap, abundant, difficult to process and understand or what so called big data. Nevertheless, all the data are only useful when we can drag information and conclusion out of it that's where data visualization comes in. Data visualization is the process of taking raw data and transform them into charts, graphs, tables, images, videos and maps that explain the data, solve problems, provide insights, creates a value and spot trends. There are many industries which has already emerged data visualization into their business. Usually in the field of data visualization, the results and layout varies on the raw data and the analysts perspective which always results in a unique output. For instance, Figure 6 shows a sample manufacturing subsectors data in 36

countries. The data shown can be represented in different ways as shown in Figure 7. In the power industries, the data are represented in different ways, however, till date there is no industry where data science tools were emerged to generate reports.

Figure 6: Manufacturing subsectors data (http://mickmcquaid.com/ocounties.pdf)

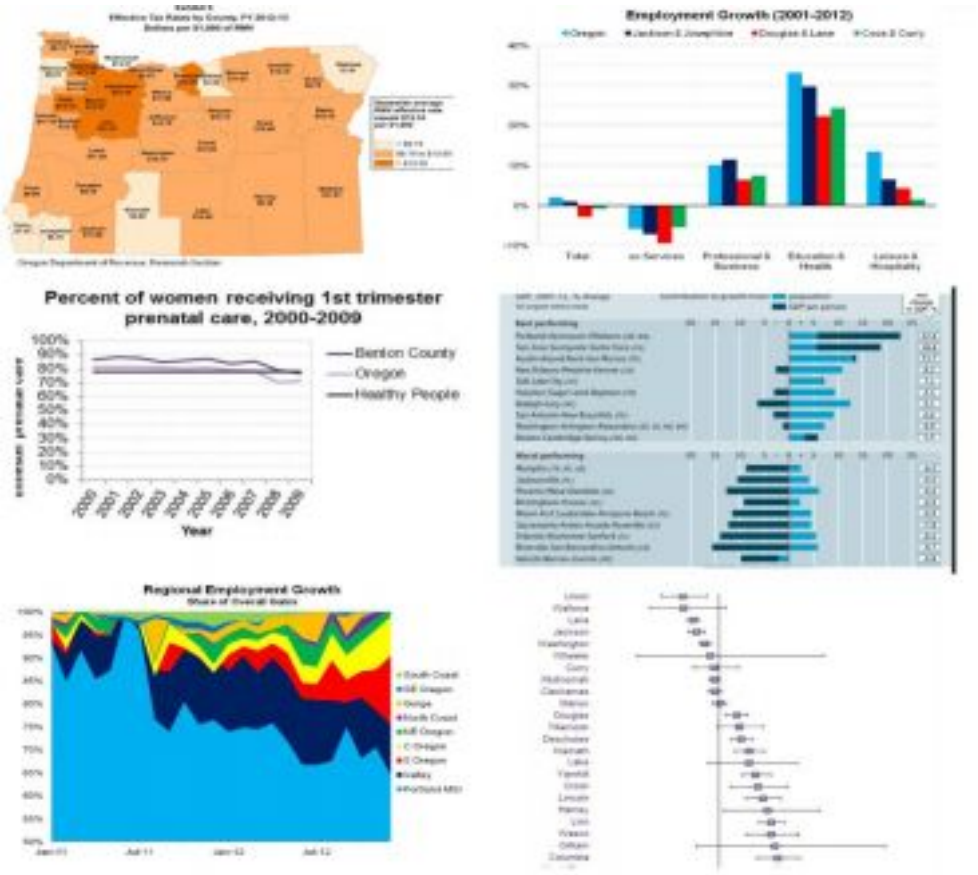


Figure 7: Different visualizations for same dataset

Analytics Digital Platforms

Digital platform is the main part of digital transformation ecosystem. As the concept is relatively new, many definitions has been introduced in the discipline of digital transformation. Parker, Van Alstyne and Choudary has defined digital platform in Platform Revolution book as "a business based on enabling value-creating interactions between external producers and consumers. The platform provides an open, participative infrastructure for these interactions and sets governance conditions for them. The platform's overarching purpose: to consummate matches among users and facilitate the exchange of goods, services, or social currency, thereby enabling value creation for all participants". In another words, platform is simply a basic infrastructure between two sides producer and consumer to facilitate value creation by exchanging information, goods and services. Parker, Van Alstyne

and Choudary has emphasized that even through platforms seem simple yet it is adds miraculous value to enable digital technology [12].

There are variety of analytics platforms available in the Market for instance Microsoft, Tableau, IBM, Qlik, Oracle, SAP, ThoughtSpot, SAS and many others. Venders analytics and business intelligence platforms has been classified by Gartner as per their capability in execution and vision completeness (refer to Figure 8).

Figure 8:Gartner magic quadrant

Leading platforms strengths and weaknesses will be studied to select best solution for capstone project [17].

Firstly, Microsoft Power BI which was lunched in 2013 is considered as a leader in analytics and business intelligent. Basically due to the product visionary roadmap and large market share through Microsoft Office 365 E5 package. The application has multiple capabilities specially for data preparation and analytics on cloud (Azura), machine learning and augmented analytics. Nevertheless, the software has shortfalls in the on premises version for instance dashboards, alerting, streaming analytics, augmentation and many others. Furthermore, Microsoft offers only SaaS on Azure cloud only and doesn't run in another IaaS cloud service. Finally, it has been noticed that connecting Power BI with SAP datasets is

problematic (for SAP high-performance analytic appliance (HANA) and business information warehouse (BW)).

Tableau is considered as well one of the leaders in analytics and business intelligent. The platform has powerful capabilities specially in data preparation, analysis and presentation simply by drag and drop (easy to learn). Additionally, users can connect different datasets from a wide range of servers and files to create single dashboard. However, Tableau roadmap/ direction is uncertain as its roadmap is overlapping with Salesforce (acquired Tableau). Finally, compared to other visualization platforms, tableau pricing is considered expensive [17, 18].

Qlik is ranked as leader in Gartner magic quadrant mainly because of platform strong vision to adapt artificial intelligent and machine learning. Yet, compared to Power BI and Tableau, Qlik market momentum is relatively low. On the other hand, Qlik gives the customer the freedom to deploy the platform on any cloud or on promise or combination of both. However, many customers faced problems through data migration from QlikView to Qlik Sense compared to other vendors in the market [17,19].

Table 1: Capability of BI leading platforms

Features	**Power BIs**	**Tableau**	**Qlik**
Mobile	Available	Available	Available
Analytics/ big data	Available	Available	Available
Cloud	Azure SaaS or on premises	Tableau online or on-premises	Any cloud or on premises
Artificial Intelligence/	Available	Available	Available

Machine learning			
Frequent Updates	Yes	Yes	Yes
Price	$10 per month	$42 per month	$15 per month
Users	+10,000	+20,000	+45,000

Selecting Analytics Digital Platforms

The selection of platform depended on variety of reasons. Firstly and most importantly, the platform shall be able to connect to different files and servers available at DEWA for example SAP BW, SAP HANA, Supervisory Control and Data Acquisition (SCADA) system (Operational Database (ODBC)). Moreover, the selected application user interface supposed to be user friendly and easy to learn to enable fast adaptation by Distribution System Study and Reporting Department. Finally, the platform shall be secure and approved to be utilized on DEWA Personal Computes by DEWA Innovation and The Future (IT and IT security

departments). Accordingly, and as recommended by Smart Technology & Business Intelligent department, Tableau desktop 2019 has been selected to develop the dashboard of Shams Dubai project.

Chapter 3 : Solution & Methodology

Methodology & Evaluation

Business Understanding

The methodology used during the project life time was an iterative approach of the problem solving process. First step targeted understanding the business current report structure, data required, data sources and challenges faced by domain expertise. To do so, multiple meeting has been conducted with Solar Specialist in DEWA who is responsible about generating latest Shams Dubai Updates to the management (who works under Distribution Power> Connection Service). As per Solar Specialist, all the data related to the new connection of shams Dubai are only maintained in an excel data sheets and updated whenever there is a project update.

After understanding the data in Shams Dubai project dashboard, meeting has been conducted with management to focus on the desired dashboard requirement. As per Senior Manager Distribution Control Center (SM-DCC), shams Dubai dashboard shall identify project aggregated capacity per MV substation, primary substation, loop and zone. Furthermore, Vice President Connection Service (VP-CS) is interested to have an overview of project stages and number of projects/ capacity in pipeline.

Data Review, Requirements & Collection

Once business understanding stage is over, it was clear that Shams Dubai dashboard data will not be the only dataset utilized to generated the new dashboard. The data maintained in existing Shams Dubai dashboard has multiple missing fields and not well structured as Summarized in Table 2 (Figure 9 represents a sample of existing shams Dubai dashboard).

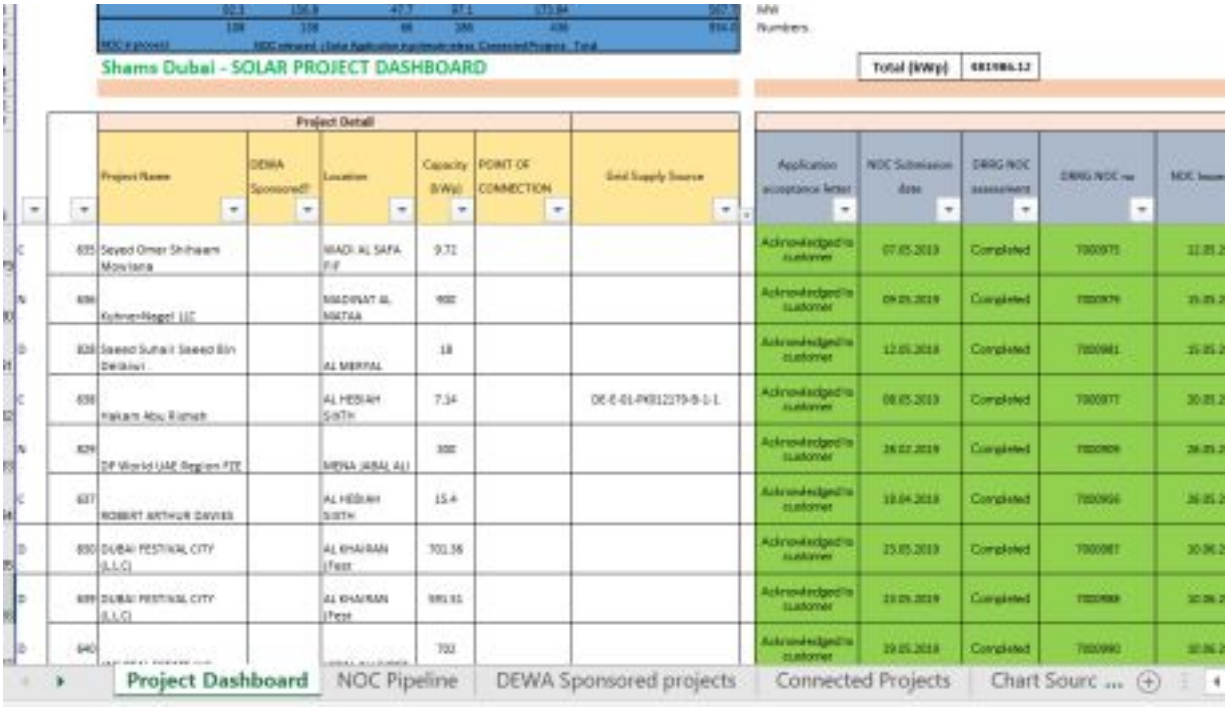


Figure 9: Sample of existing Shams Dubai dashboard

Table 2: Data Available in Shams Dubai Dashboard

No.	Data	Description	Gap
1	Project stage	Identifies current project stage: NOC in process, NOC released, getting solar application, estimate released or connected.	NA.
2	Project owner	Describes the owner of the project.	NA.
3	Location	Contains project location.	Data is not structured and many fields are missing.
4	Capacity	Identifies the maximum installed capacity.	NA.
5	Point of connection	Identifies voltage level.	Data is not structured and many fields are missing.

6	Grid supply Source	Identifies to which substation project is connected.	Data is not structured and many fields are missing.

7	Connection Service	Contains connection service department process details (maintained in SAP).	NA.
8	Inspection	Contains inspection department process details.	NA.
9	Contractor	Contains solar contractor details.	NA.

Accordingly, the first action has been taken was to raise new SAP Business Requirement Document (BRD) to migrate all Shams Dubai project details to a professional enterprise system (refer to Appendix point 1 for Minutes of Meeting). Secondly, all data required such as grid supply source, connectivity (to find primary substation, loop, zone) and coordinate locations were collected from various resources for instance SAP and SCADA. Next stage encompassed combination of multiple source data as an alternative solution till SAP BRD development is over. Excel datasheets has been used as temporary main dataset and few formulas has been developed to map different sheets. Figure 10 represents the new dataset utilized to generate new dashboard.

Figure 10: New temporary dataset

Dashboard Modelling, Evaluation & Feedback

Once datasets wasready, reports and dashboards was generated using Tableau platform. During the report and dashboard generation process the results was evaluated to ensure the quality and benefit of the outcome. Furthermore, first draft has been represented to SM-DCC, Distribution System and Network Application (DSNA) team and Distribution System Study and Reporting team for their feedback and verification of data. The feedback from different departments has been incorporated to modify datasets and refine the dashboard.

Deployment

When the dashboard finalized and approved by SM-DCC, it has been deployed into MyAnalytics server (quality server for DEWA dashboards used for testing purposes). Additionally, approvals and cyber security clearance has been maintained from DEWA

Innovation & The Future division to publish new Shams Dubai Dashboard into production (analytics server) and DEWA Smart Office Application for mobile and tablets. after deployment, management were granted with view only access to new Shams Dubai Dashboard which is automatically updated whenever database is changed [20-22].

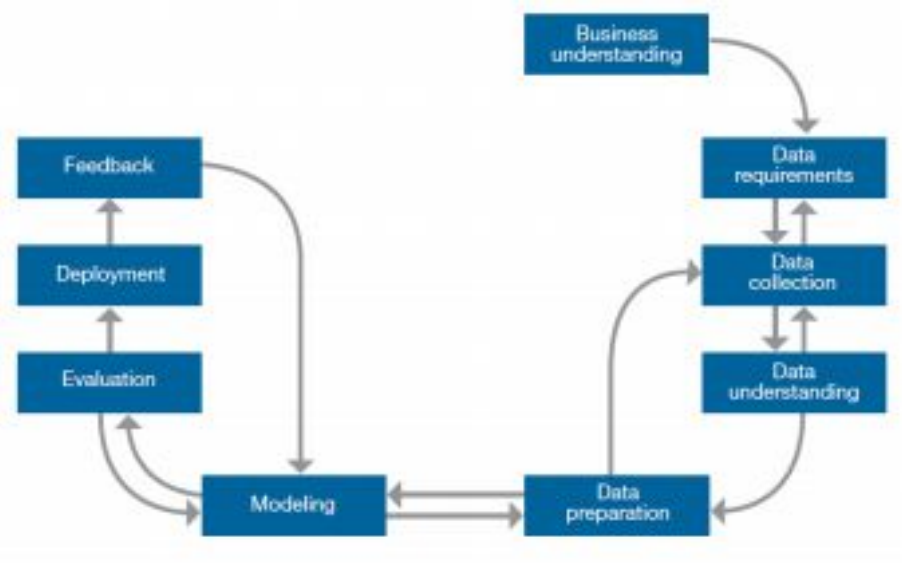


Figure 11: Project methodology

Analysis & Results

Tableau file structure consists of worksheet, dashboard and story. A worksheet is where data can be viewed and built by dragging and dropping fields onto shelves. On the other hand, dashboards are a combination of several views (worksheets, images, text …etc) that is arranged for monitoring and can be considered as slides in a presentation. Finally, stories can be used as presentations to present a sequence of views (worksheets/ dashboards) to convey information

[23].

For Shams Dubai project the file has been developed using Tableau Desktop 2019 version and it contains a story which consists of 3 dashboards and 13 worksheets where each worksheet represent certain data/ information.

Dashboard 1: Shams Dubai Projects

Shams Dubai Project dashboard contains 5 worksheets as shown in Figure 12. The first dashboard objective is to provide an overview of current projects & capacities in pipeline. Further, the percentage increase per year is illustrated as well(% of yr n-[yr n-1]). The dashboard has been generated for Connection Service super department using 5 worksheets as summarized in the below table.

Table 3: Dashboard 1 worksheets

No	Worksheet Name	Description
1	Connected Projects Per Year	The sheet provides a comparison in the capacity installed per year from 2017 till 2020 and the rate of increase each year.
2	Shams Dubai Projects Applications	The bar chart represents the total number of projects per stage.

3	Shams Dubai Project Capacity	The bar chart represents the total capacity of projects per stage in Megawatts (MW).
4	Projects in Pipeline	The pie chart represent upcoming project numbers percentage per stage.
5	Projects Capacity in Pipeline	The pie chart represent upcoming project capacity percentage per stage.

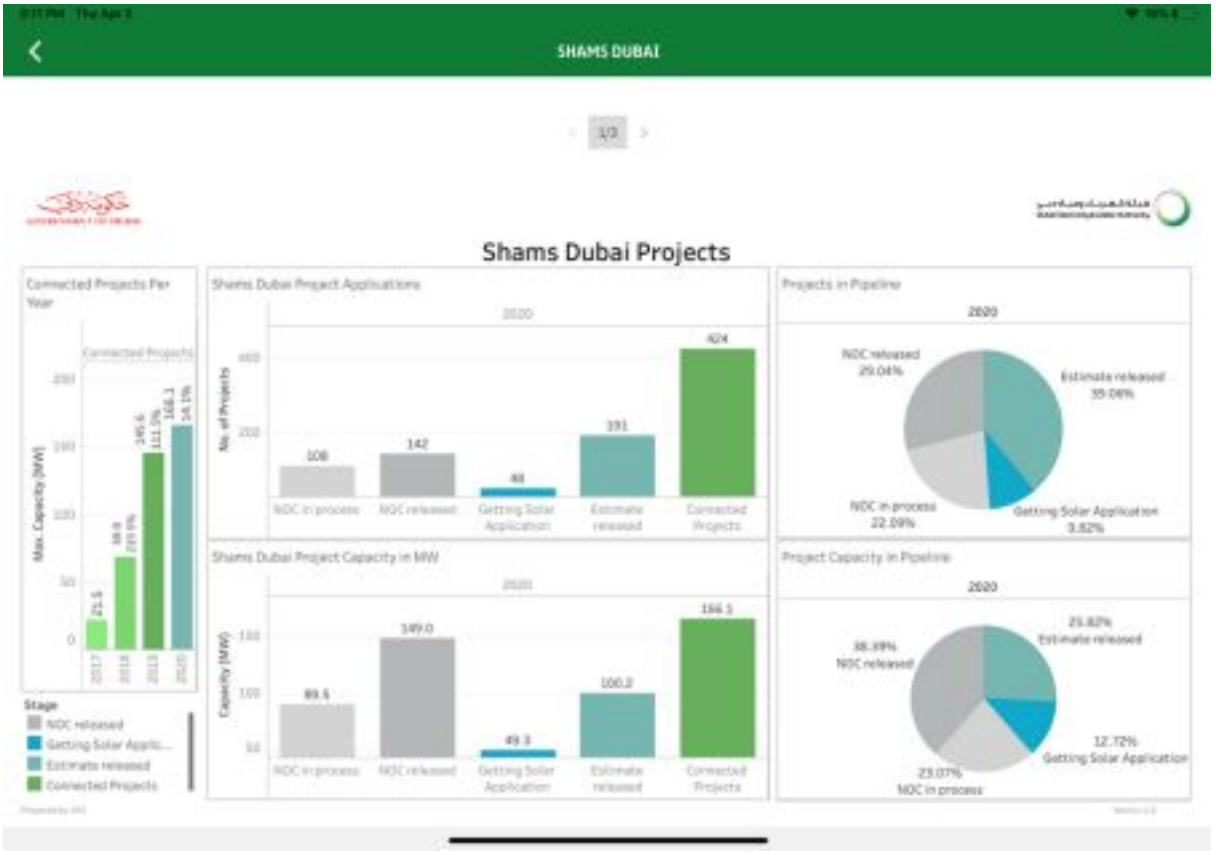


Figure 12: Dashboard 1: Shams Dubai Projects

Dashboard 2: Connected Projects per Zone

Connected Projects per Zone dashboard contains 4 worksheets as shown in Figure 13 (iPad version). The second dashboard objective is to provide an overview about connected projects per operational zones and 400kV substation loops. The dashboard has been generated for Distribution Control Center department and Distribution System Study & Reporting department using 4 worksheets as summarized in the below table.

Table 4: Dashboard 2 worksheets

No	Worksheet Name	Description
1	Shams Dubai per Loop - Map	The sheet represents the total capacity of solar connected in each 400kV loops on map and coloured per zone.

2	Shams Dubai per Loop – bubble	The bubble chart compares the total connected solar in 400kV loops (coloured per zone).
3	Shams Dubai Top 10 Loops	The bar chart arranges the top 10 total connected capacity in 400kV loops (coloured per zone).
4	Shams Dubai per Zone	The pie chart represent the total connected projects per operational zones

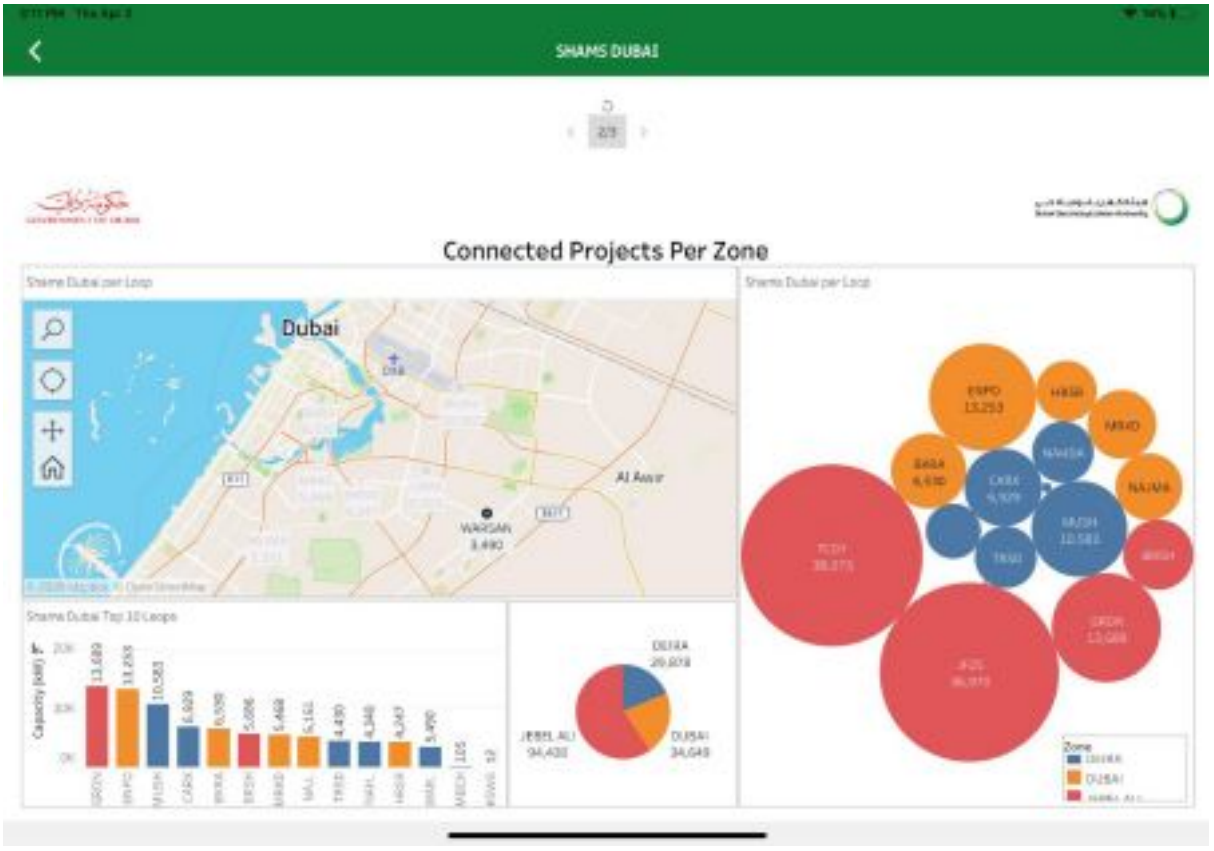


Figure 13: Dashboard 2: Connected Projects per Zone

Dashboard 3: Connected Projects per Primary Substations

Connected Projects per Primary Substations dashboard contains 4 worksheets as shown in Figure 14 (iPad version). The Third dashboard objective is to provide an overview about connected projects per operational Primary Substations (132/11kV). The dashboard has been generated for Distribution Control Center department and Distribution System Study & Reporting department using 4 worksheets as summarized in the below table.

Table 5: Dashboard 3 worksheets

No	Worksheet Name	Description
1,2,3	Primary Substation Capacity per Zone	Three sheets has been used to represent top 10 highest primary substation solar capacity per zone.
4	Connection per Primary Substation- Map	The sheet represents the total capacity of solar connected in each primary substation on map and coloured per zone.

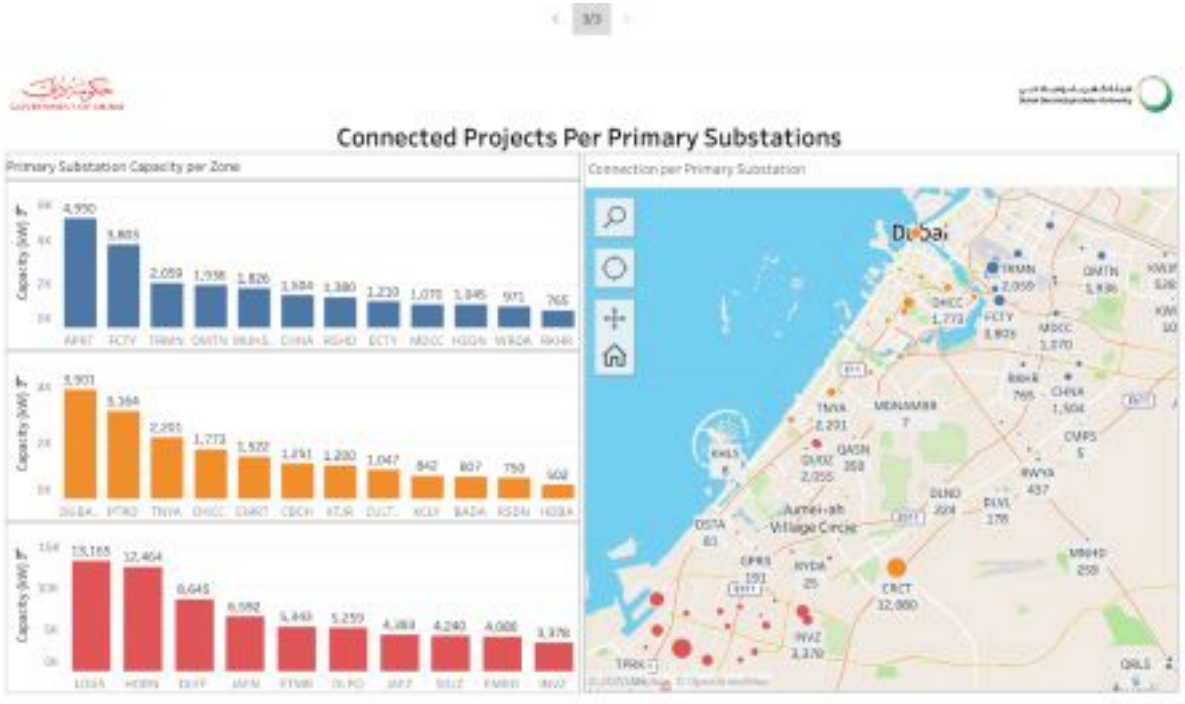


Figure 14: Dashboard 3: Connected Projects per Primary Substations

Testing & Improvements

After the Shams Dubai Story has been deployed into Analytics server, selected users had view only access and provided their feedback. Nevertheless, the full development process has been iterative process and the final feedbacks were minor. The final improvement step was to link Tableau story with SAP system (after BRD development is over) yet the development of Solar data are not yet over by IT department.

The dashboard has been deployed since Feb 2020 and their where no problem yet faced with automatic updates. However, during testing period (past 2 months) the dashboard numbers has been verified manually with existing database.

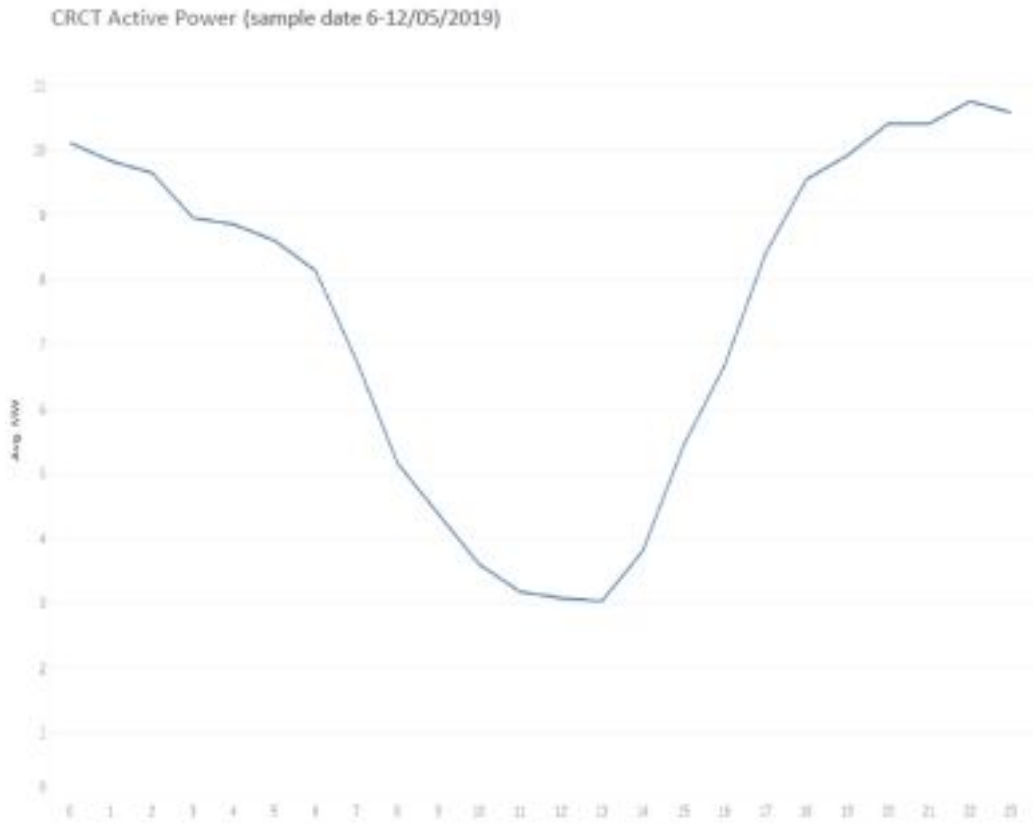


Figure 15: Load Profile of CRCT (P, MW)

Additionally, since in first draft the highest penetration of Shams Dubai capacity was connected to "CRCT" primary substation, the substation load has been studies and the results

indicated that the active power of the substation has an opposite off peak (at 12PM) and peak hours (10PM) compared to DEWA load profile (refer to Figure 15). Accordingly, the information was highlighted to Distribution System Study and Reporting department for their further study.

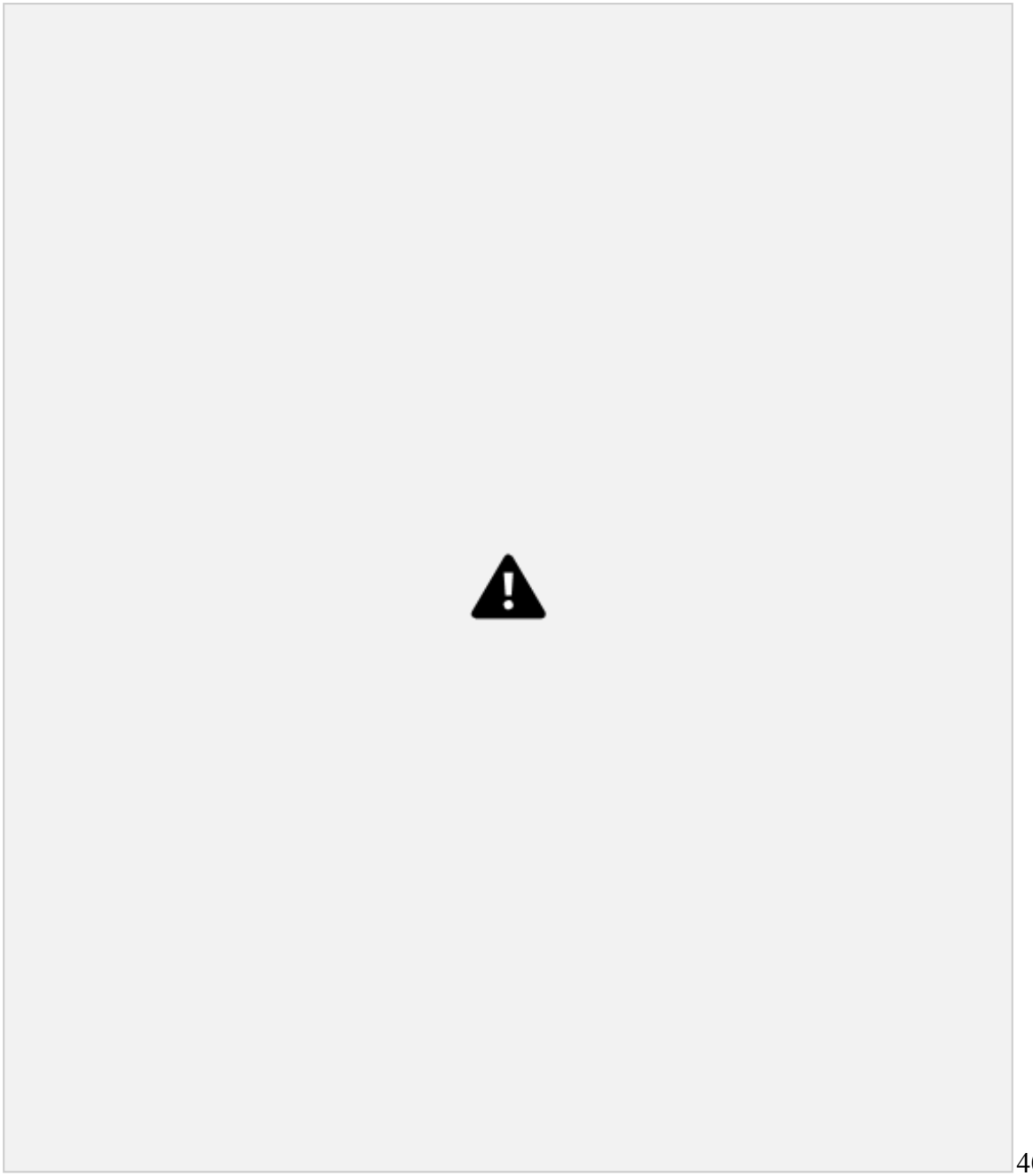
Finally, knowledge sharing sessions has been provided to selected users at Distribution Operation super department to enable other employees of utilizing Tableau Desktop platform for daily study. As a result, new team has been formed to emerge data science tools and utilize them in Daily Operational Report and other reports (refer to Chapter 5 Way Forward for KPI Calculation and Reporting Enhancement Lean Six Sigma Method).

Chapter 4: Project Management

Project Timeline & Tasks

The project deliverables has been studied, designed and deployed within 6 months refer to Table 6 for project tasks & Figure 16 for project Gantt chart.

Table 6: Project timeline



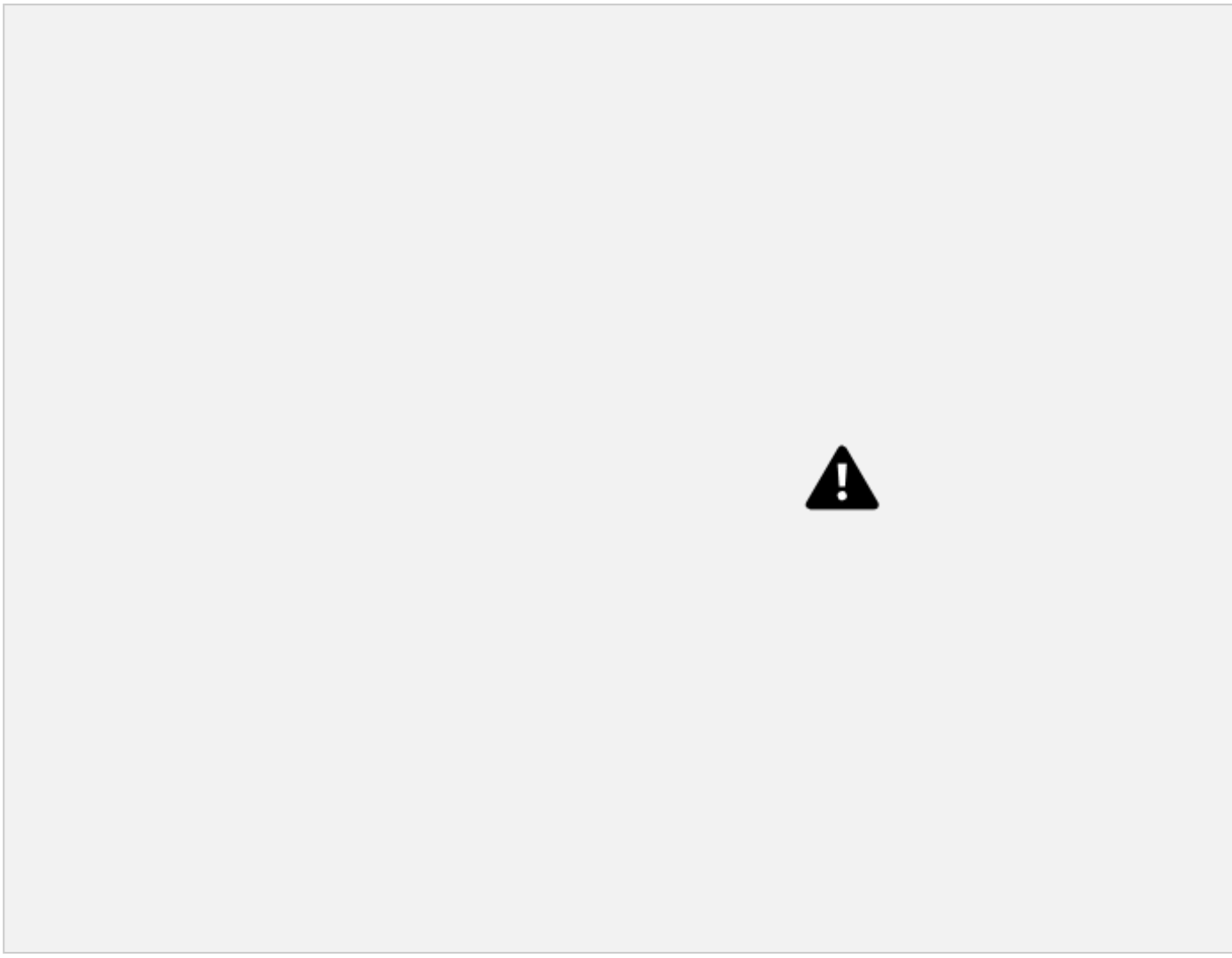


Figure 16: Gantt chart

Project Budget

The project has executed through utilizing multiple resources starting from books, DEWA datasets, internet, Tableau license, DEWA my analytics server, DEWA analytics server, DEWA smart office application server. DEWA has number of Tableau license purchased with maintenance contract and precise price per user is not clear (as it is purchased by different division). Additionally, Tableau desktop is utilized for other dashboard and reports not dedicated for Shams Dubai only. Furthermore, the exact price for servers and server maintenance is not clear as it is maintained by I&TF division. Nevertheless, Table 7

summarises an approximate cost of the project [24].

Table 7: Approximate project cost

No	Item	Unit Price/ Month	Months	Total Prise
1	Tableau Desktop	$42	2	$84
2	Tableau Server	$66.67	4	$267
3	Server Maintenance	$16.67	4	$67
Total Project Cost				**$418**

Chapter 5: Conclusion & Way Forward

Conclusion

In conclusion, digital transformation is emerging into smart cities and energy sector specially distribution. Lacking the right tools to automate and visualize the existing network data may lead to delay in taking accurate decisions. Accordingly, the project has targeted to benchmarking data science tools, suggested most suitable solution to the cooperation needs, automated/ visualize Shams Dubai report in a holistic manner followed by providing knowledge sharing sessions to distribution system study and reporting team for utilizing the new suggested tool.

The project has achieved the target and automated an improved visualization of Shams Dubai report for management and operators. The final solution has been developed using Tableau software and the report is currently accessible on premise servers and even published on cloud. Moreover, the report can be viewed either from website, tablets, iPad or even mobile phones from anywhere in the world.

There were multiple skills learnt during the project for instance communication with

stockholders. Communication during the project has supported to achieve the expected results and meet stockholders requirement. Further, it has facilitated getting Tableau listen, SAP enhancement, SAP data extraction, SCADA data extraction from different divisions. The channels of communication were different and included emails, face to face meetings, web and online meetings. Additional skill learnt was technical skills in Tableau desktop, MyAnalytics server and SAP system. Finally, during the full time of the project, time management was an important factor to deliver the project as planned and on time.

Way Forward

In future, and as the development of SAP BRD enhancement is not yet over by IT, Tableau Shams Dubai file dataset will be changed from existing excel dataset into SAP BW database once development is over. The existing database link only will be changed while the dashboard will not need extra toning as new source will automatically be linked to the graphs. Moreover and as highlighted earlier task force has been created to migrate Distribution System Study and Reports department reports/ dashboards into Tableau starting from Distribution Automation Overview Report (completed on March 22nd) to Distribution Operation Daily Report (on going refer to Figure 17, 18). Figure 19, 20 represents the new Distribution Automation Overview Report developed for migrate Distribution System Study and Reports department. Finally, new initiative has been started to forecast the solar data generation of Shams Dubai with Solandeo (german company) and it is currently under testing.

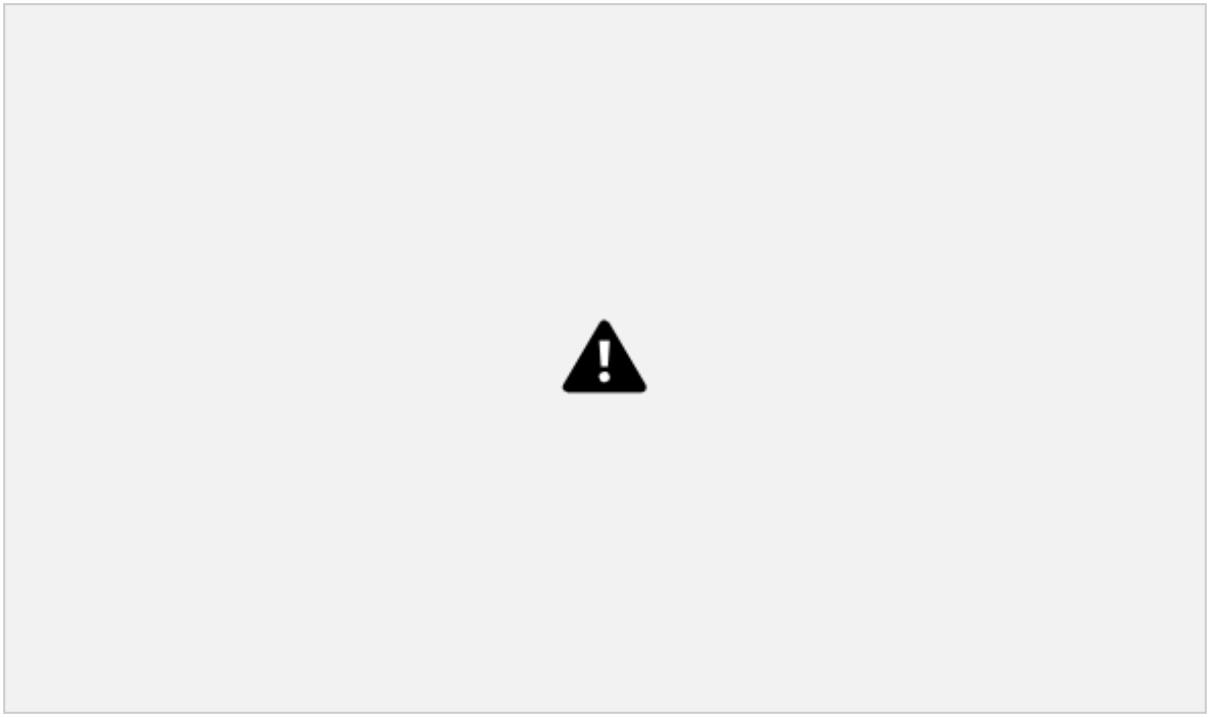


Figure 17: Distribution Operation Daily report frame work

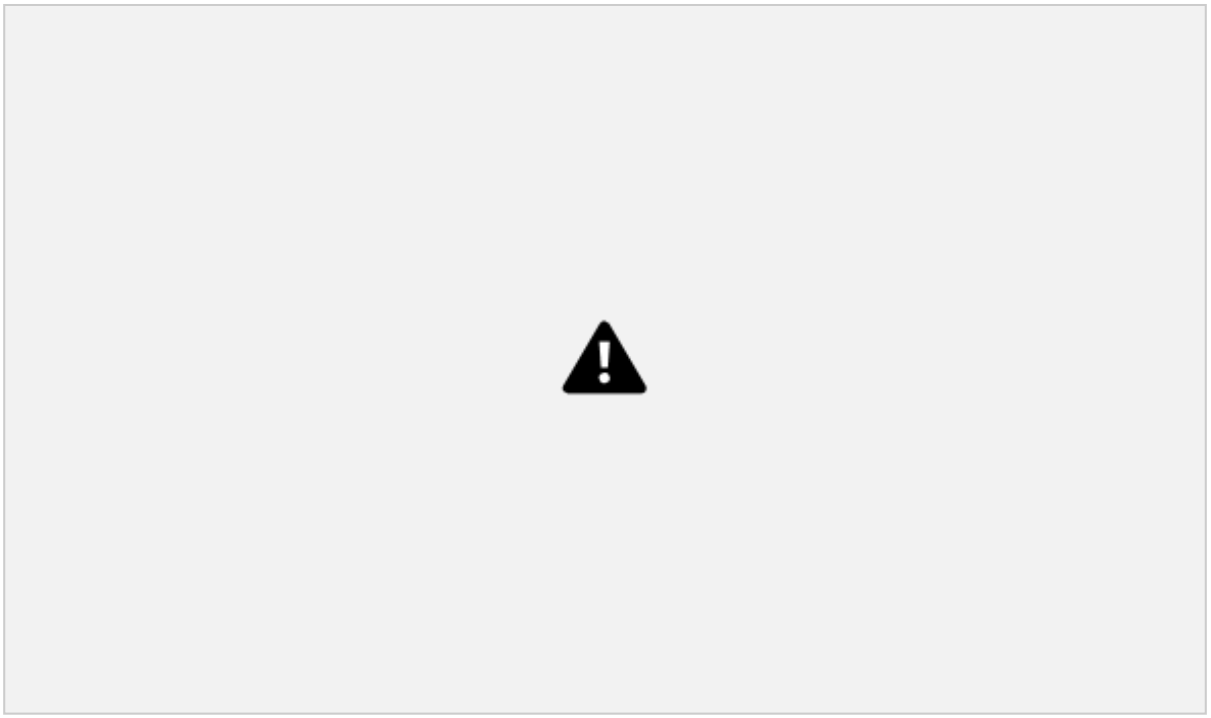


Figure 18: cont. Distribution Operation Daily report frame work

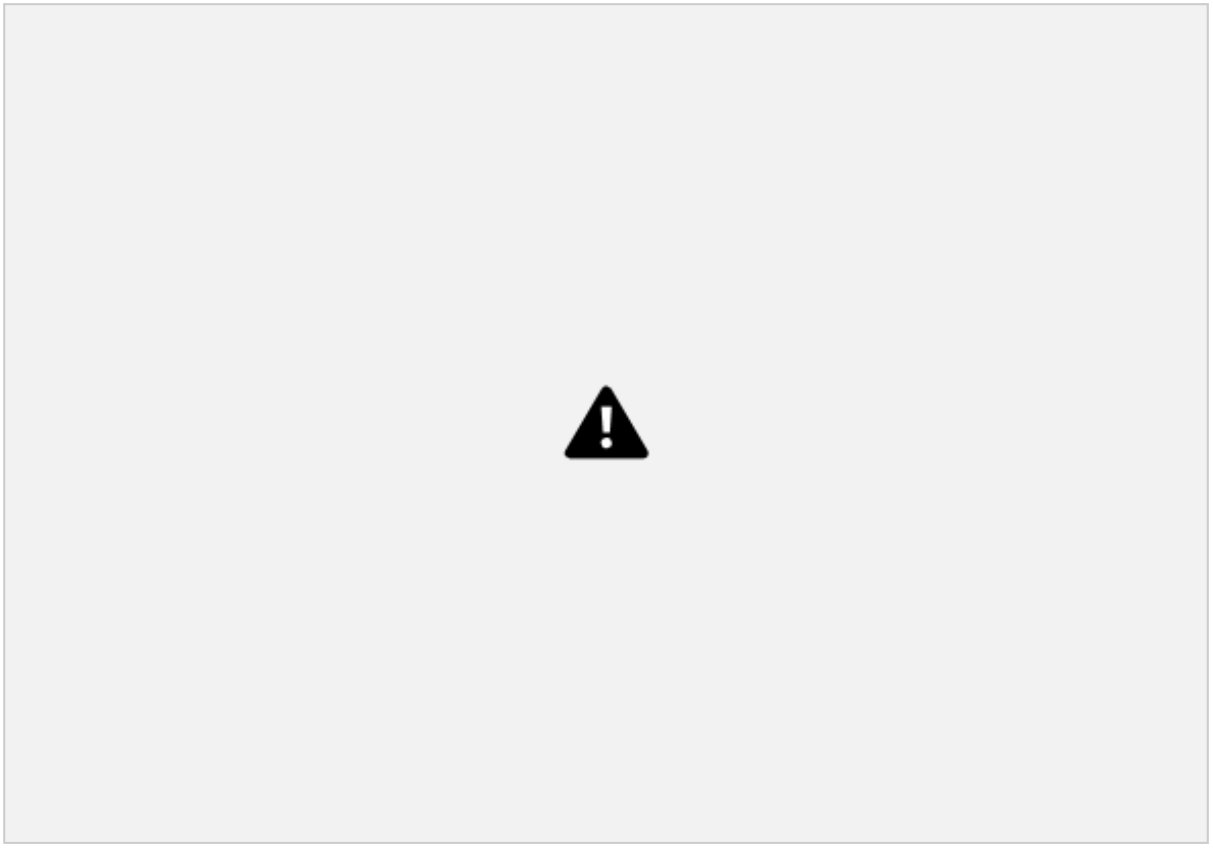


Figure 19: Distribution Automation Overview Dashboard 1

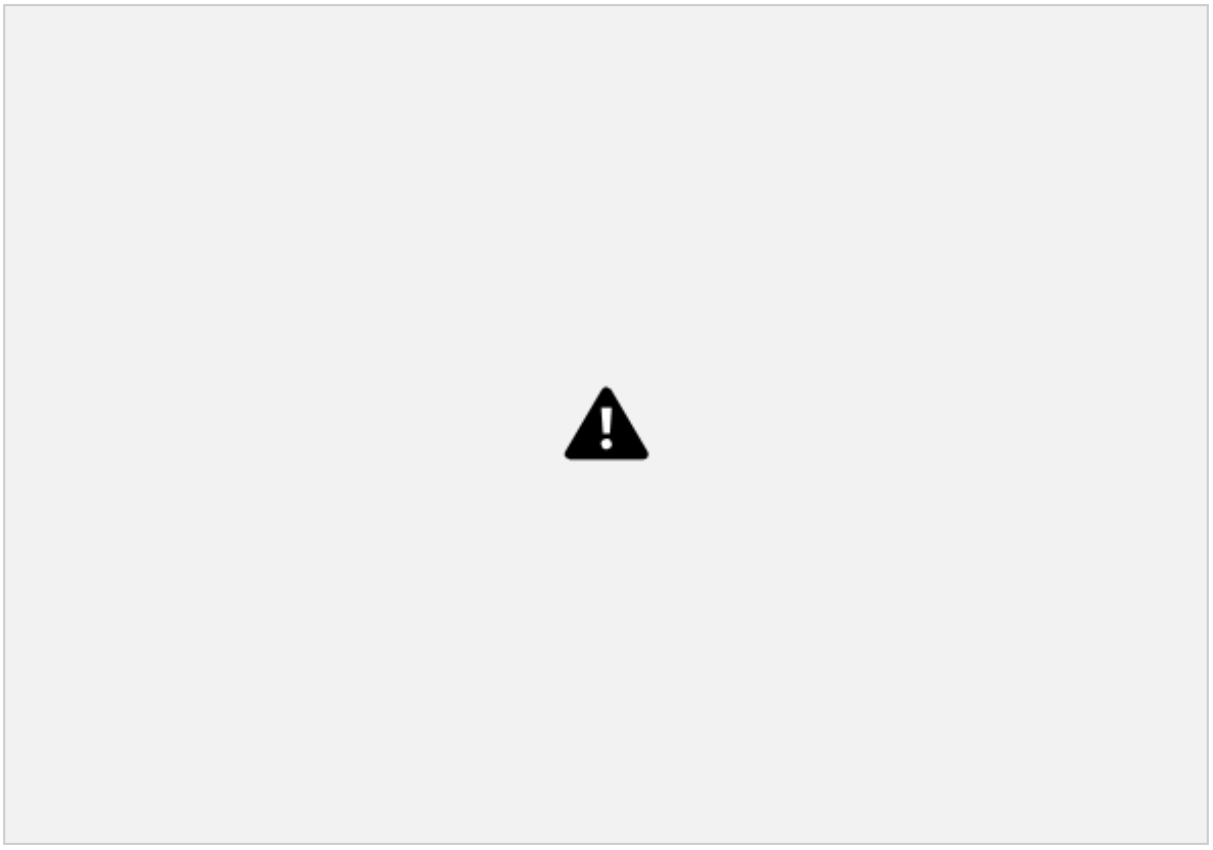


Figure 20: Distribution Automation Overview Dashboard 2

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Appendix

1- SAP BRD Enhancement Minutes of Meeting