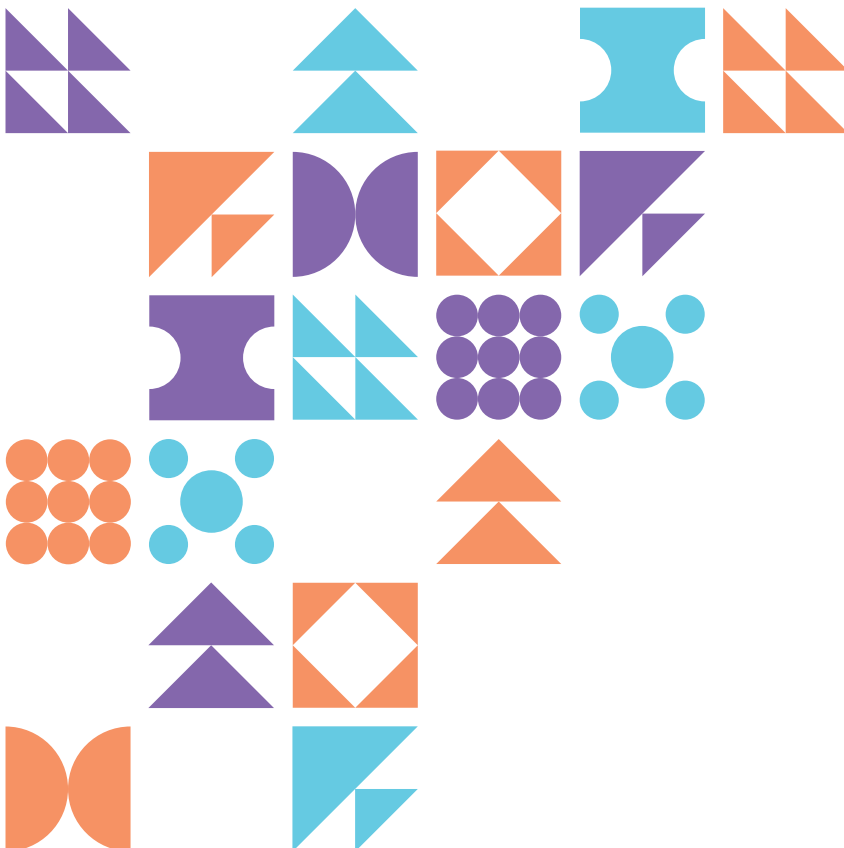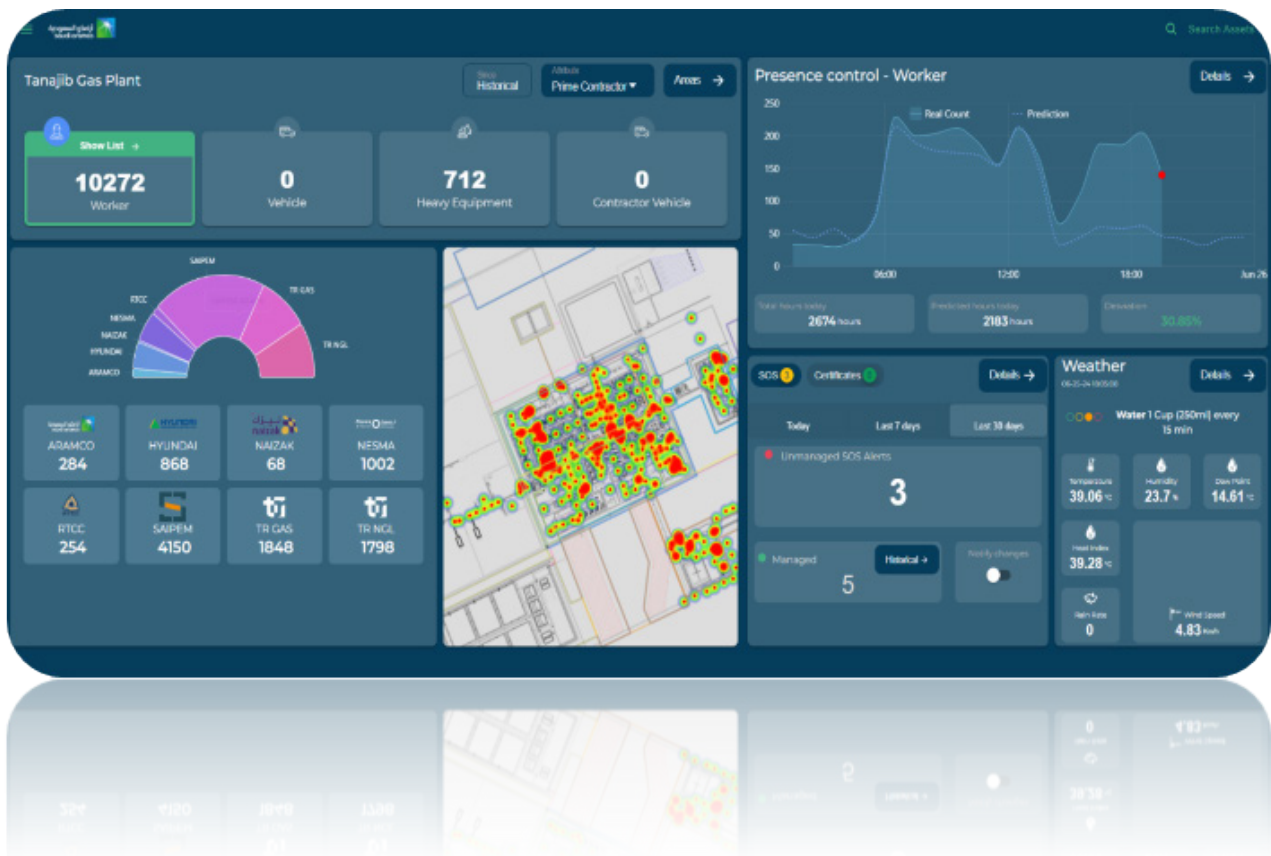# Project Management Institute® Kingdom of Saudi Arabia

Smart Resources Management System for the Construction and Operation of Oil & Gas Industry

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Smart Resources Management System for the Construction and Operation of an Oil & Gas Industry

1.Abstract

The Smart Resource Management System for Oil and Gas refinery construction and operation is an innovative on-site solution developed to handle the particular issues of managing a large-scale construction site and operational facilities. This system combines various technologies, including Bluetooth Low Energy (BLE) 5.0, long-range communication protocols, and edge computing, to monitor manpower resources on-site for both contractor and management personnel. It could also track construction resources like heavy equipment, utility vehicles, active work permits, and high-risk activities. The platform is powered by strong data security, improves operational efficiency, and ensures safety compliance through its extensive features.

Challenges on the Construction Site

•***Monitoring Worker Presence:*** With thousands of workers on site, it is important to know their real-time locations to coordinate tasks and ensure safety. It is challenging to track real-time data of all workers that can be used to allocate resources more effectively, such as assigning tasks based on work priority or equipment availability.

•***Adverse Environmental Conditions:*** Weather conditions can vary drastically, affecting not only safety but also work efficiency. Having accurate and up-to-date weather information is crucial for making informed decisions and preventing accidents and further delays the project.

•***Management of Vehicles and Equipment:*** The logistics of vehicles and heavy machinery on a construction site of this magnitude are complex. Lack of visibility over the location and status of these assets can result in inefficient utilization (misuse) and reducing risk of man-machine interface accidents. You can also, the manage the traffic flow at site during peak hour.

•***Monitoring High Risk Activities:*** Tracking high-risk activities at a construction site is important for mitigating hazards and ensuring worker safety. By monitoring these activities, such as working at heights, operating heavy machinery, or performing tasks in confined spaces, site managers can implement targeted safety measures, conduct real-time risk assessments, and respond promptly correct any unsafe acts or unsafe conditions. However, tracking high-risk activities is challenging due to the need for constant vigilance and the potential for human error in monitoring dynamic site conditions.

•***Monitoring Active Work Permit at site:*** Knowing the active work permits and tracking these permits, management can identify ongoing high-risk operations such as working at heights, hot work, or confined space entry, allowing for enhanced safety measures and focused on supervision.

•***Safety and Emergency Response:***delays of response in case of emergency due to difficulties in locating troubled workers and inadequate monitoring, without an effective alert system, emergency communication can be slow, increasing the risk of severe injuries or fatalities.

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2.The Solutions (Smart Resource Management System)

The Smart Resource Management System for the construction and operation of an oil and gas refinery can manage construction site and can hosts 50,000 workers, 10,000 pieces of heavy equipment, and 15,500 utility vehicles. This system captures and analyzes data in real time, allowing for continuous monitoring of large amounts of resources. It integrates with other site management technologies to create a full site management solution. Furthermore, the system has user-friendly interfaces that are compatible with both desktop computers and mobile applications.

The system's primary features include real-time positioning and tracking of people and equipment on-site, the integration of AI-driven data analytics, and the deployment of weather sensors and emergency response systems. The platform also includes specialized modules like the Worker Management System (WMS), Air Quality Monitoring, Automatic Detection of Personal Protective Equipment (PPE), and Scaffold Management System, as well as support for crane operations and other construction activities as needed. The system includes advanced alarm management and proactive alert systems, which allow the command center and supervisors to respond quickly in emergencies or when assistance is requested. The system can handle the record of al worker such as training history, skills, age, blood type and other important information as well as tracking the location of workers historically.

These alarms, along with SOS alerts, are presented on a dashboard with both audible and visual feedback, ensuring rapid response to incidents. Additionally, the system allows for the creation and management of work schedules, tracking active work permit and determine dynamically the High-Risk Activities. Please refer to Figure 1.
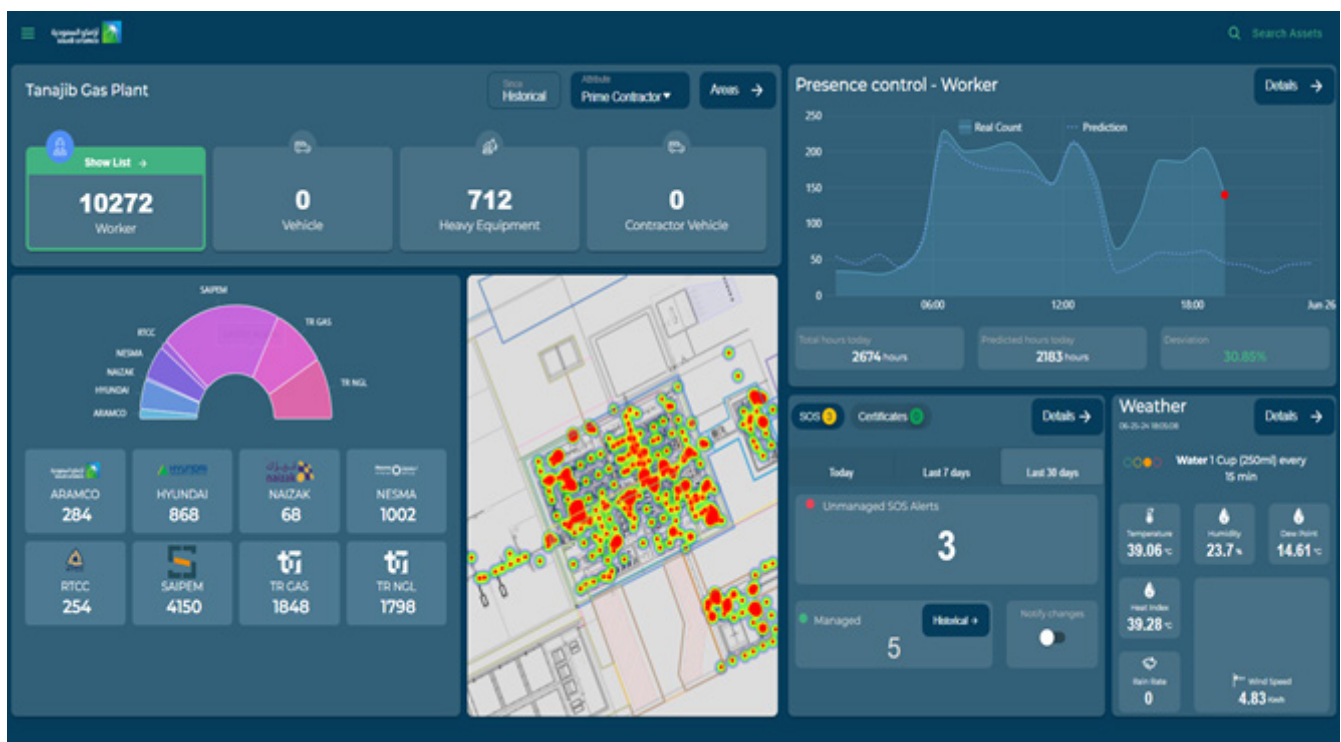

Figure 1: Smart Resources Management System Platform

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The architecture of this solution is shown in Figure 2. This comprehensive system integrates various technologies and devices to ensure efficient and secure site management. The solution includes 4S devices, such as Automatic Vehicle Location (AVL) systems for vehicle tracking, gas and Carbon Dioxide (CO_2) monitoring devices, and end-user devices like helmets and personal terminals. Networking platforms like Long Range Wide Area Network (LoRaWAN) gateway, Bluetooth Low Energy- Long Range (BLE-LR), and Industrial WiFi facilitate seamless communication across the site. CCTV trailers provide mobile surveillance with PTMP (Point-to-Multipoint) connectivity and power supply. Data from these devices and networks is transmitted to the Safety Control Center (SCC), where the platform Infrastructure processes and analyzes the information. The system integration involves protocol converters and channel connectors to ensure compatibility with external protocols and platforms. This integrated approach allows for real-time monitoring, data analysis, and proactive management of site operations, safety and compliance.
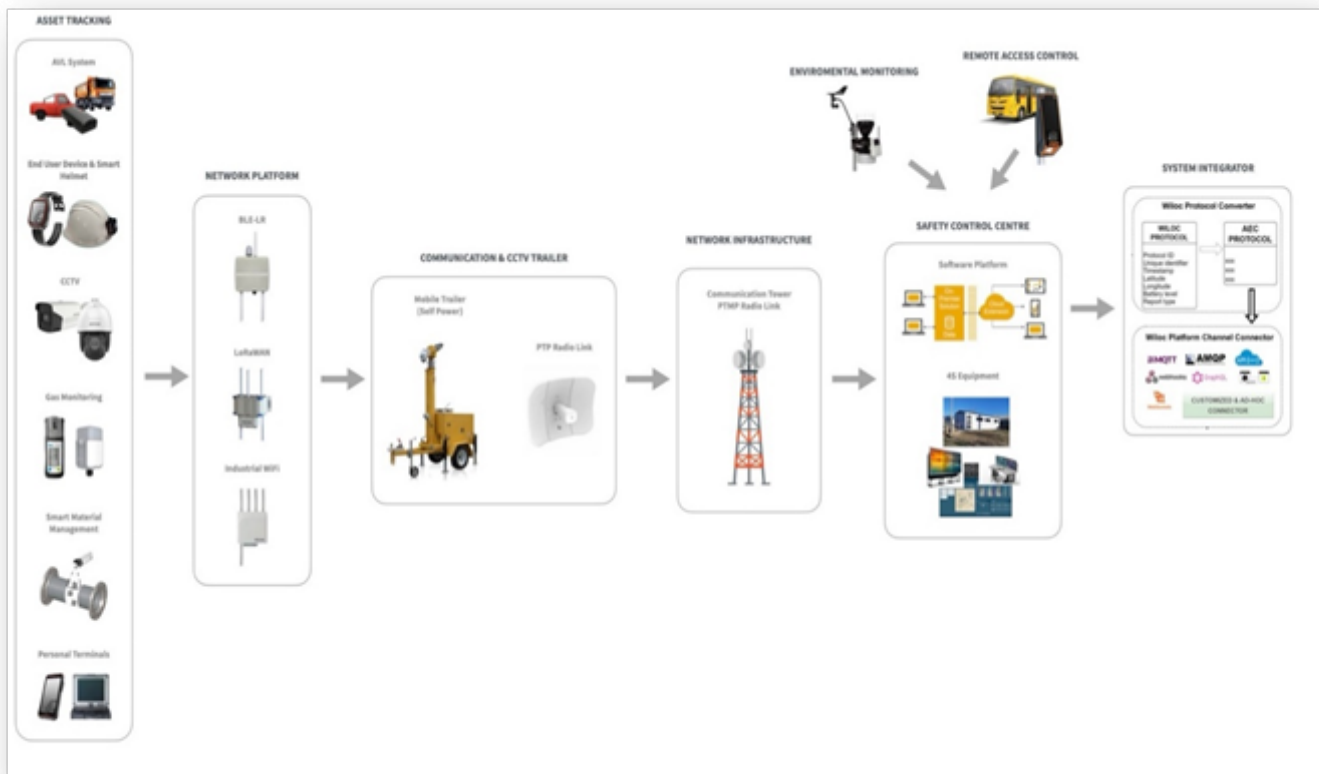

Figure 2. Diagram of the solution architecture

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3.Solution features description and benefits
Here are the features and benefits of Smart Resources Management System:

Functionalities & Features	Description of Benefits
Real-Time Worker Tracking	Monitors the real-time location of 15,000 workers using BLE tags, displayed on a site map. Workers could easily track the real time location at site
Vehicle and Equipment Tracking	Tracks 50,000 pieces of heavy equipment and 10,00 utility vehicles to optimize utilization and safety. By utilizing Global Positioning System (GPS) it can monitor equipment usage in real-time, reduce idle times, and prevent unauthorized access. Additionally, this tracking capability enables timely maintenance scheduling, minimizes the risk of theft.
Weather Monitoring	Integrates a weather station to provide real-time and historical data on environmental conditions such as Heat Index, wind speed, rain rate, etc. which can use to predict any inclement weather conditions.
Alarm Management	Manages various alarms, including low battery, panic button, expired training certifications for workers, expired inspections for vehicles, geofencing areas for high-risk activities. Alarms are displayed on a dashboard with audible and visual alerts, and a smartphone application proactively alerts operators and supervisors on-site. This tool can be used to track workers if in emergency situation.
Itinerary and Schedule Management	Allows creation and management of work schedules, tracking entry and exit times for compliance. The system could detect when did they reported to site and leave from the site.

Functionalities & Features	Description of Benefits
Historical Data Analysis	Stores and analyzes historical data on worker and vehicle movements, environmental conditions, and alarms to improve planning and safety protocols. Can save the historical of the location of every worker.
Integration with Safety Systems	Integrates with existing safety systems to enhance emergency response and compliance with safety regulations.
User-Friendly Interfaces	Provides intuitive desktop and mobile applications for real-time data visualization, alert management, and resources tracking.
Scalable and Flexible Architecture	Designed to scale with the number of assets and adapt to various site conditions and operational requirements.
Edge Computing and Local Servers	Uses edge computing for real-time analytics and local servers for robust data storage and reduced latency.

Worker Management System	Manages work data, training records, and certifications for workers, ensuring compliance and safety.
AI-Driven Data Analytics	Utilizes Artificial Intelligence (AI) for data analytics and edge computing. This feature detects behavioral issues such as not wearing Personal Protective Equipment (PPE) while exposed to hazards, standing behind moving vehicles or heavy equipment, working at height without using a fall body harness, etc. It is easy for the system to track and perform trending of all the safety findings.
Integral Access Control System (IACS)	The solution implements access control through the Bus Management System, improving the security and efficiency of access management. Monitor the number of buses and workers coming in and out of the plant. Additionally, its technology facilitates efficient and speedy entry, minimizing congestion at access point using Radio Frequency Identification (RFID).
Air Quality Monitoring	To improve the health and safety of workers on construction sites and monitor the concentration of harmful particles in the air, we deploy sensors to measure CO2, dust, and other particles depending on the type of risk present on the site.
Monitoring High Risk Activities (HRA)	The mapping features of High-Risk Activities (HRA) allows visualization of high-risk critical activities and management allocated resources, safety interventions and vigilant.
Permit to work	It has a centralized system for managing work permits at construction sites to facilitate tracking of issued work permits, their types, and expiration dates. This feature reduces the risk of unauthorized work and ensures timely renewals. This process minimizes project delays due to permit-related issues.

4.Conclusions

Implementing the Smart Resource Management System in an Oil and Gas refinery's construction and operations marks a significant advancement in site management and safety compliance. This system offers a thorough approach for real-time oversight and management of personnel, equipment, and environmental factors, work monitoring and leveraging advanced technologies that are compatible with and can easily integrate into various existing software. It is a robust, scalable, and flexible solution aimed at addressing the changing demands of large construction projects while ensuring lasting value and sustainability in safety measures.

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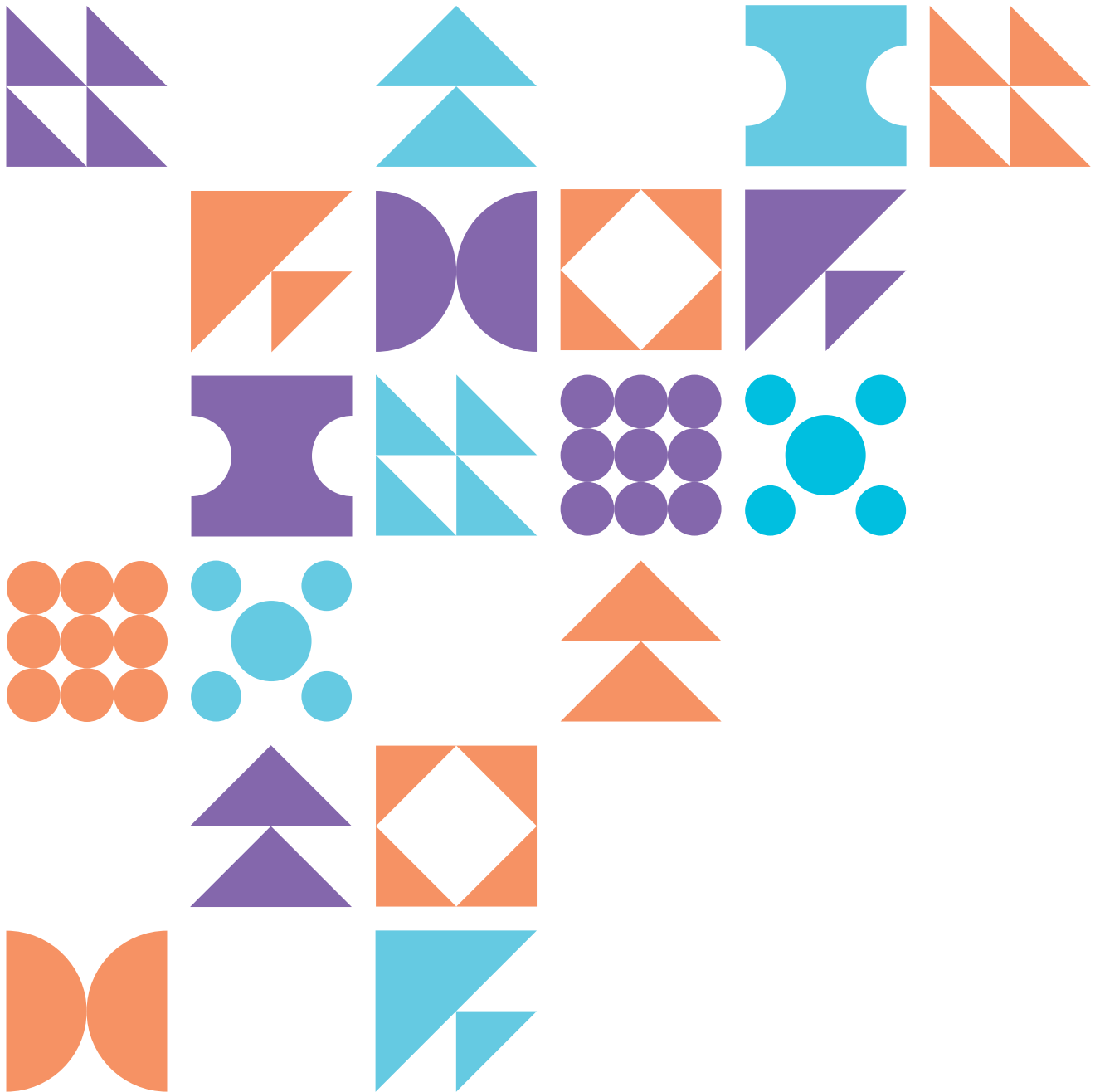
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