International Journal of Multidisciplinary Studies and Innovative Technologies

e-ISSN: 2602-4888
dergipark.org.tr/en/pub/ijmsit
Research Article

2022, 6 (2), 244-249
DOI: 10.36287/ijmsit.6.2.244
Received: Dec. 1, 2022; Accepted: Dec. 28, 2022

TRANSFERRING VULCANIZING PRESS DATA TO THE ERP SYSTEM ON THE CLOUD

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Abstract – Industrial systems have experienced four major revolutions from the past to the present. In light of these revolutions, mechanical systems have replaced human power for the first time. Over time, starting from the steam in mechanical systems, a mass production system has been started, which has reached the present day with electrical energy. Automatic studies have been carried out using electronic relays and control units in systems that have emerged as the concept of automation. Today, controllers have begun to collect the data they receive from the system and need to enable the system to run a process without the need for a human. Thanks to these developments, the importance of collecting and processing data in production facilities are increasing day by day. In line with these collected data, many improvements and reports can be made in production with the support of artificial intelligence. Within the scope of this study, it is aimed to transfer the data obtained from the vulcanization presses in the facility or on the site to the ERP (Enterprise Resource Planning) system. It is aimed to provide faster and ubiquitous access to the requested data by selecting cloud ERP, not physical ERP, as the source of the ERP system. The data are processed primarily in PLCs (Programmable Logic Controller) located over the presses. The processed data is recorded by connecting to a database through the KEPServerEX program based on the OPC (Open Communication Platform). The Node-RED development tool is used for the connection of the database and cloud ERP system, as well as for urgent field maintenance and process preparation stages. Thanks to this program, it is easy to connect multiple applications that are different from each other. Thanks to a node located in the system, the data determined can be sent to authorized persons via e-mail or SMS notification. In this way, the user is notified quickly to prepare the production line for the anomalies that occur or for the different product types in the queue. In line with the collected data, failures that may occur in the future can be prevented, maintenance periods can be deducted with predictive maintenance and other problems that may occur can be prevented. Out of this, production capacity can be determined, the working performances of the working operators can be deduced and planning works can be carried out healthily.

Keywords *– Cloud Computing, Enterprise Resource Planning, KepserverEx, MSSQL, Microsoft Azure, Node-RED, OPC, PLC*

I. INTRODUCTION

There have been four industrial revolutions from the past to the present. The first industrial revolution, known as Industry 1.0, started with the use of mechanical systems that use water and steam power instead of human power. The second industrial revolution, known as Industry 2.0, is the period when mass production lines were created and electrical energy was used. The third industrial revolution, known as Industry 3.0, is the period when programmable logic controllers (PLC) emerged, where digital technologies were used in production. Industry 4.0, known as the last industrial revolution, refers to the system in which production technologies, automation systems, and the technologies that make up this system exchange data with each other. This new system consists of high-tech components such as cyber security, cyber-physical systems, cloud technologies, smart factories, the Internet of things, internet services, learning robots, big data, virtual reality, and 3D printers. With the development of industrial systems, new needs have emerged. One of these needs is the collection and processing of data, and the other is to provide easy access to the collected data. In line with the data collected from industrial systems at regular intervals, the efficiency of production can be calculated, maintenance periods can be calculated with predictive maintenance, and life tests of the materials used can be performed. The collected data can be moved to a cloud system and stored online. Access to the recorded data can be easily provided by people who have internet access and access to the cloud system.

Vulcanization is the process of applying sulfur or equivalent sulphurize to make raw rubber and similar materials more durable. Vulcanization presses provide the process of shaping durable rubber according to the desired molds. As seen in Figure 1, the press consists of three parts: the upper core, the die, and the lower core. First, it provides an upward movement to the lower core. On the bottom core, which enables its movement in the upward direction, the rubber, which is wrapped with certain angles according to its type, is placed by the personnel. The upper core provides a downward movement to exert pressure on the placed rubber. After completing the upper core movement, the mold moves downwards and takes the rubber inside. Steam is given to the system for the cooking process of the rubber surrounded by the mold. When the steam injection process is completed, nitrogen should be introduced

into the press to ensure that the rubber and the mold fully adhere to each other. When the cooking process is finished, the product is divided into three groups with the control of the operator. These groups are given agency, repair, and scrap names. The agent is the nomenclature that corresponds to the available product. Repair is the nomenclature denoting the rework of the product. The products in the repair group are subjected to the re-cooking process. Scrap is the nomenclature that corresponds to the unusable product.

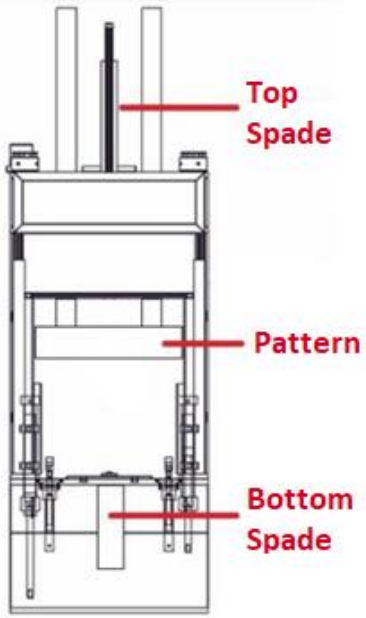

Fig. 1. Vulcanization press working principal diagram

This study aims to transfer the data received from the vulcanization presses to the ERP system. The data read from the PLCs on the presses are transferred to the MSSQL database by using the KepserverEX program. The transferred data is connected to the Microsoft Azure Cloud system through the Node-RED program. Production data can be sent to authorized persons via e-mail thanks to the trigger function created in the Node-RED program. The trigger is created by the code written in the function node. In the production data, firstly, the number of products processed in the presses and how many of these products are processed successfully are selected. Thus, the efficiency of the machine can be analyzed. As another data, it is possible to obtain data on which personnel produce how much product in which shift. In this way, the success percentage of the personnel can also be calculated.

II. OPC PLATFORM

Each device used in industrial systems has a unique communication protocol. Fieldbus, Profibus, Modbus, and CANbus protocols can be given as examples. It is quite difficult to link these protocols together. It is possible to perform operations with the OPC (OLE for Process Control) open communication platform. OLE (Object Linking and Embedding) is a structure that Microsoft has fulfilled due to the low bandwidth of the DDE (Dynamic Data Exchange) object, which enables data transfer between different applications. The importance of OLE/COM integration for automation solutions is recognized by software providers. OPC is a communication standard based on OLE and allows for more efficient and easier communication between different automation levels. This situation is shown in the OPC connection template in Figure-2. Using the OLE technology described above, OPC defines methods and objects to enable communication between different software applications, regardless of whether they reside on a PC or process control equipment in the process management environment [1].

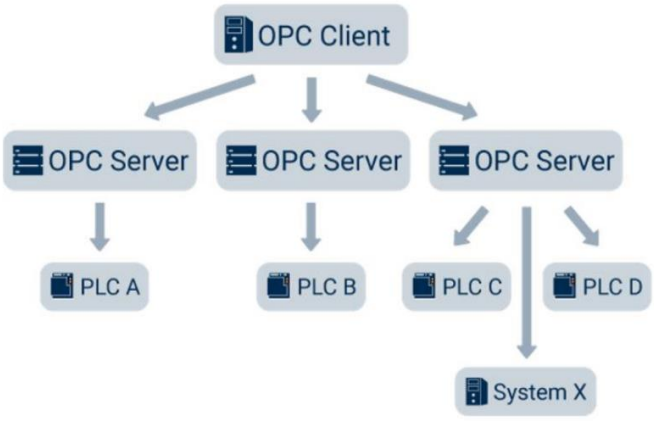

Fig. 2. OPC connection template

OPC standards can be examined under six headings.

1. OPC Data Access: Allows reading and writing data from the system in real-time.
2. OPC Alarm & Events: Allows monitoring of events taking place in the system.
3. OPC Historical Data Access: Allows reading data found in the past.
4. OPC Security: It ensures the security of the connections created on the interfaces.
5. OPC Data Exchange: Provides direct connection between OPC servers.
6. OPC Unified Architecture: It is the standard that uses all OPC standards and web services together. For security in OPC UA, the certificate model has been applied to the computers that will be used to exchange data. According to the certificate model, instead of allowing all kinds of connections, applications with a certain identity are allowed to access through certain ports. Thus, data security is maximized.

III.KEPSERVEREX PLATFORM

KepserverEx is a communication platform that enables connection to different automation devices and software from a single source. It provides the opportunity to control, monitor, and manage the drivers in its system by connecting from a single interface. The above explanation is shown in Figure-3. KepserverEx; It has many drivers such as ABB Totalflow, Allen Bradley ControlLogix Ethernet, Analog Devices, BACnet/IP, Fanuc Focas Ethernet, Mitsubishi Ethernet, Modbus Serial, Omron Host Link, OPC UA Client, WAGO Ethernet, Yokogawa DX Ethernet. It uses OPC and IT communication protocols to present industrial data from a single source.

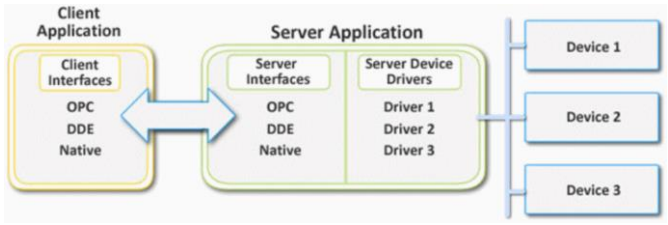

Fig. 3. KepserverEx connection type

This software-based server is designed for accurate communication, rapid deployment, industrial devices, and unmatched interoperability between client applications and systems. The server provides a wide variety of plug-ins and device drivers, and components suitable for most communication needs. The plug-in design and single-user interface provide consistent access from standards-based applications and non-standards-based applications with native interfaces [2].

IV. MSSQL DATABASE

MSSQL (Microsoft SQL Server) is a relational database developed by Microsoft to store data. Relational database management (Relational Database Management System) is called the system that enables the construction of the database by connecting the tables in which the related data are recorded. MSSQL is a corporate system that allows data to be stored securely as well as used by multiple users at the same time. It supports data processing and storage, data indexing and querying, database management, data flow optimization, data reporting, and policy-based data access.

V. NODE-RED INFRASTRUCTURE

Developed by IBM (International Business Machines), Node-RED helps intelligently combine hardware, API (Application 4 Programming Interface), and other online services. It is a browser-based stream editor [3]. The visual of the explanation in Figure-4 has been created. Programs run by connecting more than one node and creating a flow. Node-RED runs on an engine developed by Google called NodeJS and is programmed in JavaScript infrastructure.

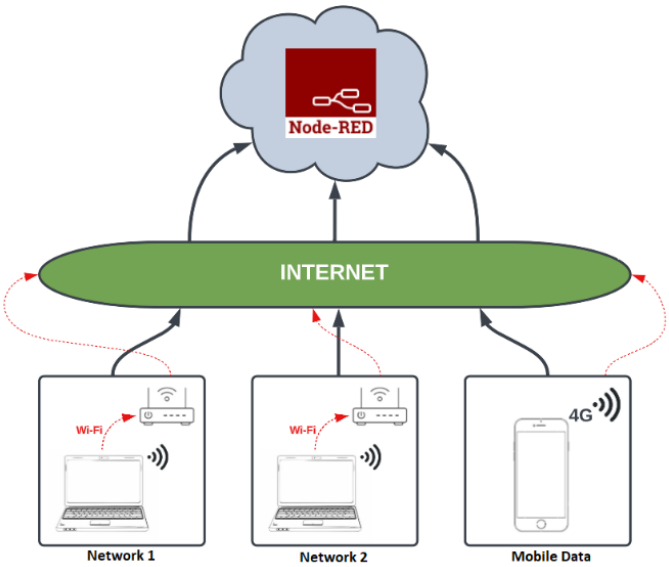

Fig. 4. Node-RED connection type

VI. CLOUD PLATFORM

Cloud computing enables services such as processing, transferring, and storing data over the Internet. They can work independently of hardware and operating systems. They provide a common platform on different hardware and different operating systems and enable applications to run on this common platform. The Cloud computing service model is divided into three models Infrastructure service (IaaS), Software service (SaaS), and Platform service (PaaS) [4]. The Cloud computing service model is created in Figure 5.

Infrastructure as a service (IaaS) is a type of cloud computing service that provides basic computing, storage, and networking resources. Software service (Saas) enables users to connect and use cloud-based applications over the Internet. Platform as a service (PaaS) is a complete cloud environment for development and deployment with resources to enable the deployment of anything from cloud-based applications to advanced cloud-enabled enterprise applications.

Amazon Web Service (AWS), Microsoft Azure, Google Cloud, IBM Cloud, and Oracle Cloud are examples of top cloud computing companies [10]. Microsoft Azure has been chosen as the cloud computing system in this article.

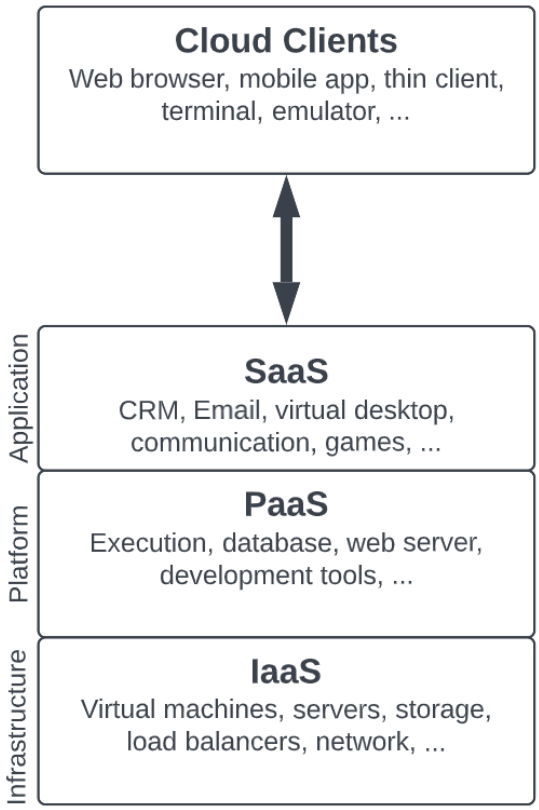

Fig. 5. Cloud platform service model

Microsoft Azure is a cloud platform that can host existing applications and facilitate new application development. Can develop on-premises applications with Azure. Azure allows the integration of cloud services needed to create, test, deploy and manage applications while taking advantage of the efficiency of cloud computing [5].

Three different cloud systems are compared in Table-1. In a situation where the user is interested in analytics such as data visualization, data storage, data log monitoring, and device-cloud messaging, Microsoft Azure is preferred because it has more options than AWS and Google Cloud [7].

Table 1. List of analytics services for the IoT cloud platform

Microsoft Azure	AWS	Google Cloud
Azure Monitor	Cloud Watch	BigQuery
PowerBI	Quicksight	Stackdriver
Azure Storage	Amazon Kinesis	App Engine
Azure Events Hubs	IoT Analytics	Compute Engine
Stream Analytics		

VII. ERP SYSTEM

Enterprise Resource Planning (ERP) or business resource planning is the general name given to integrated management systems that enable the efficient use of resources such as labor, machinery, and materials required for the production of goods and services in enterprises. Enterprise resource planning (ERP) systems are systems that are generally simple to use and try to bring together or help bring together all the data and processes of a business [6]. Figure-6 shows the relationship between the departments covering the ERP system.

Dia, SAP, Canias, Workcube, IFS, Uyumsoft, Logo, Netsis Bilişim, and Akınsoft programs can be given as examples of some of the ERP programs used in Turkey.

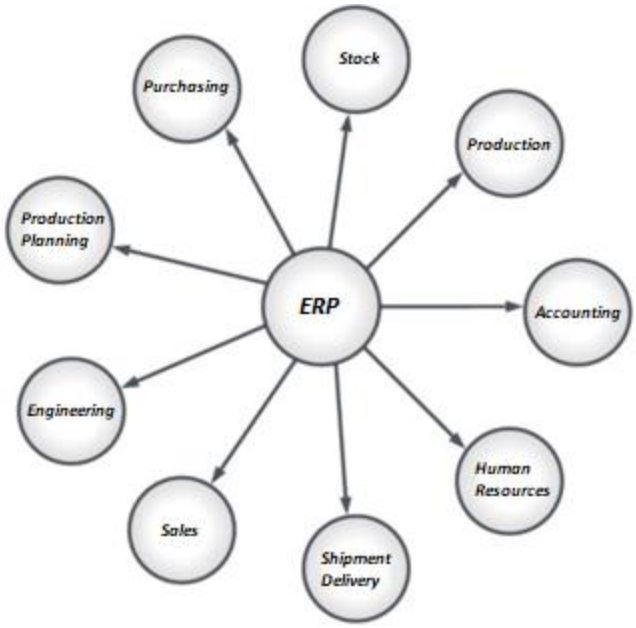

Fig. 6. ERP system

ERP system is divided into two physical ERP and cloud ERP. Hardware and software setups are required for physical ERP systems. There is no need for hardware and software installations for cloud ERP systems. The advantages of the cloud ERP system over the physical ERP system are as listed below;

- Low upfront cost
- Low operating costs
- Fast application
- Scalability
- Ability to focus on core competencies
- Quick updates and upgrades
- Improved accessibility, mobility, and usability
- Easier integration with cloud services
- Enhanced system availability and instant disaster recovery
- Cost transparency
- Sales automation
- Establishment of safety standards
- Free testing opportunity

The cloud ERP system has made it easy to access the desired information from anywhere and at any time when the Internet is available. Payment is made according to the space used on the server. Thanks to this feature, unnecessary payments within the company are prevented. In line with the reasons explained, a cloud ERP system was chosen instead of the physical ERP system in this study. In this way, information is provided through Node-RED in line with the answers from the cloud ERP system.

In this article, we are using Canias ERP system which is one of the most compatible ERP System with Automotive and Energy system. So, this system is able to develop custom scripts with their own programming language. This language name is Troya. For validate this article, I developed small scripts with Troya. These scripts are actually connect data and previous calculations which we gather from Node-Red and database. For instance, The Node-Red service is sending staff shift working performance data, and the script compare their performance with another shift staff data. Another script is saving this data to human resource table with real-time salary calculation. Besides of these, another script is measuring staff's production quality with previous his work shifts. All these personnel scripts are running simultaneously in ERP cloud.

For conclusion, the data performance is totally related with ERP's modularity and database's performance. According to my research, Canias's Troya and Sap's ABAP are best flexible languages for processing big data. With this language, you do not need any high-level programming information such as C#, Java etc.

VIII. TRANSFERRING FIELD DATA TO THE CLOUD

PLCs are generally used to control the input and output elements in the industrial system. PLCs to be used in Vulcanization Presses have been chosen as Siemens' S7 1200 series. The transfer of data to the cloud is shown in the flowchart in Figure-7.

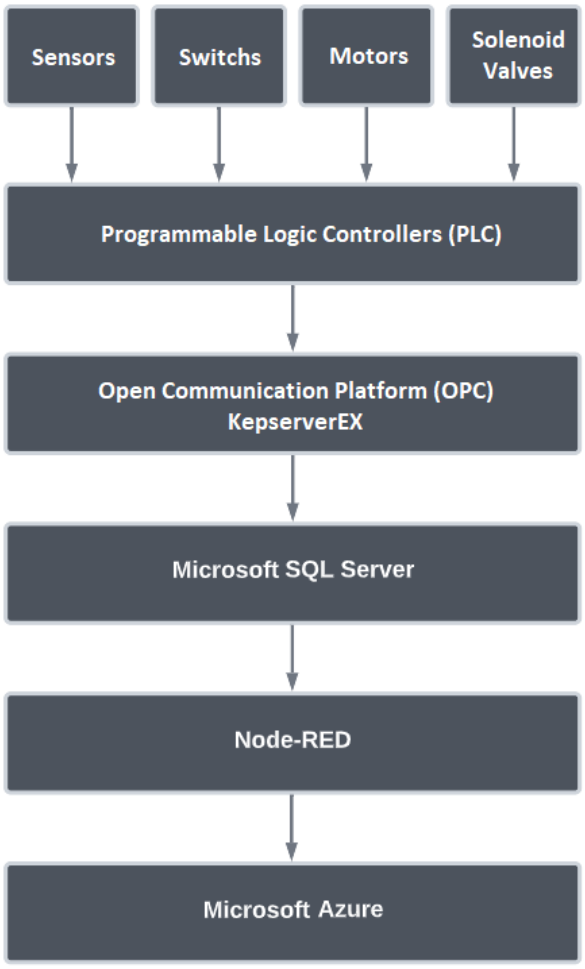

Fig. 7. System flow chart

First of all, 6 of the input and output elements such as sensors, limit switches, motors, and solenoid valves in the system were physically connected to the PLC. The programming of the equipment connected to the PLC is done using the Siemens TIA Portal program. Programming is done using ladder diagrams. The inputs/outputs for which data are requested are defined by the KepserverEX program. For the KepserverEx program, first of all, the channel to be connected to the PLC must be selected. Siemens TCP/IP Ethernet was chosen as the connection channel for this study. After the identification process of the KepserverEx program was completed, the connection with the Microsoft SQL Server (MSSQL) database was made using a datalogger (data collector).

As the first operation, a new database was created in the MSSQL database. After giving the necessary permissions from the created database features, how often to record from the datalogger (data collector) section is selected. After these operations, the requested data is recorded in a new table created in MSSQL. The Node-RED program is used to provide the connection between the table where the records are kept and the cloud systems. In the Node-RED program, the nodes that are used to connect MSSQL and the Azure program, which we have chosen as the cloud system, have been selected. At the same time, feedback from this node will be provided to authorized users. In order to provide the connection between Node-RED and Microsoft Azure, the Azure IoT Hub node was chosen. Azure IoT Hub node allows to connect with four different protocols [8]. These protocols are HTTP, AMQP, MQTT and AMQP Web Socket. MQTT, one of the most popular and reliable methods, was chosen as the connection protocol [9]. The connections of the selected nodes are shown in Figure-8.

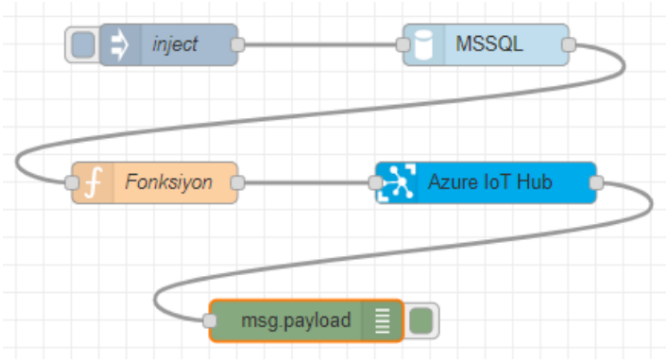

Fig. 8. Connection view of Node-RED nodes

After the data is transferred to Azure, it will be connected to the ERP system used in the company, and it will be visualized and reported in system languages.

IX. RESULTS

Thanks to its integrated structure, the ERP system easily provides information sharing with all units within the company. Thanks to this study, using the data obtained from the vulcanization presses, it has become easier to get reports with certain periods such as daily, weekly, and monthly. In line with the reports received, it facilitated the access of units such as stock, sales, purchasing, or accounting to the number of products produced in the presses, the number of faulty products, or the data generated in the production unit such as malfunctions, increasing communication between units within the company, and a healthy operation was ensured.

Within the scope of this study, the data obtained from the vulcanization presses in the facility or the field were transferred to the ERP system. By choosing the cloud, not physical, as the source of the ERP system, the desired data is accessed faster and from anywhere. The data was first processed in PLCs located on the presses. The processed data was recorded by connecting it to a database through the KepserverEX OPC program. The Node-RED program was used for database and cloud ERP system connection. With this program, two different applications are connected. Data determined by a node used in the Node-RED program could be sent to authorized persons via e-mail. In line with the collected data, future problems were prevented, the production capacity of the facility was determined, and the planning works were carried out healthily. As a result of these processes, it has been ensured that the employees throughout the company, regardless of their business unit or location, can work with the desired data and make decisions in a faster and more reliable way.

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