Data Acquisition and Management in Industrial Businesses Fundamentals and Methodologies

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Abstract – In industrial enterprises, data acquisition is an essential procedure, basically in the industry 4.0 context. It entails taking signals and converting them into digital values that a computer can manipulate. In order to transform analog waveforms into modern values for further processing, information gathering systems are essential. This article focuses on the process of acquiring data in industrial enterprises throughout the age of Industry 4.0 reviewing the constituents of data gathering systems and the significance of accurate and dependable data in portraying industrial processes. In addition, the study examines the classification of production systems according to criteria that influence data accessibility, as well as the various techniques and approaches used for data acquisition. The limitations of human data collection are highlighted, along with the benefits of automated and semi-automated data capturing technologies. Management support systems may get data from industrial automation systems, which are also investigated in the research. Using dedicated servers and communications protocols to consolidate data, it investigates the issues with industry-wide fragmentation in automation systems. The research goes deeper into how machine vision, barcodes, and RFID devices are used to gather data. Finally, the paper emphasizes the need of analyzing the company's organizational and technical environment and proposes a strategy for building a Manufacturing Information Acquisition System (MIAS).

Keywords – Manufacturing Execution System, Enterprise Resource Planning, Manufacturing Information Acquisition System, Supervisory Control and Data Acquisition.

I. INTRODUCTION

It is important for the company's management to be informed about the present status of the production system (PS). The information should include a wide range of topics, such as the following: the execution of production orders, machinery and equipment efficiency, material flow, semi-finished and completed items, staff activities, and product quality. The firm management and the data systems supporting its operations, including Enterprise Resource Planning (ERP) [1] and Manufacturing Execution Systems (MES) [2] should be informed of this information either directly or via middleware. Collecting data from production systems is increasingly crucial in a competitive and globalized market. It is one of the only remaining ways to enhance an organization`s performance by integrating the manufacturing and entrepreneurship layers. Control devices in automated manufacturing systems are outfitted with systems of sensor that collect automated control signals, as well as appropriate communications networks.

Contemporary production systems often use Supervisory Control and Data Acquisition (SCADA) system [3] and Human-Machine Interface (HMI) systems [4] for the management and storage of process information. SCADA systems play a vital role in modern industrial infrastructures and facilities. SCADA systems have transformed into extensive and complex models of data systems and are more susceptible to many forms of security and privacy threats. SCADA systems are crucial for the everyday functioning of widely dispersed essential infrastructures, including gas, water, and electricity distribution, as well as transportation systems like trains. Initially, SCADA systems were self-contained, exclusive, and independent systems where the aspect of electronic or cyber security was mostly neglected.

However, these systems have seen significant transformations in recent years and have developed into complex models of diverse data systems with exceptionally advanced interactions and linkages. The growing reliance of industrial automation and vital infrastructures on these interlinked control systems has led to a rising security risk to SCADA systems. Although a major calamity has been prevented so far, there have been notable incidents. For instance, in 2003, the slammer worm managed to infiltrate a section of the network at the Davis-Besse nuclear power plant in Ohio [5]. Additionally, there was an occurrence where raw sewage was released into streams and parks at a sewage treatment plant in Australia. Furthermore, there was a recent case of hackers gaining unauthorized access to a system employed to operate a segment of a water treatment plant in Harrisburg, Pennsylvania [6].

Modern companies use Human Machine Interfaces (HMIs) that represent intricate systems, vast quantities of data, extensive automation, and safety management systems. These advancements impose a greater cognitive burden on operators, hence increasing the likelihood of mistakes. Effective interface design facilitates operators in efficiently and accurately fulfilling their tasks with few mistakes. Inadequate design leads to heightened response times and a greater probability of errors in perception and comprehension.

Halmetoja [7], a deficient HMI information display increases the chances of accurately predicting an abnormal occurrence by a factor of five. Chan, Baghbaderani, and Sarvari [8] indicates that 70% of industrial accidents may be attributed to human mistake. Thus, it is essential to create Human-Machine Interfaces (HMIs) that are tailored to operators' needs in order to optimize their use, management, and retention of process information. HMI is constructed using either an FPGA chipset or a microprocessor. The software for this interface must comprise, at a minimum, an operating system and an application program. **Fig 1** depicts a standard software system architecture for HMI. The HMI software must be compatible with both hardware of the system and the operating system.

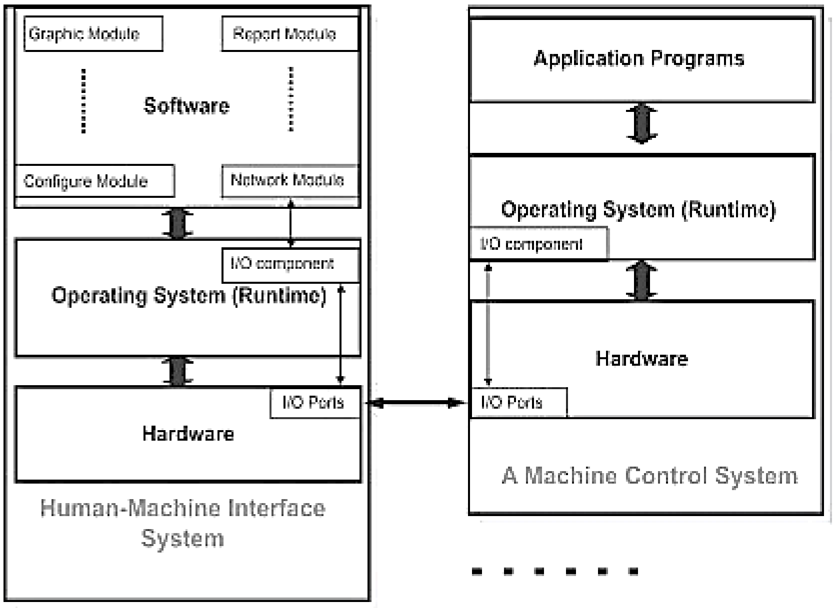

Fig 1. Software System Standard Architecture Used for Human-Machine Interaction.

The issue in this scenario might arise from the lack of compatibility and coordination across devices, networks, and software developed by various manufacturers over different time periods. Furthermore, the solutions must effectively manage a substantial volume of acquired data, necessitating the identification and extraction of pertinent information. When the degree of automation of technical processes is minimal, many issues arise with data collecting. Companies that primarily rely on basic equipment and human labor lack comprehensive data on their manufacturing processes and material flow. The acquisition of data mostly relies on manual methods, resulting in significant delays and a lack of trustworthiness. The issues highlighted need the systematization and development of ways for acquiring information on production and material flow from enterprises with varying degrees of automation in their production processes.

This paper seeks to provide a justification for the significance of data capture in industrial enterprises, particularly in the age of Industry 4.0. The text emphasizes the significance of data capture systems in transforming analog signals into digital values for further processing and analysis. The report highlights the need of obtaining accurate and dependable data in order to appropriately reflect manufacturing processes. The report also examines the distinct elements of data acquisition systems, including analog devices, digital input/output circuits, and converters. The paper elucidates the procedure of data conversion, including quantization and codification, and presents instances of gadgets that want analog-digital connections. The study emphasizes the significance of many categories of production data, such as order data, personnel data, and technical production data. The research highlights the significance of data collecting in the automated management, diagnosis, and control of production processes.

The remainder of the paper is organized as follows: The second section presents a review of the basics of data acquisition. The organization of data acquisition approaches such as manual data acquisition, automatic data acquisition, and semi-automatic data acquisition, has been discussed in the third section. The fourth section presents a review of the manufacturing information acquisition system (MIAS). This section discusses the development to analysis phases of the system; including the synthesis phase. The fifth section presents a summary of the findings in this article.

II. BASICS OF DATA ACQUISITION

The practice of sampling signals, which determine physical factors in the real world and transforming the resultant samples into modern numeric figures that may be controlled by computer systems is referred to as data acquisition (DA). DA systems, often referred to as DAS, DAQ, or DAU, primarily perform the conversion of analog waveforms into modern values to facilitate further processing. In general, DA refers to the systematic acquisition, filtering, and purification of data prior to its placement in an information warehouse or other systems of storage. The placement of big data acquisition within the broader big data value chain is shown in **Fig 2**. The capture of large-scale data is primarily regulated by four key factors known as the four Vs: value, volume, variety, and velocity. In most information acquisition situations, it is assumed that the data is high in volume, velocity, and variety, but low in value. Therefore, it is crucial to have flexible and time-efficient algorithms for cleaning, filtering, and gathering the data. These algorithms ensure that only the valuable portions of the information are processed in the synthesis conducted by the data warehouse. Nevertheless, several firms consider the majority of their data to be potentially valuable, since it plays a crucial role in attracting new clients. Data analysis, categorization, and packaging of large data quantities are crucial tasks for such businesses, after data capture.

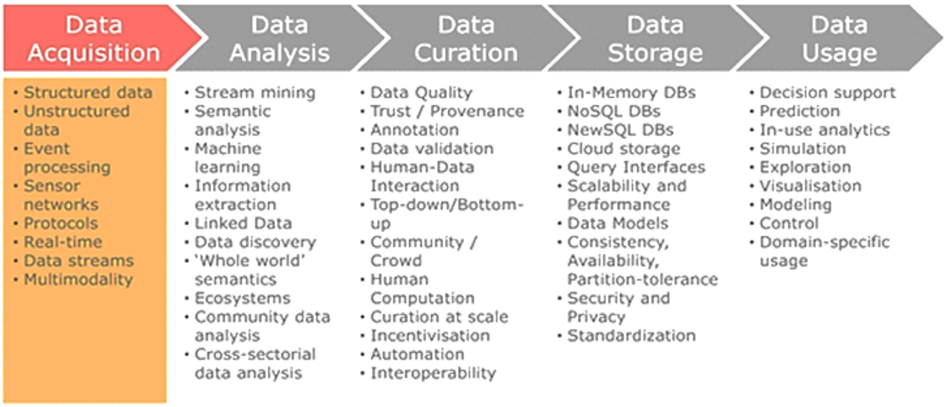

Fig 2. Information Acquisition Within the Value Chain of Big Data.

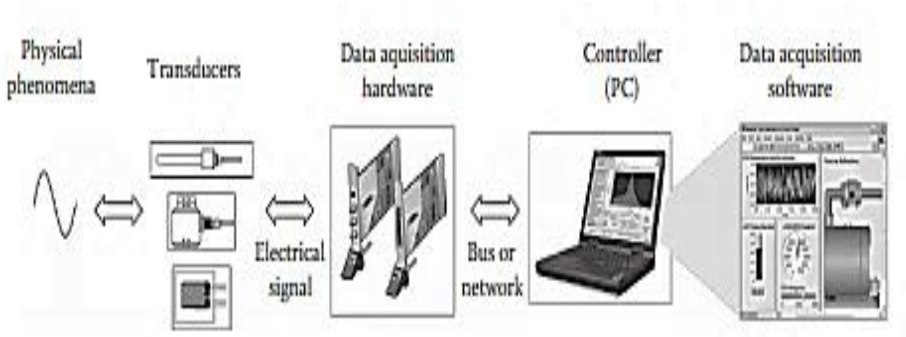

Fig 3. Fundamental Components of a Data Acquisition (DAQ) System.

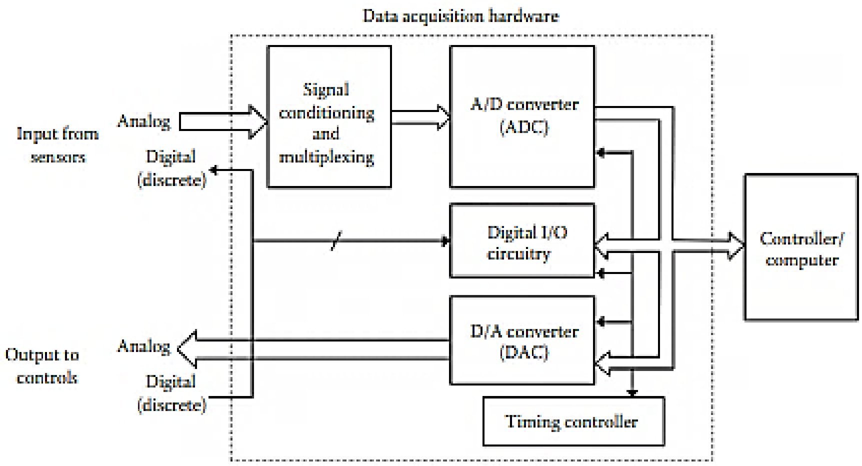

Fig 4. Structure Of a Multifunction Data Acquisition (DAQ) Device.

Fig 3 shows the fundamental components of a data acquisition system that runs on a computer. Almost all process equipment, including final control components, sensors, and transducers, are analog devices that either produce or function with analog electrical alerts. In most cases, data acquisition gear is responsible for transforming analogue signals into digital ones and vice versa. In most cases, a computer, like a regular PC, is used in co-occurrence with the DAQ device. DA software processes and records the data on this figure's computer. There is a wide variety of possible designs and implementations for the DAQ devices. In addition to modern outputs and inputs, analog outputs, and other timing and counting functions, the majority of these devices also have the ability to accept analog inputs. For instance, a simplified block diagram of a common versatile device that is sold by many suppliers is shown in **Fig 4**. The components comprise a time controller, digital input/output circuitry, an analog-to-digital converter (A/Ds or ADC) with associated signal constraining, a digital-to-analog converter (D/As or DAC) or converters, and maybe more.

Data conversion, or the process of transforming analogue signals into digital forms and back again, is fundamental to data acquisition systems. The signal is quantized and then codified in two stages to complete the conversion. Codification is the process of expressing these distinct values by bit succession, while quantization is the process of encoding the constant values of the analog alert using a set of distinct values. For any given number of bits in these sequences, there are 2n potential conversion values. Common examples of devices that call for analog-digital interfaces are electronic fuel injection, temperature controls, CD music systems, computers and associated peripherals. All of the quantification and codification work is done by the A/D electronic circuit. For instance, the analog-to-digital operations operate within the range of -SV to +SV using signals of defined magnitude. The conversion of digital signals to analog signals is carried out by an auxiliary electrical circuit known as a digital-to-analog converter (D/A). This device converts n-bit digital information into a signal that has 2_n distinct current and voltage levels.

III. ORGANIZATION OF DATA ACQUISITION APPROACHES

In the age of Industry 4.0, obtaining production data is a crucial part of digitization for industrial companies. The rationale for this is that precise and reliable data is necessary for manufacturing businesses to get an authentic representation of their production activities. In order to streamline the process of production planning and administration, it is necessary to use an automated Personal Digital Assistant (PDA) system [9]. In today's data-intensive environment, several industrial enterprises now depend on intelligent personal digital assistants (PDAs) to gather production data automatically, precisely, and instantly. Consequently, they may enhance the level of transparency in the production process, detect areas that need improvement, and take appropriate action. PDA systems, like Böhme & Weihs' devices, are a prevalent element of intelligent MES. A MES enables the implementation of an automated workflow for production planning and management, beyond the capabilities of an Enterprise Resource Planning (ERP) system. **Table 1** provides a detailed comparison of organizational production data and technical production data, which are only two examples of the many types of product data.

Table 1. Types Of Product Data

Type of product data	Sub-category	Description
Organizational production data	**Order data**	Order data is used to track the status of the order. They play a crucial role in the further processing of produced goods. The data include production metrics such as quantity, weight, and numbers, as well as work progress, order status, and feedback about order-related performance.
	Personnel data	Personnel data document the attendance and nonattendance of workers. Flexible work time models allow for precise calculation of pay. Personnel data include several types of information, such as attendance records, work hours, compensation expenses, and access restrictions.
Technical production data	**Machine data**	Machine data refers to the whole of information that is produced by machines. The factors to be considered include the duration of operation, the extent of use, the periods of inactivity, the occurrences of failures, and the amount of energy consumed. Additionally, the quantities of output, the efficiency of production, and the number of rejected items should also be taken into account.
	Process data	Process data involves analyzing and evaluating the many aspects that impact the production process, with the aim of stabilizing and improving the processes. They include crucial data on quality attributes, setup details, and process variables.

Data acquisition is often performed in production systems for several purposes, such as the automated control of technical steps, the diagnosis of machinery, processes, and the administration of an organization`s production system. To address the issue of information acquisition for maintenance objectives, it is necessary to first categorize production systems based on the factors that impact data availability. The primary criteria for this categorization might be the level of automation in the technical operations. Based on these criteria, it is feasible to categorize the following kinds of systems of production: 1.

Mechanized systems devoid of any means of automation, 2. Automated systems (AS) utilizing older or less improved control machines lacking interfaces of communication, 3. Automated systems employing contemporary control machines with network interfaces, 4. Systems predominantly reliant on manual operations or basic equipment and tools. It is necessary to classify the means and methods of data gathering in order to facilitate the creation of a methodology for data collecting for management objectives. **Fig 5** depicts the recommended categorization of data collecting techniques for the purpose of firm management.

In firms where manual procedures are prevalent, the primary means of retrieving information is via manual acquisition. It relies on direct conversation among workers at various management levels. This method is characterized by several limitations, namely its inefficiency within the framework of contemporary industrial systems. The process of traditional acquisition is often linked to the occurrence of delays and mistakes. Moreover, diverting staff from their main duties to maintain records diminishes productivity. In order to meet the demands of contemporary systems of management such as ERP and MES, it is essential to use result that are both highly dependable and efficient. This results in the establishment of the acquisition technique, known as semi-automatic acquisition (sometimes referred to as aided manual acquisition).

These approaches include less human engagement, with the employee's activities being supported by hardware and software solutions. These solutions help decrease errors in data collecting and improve its speed. Stationary or mobile hardware and software solutions may be used to achieve semi-automatic data collecting. The foundation of most of these solutions is in the technology of autonomous object recognition. These solutions enable the gathering of data for managerial reasons, from both non- and semi-AS of production. At now, several techniques are used for the automated recognition of objects. They may be derived from several sources such as barcodes (optical scanning), magnetic tracks, radio frequency identification (RFID), picture studies, or speech recognition. Automatic acquisition refers to the extraction of information from automatic control systems and technological processes without any human involvement. The data is supplied from a variety of devices including SCADA systems, sensors, industrial controls, "smart" actuators, robots, CNC machines, and other sources. Machine Vision and automated identification technologies are often used in this scenario to assist with process control and data collecting.

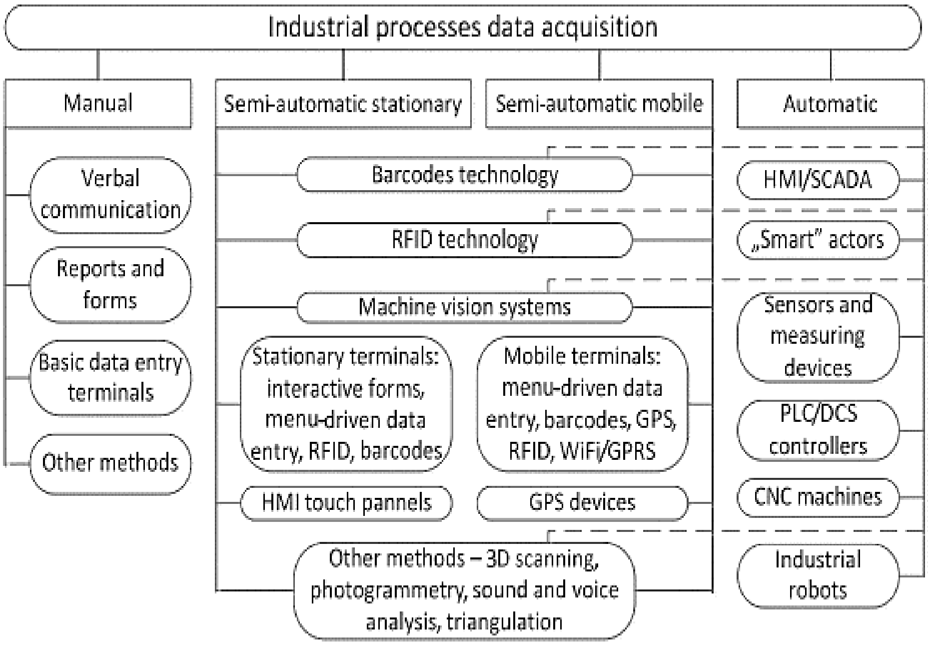

Fig 5. Categorization Of Techniques for Gathering Data from Production Systems.

Manual data acquisition

The use of automation, robotics, and mechanization in industrial processes leads to a significant decrease in human involvement. However, several operations remain unautomated mostly owing to inadequate profitability. Based on the particularities of the production procedure, the employee may assume various roles such as doing manual activities, working in the warehouse, equipment, operating machinery, or modes of transport. Data collected from employees is often inputted into the control support models by data entry operators or mid-level supervisors. Information may be inputted directly into the entrepreneurship layer, such as ERP models, or into different kinds of templates using a typical spreadsheet. Research and experience have consistently shown that workers are an unreliable source of information, often delivering it with significant delays and inaccuracies due to subjectivity, carelessness, or intent. The predominant approach to manual data acquisition is gathering information directly from workers via conversations (either in person or over the phone) or through the use of forms and reports (which may also include basic computing tools such as spreadsheets and word processors). These procedures are inadequate in the contemporary industry, and it is essential to develop new, more dependable ways.

Automatic data acquisition

Data acquisition (DA) [10] for management purposes may be automated in production systems. These technologies adequately address the requirements for acquiring data from the automated portion of the PS. DA for control purposes is often automated, eliminating the need for staff interaction. Collected data for process control may also be used for management objectives, although preprocessing and suitable interfaces are often required. The different elements of the automated data acquisition method have been described in **Table 2**.

Table 2. Components Of Automatic Data Acquisition

Component	Description
Primary data sources	The primary sources of data consist primarily of a range of transducers and sensors that convert the physical events present in the habitat into electrical signals. Sensors are capable of quantifying or identifying several parameters, including acceleration, location, temperature, motion, pressure, and the availability of objects within the sensor's operational range.
Secondary data sources	Secondary data sources (SDS) [11] include systems and devices that depend on data derived from main sources. SDS have the ability to generate additional data from the original data, which is essential for the purpose of control. Some examples of these devices include industrial controllers such as PLCs, DCSs, and IPCs, as well as SCADA systems, CNC machines, and industrial robots.
Interfaces, standards, and networks	The data collected from the control models has to be transferred to the higher-level business models through suitable interfaces, facilitating the advancement of these systems at both the software and hardware levels. The market of automation systems is plagued by several issues stemming from excessive fragmentation.
The OPC standard	The OPC standard included dedicated servers that are responsible for gathering and distributing diverse data from industrial control devices. OPC enables the provision of client software with access to a wide range of data, including current and historical data, alerts, events, and more. The server is often specialized for a certain collection of PLC machines from a particular standard or a single vendor.
MTConnect	MTConnect [12] is a recently developed global communication protocol that enables users to get data from CNC machines. MTConnect enables the consolidation of data from several machines into a unified, object-oriented format.

The components of industrial AS that can supply information to ERP models encompass measurement and control devices such as sensors and transducers, quality control tools, industrial automation actuators like solenoid valves and servo drives, automatic identification models such as barcode readers, machine vision systems, and RFID, control devices such as SCADA [13], corporate computers [14], distributed control systems (DCS) [15], operator panels, and equipment, and machinery involved in various processes such as palletizing systems, CNC machine tools, transport systems, and industrial robots. The aforementioned devices, which act as a means of collecting information, may be categorized into two separate groups: secondary and primary. Primary sources often consist of sensors and measurement equipment that directly detect and react to transformations in the physical processes.

Devices such as CNC, industrial robots, and controllers (such as DCS) might be considered secondary sources since they transmit signals from main sources. Simultaneously, they produce fresh data as a consequence of control algorithms analyzing raw information. SCADA serve as secondary sources by consolidating data from many sources. Simultaneously, SCADA systems have the capability to gather information from process supervisors or operators via the input of instructions and data, or produce data through the use of master control algorithms.

Semi-automatic data acquisition

Semi-automated data gathering techniques are used in enterprises due to the need for more efficient and dependable solutions compared to manual acquisition. To enhance the manual acquisition process, a simple and effective approach is to provide computer terminal access to lower-level personnel, equipped with data input software. The terminal may be either stationary or portable, and software intended for data input should be developed in a manner that simplifies data entry while also minimizing the likelihood of mistakes. This method still necessitates the employee to spend considerable time on the laborious task of entering lengthy sequences of characters. The solution to this issue may be achieved via the use of automated systems of identification. Typically, these systems use a coded label and associated readers, enabling rapid and dependable reading.

Barcode technology and RFID technology are the most often used automated identifying methods. This classification could also integrate vision systems (VS), distinguished from earlier methodologies by their absence of reliance on labels and their broader scope of applications. Barcode technology is the prevailing technique for automated identification, mostly utilized for data acquisition in warehouse management systems. The primary benefit of barcode technology is in its cost-effectiveness, particularly in terms of the affordability of the labels. This technology's benefits make it the predominant means of identifying used in logistics, storage, and production systems. Implementing barcode scanners throughout the manufacturing system enables us to gather data on the movement of materials, partially completed or completed equipment and products. RFID systems, also known as RFID systems, operate by wirelessly transmitting data.

The labels of RFID, or tags, are small in size and can withstand various environmental conditions such as chemicals, heat, mechanical damage, cold, moisture, and dirt. Additionally, they have a wide functioning range, spanning from a few millimeters to several meters. Objects may be detected and identified from a distance, independent of their orientation, without the importance for manual machination. This enables automated data collecting, as stated by Munzert, Rubba, Meißner, and Nyhuis [16]. Machine vision technologies often serve as sensory systems, directly overseeing and regulating either the whole process or a specific component of it. VS are used for sorting purposes or quality control provide immediate access to data on the quantity of created factors or the value of production. VS may further serve the purpose of overseeing and managing mobile robots or examining the movement of substantial objects (such as tanks or wagons) as they go through the various phases of the manufacturing process.

IV. MANUFACTURING INFORMATION ACQUISITION SYSTEM

Because of the wide variety of functions and requirements inside the company, the Manufacturing Information Acquisition System (MIAS) must be established according to a complex and multi-tiered process. The primary phases of the construction of a MIAS for a particular organization are shown in **Fig 6**. The tasks involved in this project include: (a) analyzing and identifying the managerial and technological structure of the firm, identifying issues with data collecting, and examining other elements of the company, (b) developing organizational and technical solutions for MIAS, and (c) iteratively evaluating the solutions that have been established. The proposed methodology involves categorizing the identification and analysis of a company's technical and organizational structure into four levels of detail: communication level, the system level, data processing level, and data sources level. The inception of MIAS is rooted in a fundamental need identified by the firm for the system's intended use. A thorough evaluation of the prerequisites and existing capacities must be carried out at every stage.

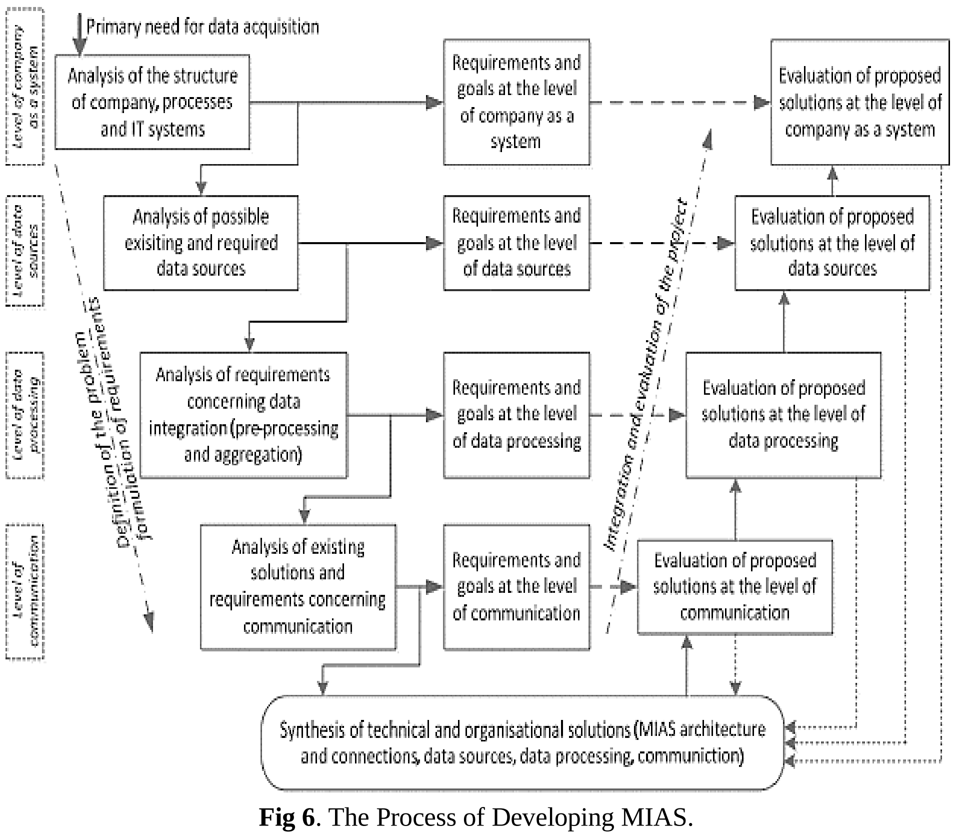

Fig 6. The Process of Developing MIAS.

The findings from this analysis will serve as the foundation for establishing objectives and requirements for MIAS at that particular level. Following a thorough study at all levels of detail, a synthesis stage may occur, during which specific solutions for MIAS are generated, based on the specified requirements and peculiarities of the PS. The evaluation stage includes a step-by-step review of the MIAS system project at several levels of intricacy, with a specific emphasis on its capacity to fulfill the objectives, specifications, and goals set during the analysis phase. If the assessment of proposed solutions is considered unsatisfactory, the project returns to the stage of developing specific solutions for modifications, and then passes another validation procedure until all criteria are fulfilled.

MIAS Development – Analysis phase of the production model

Prior to the development of MIAS, it is essential to conduct an analysis of the solutions previously implemented inside the firm, as well as the unique processes, requirements, constraints, and desired functionalities of MIAS. The analysis should be conducted at several degrees of detail, using a multistage approach. The following chapters offer the topics of study on four recommended detail levels. The findings of this analysis serve as the foundation for developing customized solutions, which form a framework that enables the creation of a comprehensive and dependable system.

Company as a system level

The investigation should begin by identifying the fundamental requirement that has sparked interest in implementing a solution that allows access to data from the PS. To determine the requirements for the architecture of the produced data collecting system, it is necessary to analyze many particular concerns after defining the fundamental need. The problems at hand are: The analysis of the organization`s structure involves examining the connections between functional processes and components. This study may be presented in two ways: (a) either as a basic PS or as a more involved PS that maps the processes and structure of a firm utilizing entrepreneurship process modeling standards like as BPMN, SysML, UML, etc. (b) Research into the currently utilized IT systems to identify the data, formats, and interfaces that are essential to these systems and any data, which may be extracted from them. (c) Problems with the PS's operation should be identified so that they may be addressed. This includes both regular and infrequent problems. (d) Examination of the presently used methods of depending on orders. (e) Determination of formal needs on DA - some sectors have a legal need to gather and store certain data.

Data sources level

A comprehensive company analysis should include the examination of both current and necessary data sources. The study should address the following key issues: (a) An inventory of present data sources (DS) and an assessment of their potential applicability in the MIAS should include manual data, automatic identification systems, and automated control systems gathering techniques inside a corporation. (b) Assessing the feasibility of integrating storage units and other applications that directly collaborate with the entrepreneurship layer into the newly established MIAS. (c) Pinpointing of the requirements for establishing novel DS– to generate new DS that are not already present in existing systems, which are essential for facilitating company management. (d) Identification of industry-specific limitations and requirements on the use of solutions in data gathering and transmission, such as elevated humidity, dust, pollution, explosive hazards, corrosive chemicals, and extreme temperatures. Data integration analysis. This section of the analysis addresses the following matters: (e) Examination of the connections between the available data and the necessary data- the first information gathered from sources typically consists of SCADA/PLC variables, which are retrieved via sensors or computed by control systems. Additional synthetic information is necessary for the purpose of overseeing industrial operations. In MIAS, data processing procedures are known as integration, which involves the execution of pre-processing and aggregation stages. The data should be organized in a hierarchical framework, with terminology such as manufacturing unit, production line, and department serving as the basis. (f) This program may execute pre-processing, data backup, sharing, and display in integrated manufacturing systems that use SCADA. It is used to specify the needs and capabilities of sharing data and local archiving.

Communication level

The study of communication solutions encompasses the examination of challenges pertaining to the establishment of dependable communication between components of the system, which may belong to disparate classes and interact with diverse hardware protocols and interfaces. The main considerations for this project include: (a) establishing connections for the network between the components responsible for collecting and processing data, (b) ensuring compatibility with current systems by using appropriate communication protocols and data formats, and addressing security concerns, and (c) taking into account any limitations imposed by environmental conditions or industry-specific requirements.

MIAS synthesis phase

The MIAS synthesis step is undertaken based on the outcomes of analysis performed at four detail stages. This enables the creation of a tailored data collecting system that is specifically designed to meet the requirements of a firm and is then deployed inside it. During the synthesis stage, it is necessary to present comprehensive solutions that address certain topics in depth. The synthesis step should provide an acquisition of design alternatives for technical and organizational MIAS solutions.

Selection and establishment of data sources

The components inside industrial control systems provide the most promising data sources for the MIAS. The logical way to establishing an information gathering system for management purposes in highly automated firms is to expand the production control systems with new aspects. This enables access to previously uncollected data for the control purpose. Manual data gathering is considered supplementary and should be abandoned wherever feasible, in favor of semi-automated or automatic acquisition techniques. For non-automated manufacturing processes to effectively track equipment, staff, supplies, WIP, and other objects, a unified system is needed to aid semi-automated data collecting with automatic recognition and other solutions.

Data integration from control systems

Data integration involves two distinct phases: pre-processing and information aggregation. The pre-processing phase include fundamental data manipulation tasks, such as verifying accuracy, converting analog data to digital format, digitalization, and reduction. Aggregation of information refers to the act of taking raw data from several sources and transforming it into meaningful information using methods such as if-then rules and reasoning trees. Aggregating data allows for the creation of synthetic variables that describe the condition of a bigger portion of the production system, such as a complex set of equipment or a manufacturing line.

Data archiving within MIAS

It is the job of the data sharing, documentation, and display subsystem to compile and arrange all the data that the information incorporation subsystems have retrieved from the DS. The database employed in the MIAS must include the following characteristics: capability to gather information from diverse sources in actual-time with the necessary temporal precision, effortless maintenance, provision of data safeguarding procedures, and the potential for redundancy. These criteria may be met by either specialized industrial Historian databases or traditional relational databases, which are better suited for storing massive volumes of data from high-speed operations.

Communication within MIAS

The development of communication methods between MIAS DS, archiving subsystem, and the data integration and clients involves designing physical information connections between transmission standards like XML and OPC, and establishing formats. The MIAS should minimize its impact on current systems and provide easy expansion and adjustment to accommodate the evolving needs of the firm. The specific technological processes, conditions, and limitations must be considered when determining the reliability and suitability of data transmission techniques and standards.

V. CONCLUSIONS

In the context of Industry 4.0, data acquisition (DA) has become an essential process for manufacturing companies. It comprises digitizing signals so that computers can work with them. Data collection systems are crucial for converting analogue waveforms into digital values for further processing. A number of factors govern the DA, including volume, velocity, variety, and value. Data collecting, filtering, and cleaning methods must be both flexible and efficient in order to ensure that the data warehouse analyses only relevant portions of the data. Some of the parts that make up a data acquisition system include digital input/output circuitry, digital-to-analog converters, and analog-to-digital converters. It also includes analog devices. Elements like this allow for the quantization and codification of data, which in turn allows for the accurate depiction and analysis of industrial processes.

Industrial firms rely on PDAs and other automated solutions to improve production scheduling and management within the scope of Industry 4.0. When it comes to automating operations for production planning and administration, Intelligent Manufacturing Execution Systems (MES) depend significantly on PDA devices. Order, personnel, and technical production data are among the many data types collected and analyzed to evaluate various aspects of the production process. Automatic control, machine diagnostics, and production process management are just a few of the many applications for the data collected. Based on variables that affect data availability, production systems are grouped to meet the problem of data gathering for management goals. Mechanized systems, manual systems, automated systems without communication interfaces, and automated systems with network interfaces are some of these types. A variety of techniques and tools are used to collect data, from semi-automated and automatic acquisition to human collecting.

Enterprise Resource Planning (ERP) systems and other management support systems rely heavily on data supplied by industrial automation systems. Data is collected and sent by a variety of control devices, machine vision systems, automated identification systems, control and measurement devices, and quality control equipment. Fragmentation in the automation systems industry presents issues that may be handled using OPC communication protocols and specialized servers. When compared to manual acquisition, semi-automatic data gathering approaches enhance efficiency and dependability. For automatic identification and data gathering, machine vision systems, RFID technology, and barcode technology are often used. The process of creating a Manufacturing Information Acquisition System (MIAS) entail assessing the company's technological and organizational structure, resolving problems with data acquisition, creating organizational and technical solutions, and testing those solutions repeatedly. In the age of Industry 4.0, data acquisition plays a crucial role for industrial organizations as it facilitates accurate and dependable data collecting for accurate production activity depiction and analysis.

CRediT Author Statement

The author confirms contribution to the paper as follows:

Conceptualization, Methodology, Writing- Original Draft Preparation, Visualization, Writing- Reviewing and Editing: Xiaofeng Li. Author reviewed the results and approved the final version of the manuscript.

Data Availability
No data was used to support this study.

Conflicts of Interests
The author declares that they have no conflicts of interest.

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Competing Interests
There are no competing interests

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