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Visibility of resources and assets in the shipyard through industrial internet of things

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Abstract
Industrial Internet of Things is becoming one of the fundamental technologies with the potential to be widely used in shipyards as in other industries to increase information visibility. This article aims to analyze how to develop an industrial IoT-enabled system that provides visibility and tracking of assets at SEDEF Shipyard, which is in the digital transformation process. The research made use of data from previous studies and by using content analysis, the findings were discussed. Industrial IoT enables the collection and analysis of data for more informed decisions. Based on the findings, sensor data in the shipyard are transmitted to the cloud via connected networks. These data are analysed and combined with other information and presented to the stakeholders. Industrial IoT enables this data flow and monitors processes remotely and gives the ability to quickly change plans as needed.

Keywords: Shipyard, Industrial Internet of Things, Cyber-Physical System, Visibility, Assets tracking;

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1. Introduction

IoT is the most basic component of Industry 4.0, which has the opportunity to apply in many different fields in different sectors [1]. IoT is one of the most basic technologies, which enables real-time interaction and data sharing between different smart devices with the devices such as sensors, actuators, and network connectivity. IIoT, on the other hand, covers platforms that process data produced by networked machines in factory floors [2]. Industrial IoT is seen as an effective approach to fully realize its benefits in shipyards and reduce problems by ensuring real-time visibility and communication of each asset by monitoring physical assets in real time [3].

Shipyards are distributed production sites where a wide range of production resources are used in a wide range of fields, which largely include internal logistics operations [4]. This requires effective use and monitoring of the resources and assets used in it. Searching for machines, carriers, people, and finding which one is suitable for the necessary work takes an excessive amount of time, and it needs a lot of time and effort. The lack of real time position data of production resources and assets cause disorder in the operation, which effects overall efficiency. Recently, Industrial IoT-based knowledge acquisition have been promoted for the industry to determine location of all assets in site [5]. Real-time data and business intelligence for shipbuilding gives complete visibility into production processes and is a valid business tool. First, it is necessary to implement Industrial IoT technologies that provide the data and information needed to collaborate and make the right business decisions. As delivery times shorten in shipbuilding projects and flexibility increases to meet changing customer requirements, the shipyard becomes more competitive and higher customer satisfaction, and ultimately leads to revenue growth [6]. Industrial IoT makes a significant contribution to the transition to intelligent production, which has begun to play important roles in almost all areas of industries [7].

Visibility plays a critical role in detailed monitoring of assets, resources, and tasks in a complex environment such as a shipyard. The visibility provides transparency of the flow of parts, tracking of the assets, control of resources, rapid response to problems experienced in the process, effective use of production capacity, and savings in processing times [8]. In a shipyard environment, smart devices are data sources that provide valuable insights. However, the large and diverse data presents significant challenges in real-time collection, processing and decision-making. In the shipyard environment, it is important to describe the behaviour of various objects for real time decision making. How to monitor the behaviour of various sources and visualize the real time condition is a major challenge. To overcome this difficulty, specifically for a shipyard to begin the digital transformation process, this study provide an analyse how to develop an Industrial IoT-enabled system that will enable asset tracking in the shipyard environment. An evaluation is made on how technologies and tools will be used to determine the location and to observe behaviour of various resources in the shipyard environment. This article specifically provides an analysis on how Industrial IoT technology can be used to identify location of resources and assets used in the shipyard. How to manage the data obtained with the Industrial IoT supported technology to be used is the second important issue evaluated in this study. We analyse how to make a shipyard environment visible using industrial IoT technologies. With IoT technology, it is evaluated how the data will provide visibility, and the advantages of visibility in shipyard are criticised.

1.1. Research Background

Since the subject of Industrial IoT has not been extensively studied in the shipyard sector, an exploratory analysis has been conducted to understand the relatively complex shipyard space [9]. The analysis is based on observations made at the shipyard area and available literature on the field [10]. There are several examples of the implementation of the Industrial IoT in shipbuilding [11]. Some researchers offers a study that uses Industrial IoT as a DSS tool for operators in the workshop [12, 13]. It is a multi-layered system with a service-oriented architecture and data collection with sensors. Hyundai Heavy Industries launched a project for IoT applications [14]. There is a great interest by researchers and related organizations in the application of the Industrial IoT in the shipbuilding industry. It is projected to growth the implementation of the Industrial IoT in the shipyard sector in the near future, and new architectures are being developed. Specifically for the Industrial IoT architectural model has been created that consists of end layer, platform layer and enterprise layer. At the platform layer level, hundreds of the Industrial IoT platforms have appeared, and this number is expected to continue to increase. However, many of these solutions are unique to each company. So we conducted our own research with some that seemed more suited to implementing the Industrial IoT in a shipyard [15]. While the Industrial IoT scope is very broad, there are basically three perspectives: (1) the point of view that focuses on improving object visibility, such as the traceability, state, current position, awareness of an object; (2) the point of view on network technology and network protocols used to connect smart objects; (3) the third point of view focuses on organizing information generated by smart things. This perspective was chosen as the method to the implementation of the Industrial IoT in a shipyard.

The implementation of the Industrial IoT in the shipyard includes a holistic view of the idea of the entire shipbuilding process. Thus, information infrastructure requires successful gathering and managing of data from various sources [16]. With the broad combination of the CPS and the Industrial IoT, the shipbuilding industry is entering a new era. However, the vision of data analytics, which provides visibility into production, still faces huge challenges [17]. First, automatic data collection needs to be integrated into business processes to improve the visibility of the shipyard. Second, big data collected with the Industrial IoT must be processed without delay and transferred to business decisions. It would be a valuable contribution to try to determine how to analyse the big data for visibility of the shipyard. However, in the shipbuilding industry, it will be very difficult to manually perform these tasks without using IoT and data analytics. The aim of the study is to increase the visibility the shipyard. An assessment study is being carried out on how this can be done. In this context, an evaluation is made based on existing techniques, application approaches and literature research. Lu and Xu [18] presented a framework to develop CPS to visualize resources. To fill the gap between a general CPS and extreme cloud is a solution design focused on end cloud editing [19]. Regarding fundamental digital transformation in a large organization such as a shipyard, there are different perspectives on the relationships between concepts such as IoT, the Industrial IoT, Cyber-physical systems (CPS), analytics, ML, and the other related concepts are involved and used in the digital transformation process.

1.2. Purpose of study

Although these concepts are closely related, they are different in nature in terms of concept, basic elements and their applications. For this reason, it is important to define clearly what the concepts are and to understand them correctly in a digitalizing of a shipyard environment [20]. The technologies required in the digital transformation of shipyards, which constitute the focus of this study, are briefly explained in the following subsections. This article therefor aims to analyse how to develop an industrial IoT-enabled system that provides visibility and tracking of assets at SEDEF Shipyard, which is in the digital transformation process.

2. Methods

2.1. Data collection method

The research used data from previous research and observation in the field. Data was therefore collected from credible resource journals and sites.

2.2. Data Analysis

The collected data were analysed based on the contents. Since the research is a discussion paper, the collected data and contents were summarised and discussed as such.

3. Findings

3.1. IoT and Industrial IoT

The Industrial IoT is a special area of IoT that focuses mainly on critical industrial applications in the production area [17]. The IoT is a structure that connects smart devices through the internet, allowing data to be controlled and application processes to be executed in the desired way. It contains many other structures such as remote sensing, performance monitoring, and task execution (Figure 1). In this context, the Industrial IoT is a system that includes interconnected smart objects, the CPS assets associated with cloud computing platforms, and information technologies such as real-time, smart and autonomous access, data collection and analysis. The Industrial IoT seeks to harness the power of the data collected, which enables the collected data to be used for real-time analytics to make faster, more accurate business decisions.

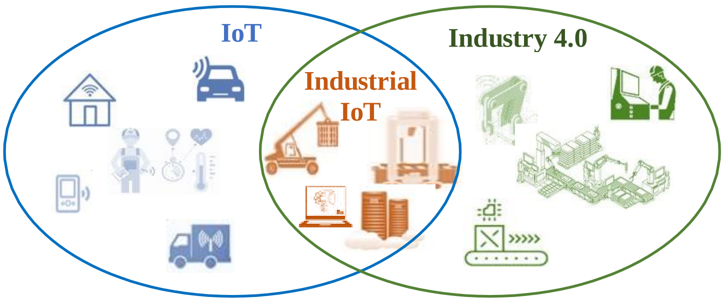

Figure 1: IoT, Industrial IoT and Industry 4.0 Relation in Shipyard

3.2. Cyber-Physical System and the Industrial IoT

The entire structure that includes communication and coordination between the physical and the cyber worlds are called CPS, which provides a completely new high level of controller, oversight, transparency and efficiency in the shipbuilding processes. CPS realizes the integration of networks using more than one sensor, actuator, control processing unit and communication device. CPS can be defined as systems that are linked to the surrounding physical world and processes, as well as providing data retrieval and data processing services [21]. Typically, a CPS physical part includes devices, machines or facilities. The digital or cyber part consists of data, software system and communication network. The cyber part of the CPS digitally represents the state of the physical part and provides automatic control or informs people about control actions [20]. When we consider a car as a CPS: the physical components constitute the physical part of the car, while the cyber part includes the data from sensors, navigation and radio system that provide information to the driver while driving. The physical and digital parts of the CPS are mutually interconnected and synchronized in real time via sensors and actuators [22, 23, 24].

3.3. Data Mining, Machine Learning Technologies

It is also necessary to analyse the data collected by IOT in shipyards with appropriate tools. In data analysis, data is examined, cleaned, transformed, and modelled to discover useful information, report results, and support decision making. There is more than one approach to data analysis, it consists of different techniques with various names. Data analysis in shipyards helps in making decisions more scientifically and working more effectively. Data mining, machine learning, business intelligence and statistical analysis are commonly used in data analysis [30]. The results of these are presented to the users with appropriate graphics and tables.

Machine Learning technologies are all somehow related to information extraction from data for a given purpose, which deal with Mathematics, Algorithms and Statistics. These techniques have common aspects, they have different purposes and are inspired by each other [25, 26]. Recent advances in IoT, CC, CPS, ML, DL, and BD provide key technologies to advance shipyard [27]. Using these technologies in the shipyard, from raw materials to machine operations, logistics and workers, data on raw materials, personnel, machinery and all other resources in the shipyard environment are collected and analysed and processed at different levels [30]. Advanced analytics turn large volumes of data into actionable and useful data as seen in Figure 2.

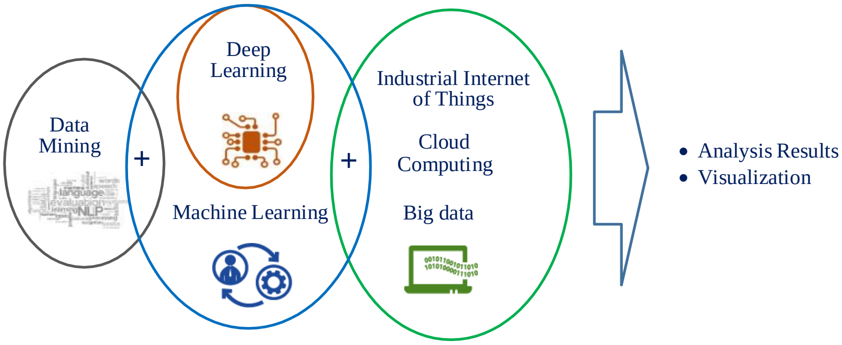

Figure 2: The relationship between data analysis approaches

Data mining Data mining techniques extract trends and patterns, such as graphs and charts, from historical data to predict future results [28]. On the other hand, Statistical analysis is an integral part of data analysis, which will become even more important in the near future. Data mining aims to discovery exciting patterns among items in a given database.

Machine learning focuses on predictions made from learned data based on known features. Data mining, on the other hand, focuses on discovering unknown features in historical data. Data mining consists of various methods used in the knowledge discovery process to distinguish previously unknown relationships and patterns. This is a step of knowledge discovery analysis in databases. *Machine learning* is basically classified as supervised and unsupervised learning [29]. Deep learning, Reinforcement Learning, and ensemble methods are other important new machine learning methods. An overview of all machine learning methods can be seen in Figure 3. The relationship between input and output variables in Supervised Learning is known. Machine learning algorithms in this category are used to predict the outcome of the input data to be compared with the expected outcome. If there is an error, this process is iteratively repeated until an acceptable level of performance is reached after the error has been corrected. Ensemble methods use multiple learning algorithms to provide a better performance than any single learning algorithm. Reinforced Learning is a machine learning inspired by human learning. It is based on how a system that perceives its environment and can make decisions on its own can learn to make the right decisions in order to achieve its goal. This method is frequently used in fields such as robotics, game programming, disease diagnosis, and factory automation. Deep Learning is machine learning that can automatically find attributes from data. It makes use of artificial neural networks with big data and high computing capacity, with many hidden layers [16].

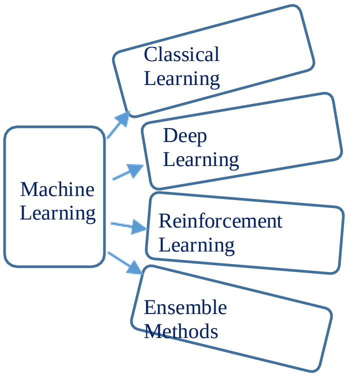

Figure 3: Machine Learning Approaches [16]

Statistical Analysis: Statistics in the main part of data mining and machine learning algorithms. Statistical analysis, on the other hand, uses numerical data and contains many equations to output useful results.

Visualization: Creating images, diagrams or animations to understand and improve the results of big data analytics. It tries to find meaning from data, especially using statistical methods. Usually by summarizing and presenting and visualizing statistics and drawing a conclusion from them. The suite of tools in this layer can enhance the functionality of analytical tools and provide basic statistical analysis capabilities. Tools in this layer include Microsoft Power BI, Tibco Spotfire, Tableau, Qlik view, SSRS, etc. [35].

3.4. Data Analytics

Data analytics is the process of extracting insights from data by analysing large datasets to support decision making [32]. With IOT technology, the necessary data is collected and analysed from each process or any equipment. In this way, hidden and valuable patterns are revealed. Data analytics is a field that has been heavily studied lately and there are still gaps in the literature. For example, although the big data application is widely used, it still poses challenges to instantly process very large Industrial IoT data in a short time.

Analyses can be made at different levels of data analytics, such as descriptive analytics, diagnostic analytics, predictive analytics, and prescriptive analytics [1]. Four categories of analytics are shown in Figure 4. The first category, the business opportunities and challenges that can help identify “what's going on or what is happening about the” descriptive-analytical reports. Descriptive analytics provides a summary of what the conditions, environment, and parameters are. For example, when performance drops or a malfunction occurs, diagnostic analytics provides a summary of the cause of all this. The second category, Diagnostic analytics relies on comparing past events to identify causes. The third category, predictive analytics, makes predictions about future events. Predictive analytics uses statistical models to make predictions. The fourth category, prescriptive analytics, explores different alternatives, advising the decision maker on course of action or suggesting further action plans. It uses technologies such as prescriptive analytical simulation, decision support, and expert systems. Prescriptive analytics goes beyond this by proposing one or more action plans.

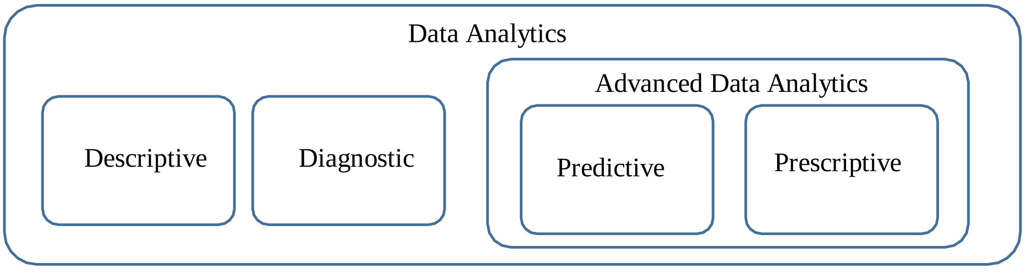

Figure 4: Data Analytics Types [1]

Descriptive Analytics: This type of analysis is usually based on actual results: it consists of reports and dashboards that summarize metrics such as performance metrics and provide the background for most business intelligence (BI) tools. Techniques such as data collection, data mining, clustering, and summary statistics are all analytics that describe a situation in the past.

Diagnostic Analytics: Diagnostic analytics also focuses on the past, however, this type of analysis looks for cause and effect relationship to prove why something happened. It relies on comparing past events to identify causes. This analysis provides support in recognizing outliers, revealing relationships, identifying isolated patterns, and diagnostic analysis.

Predictive Analytics: Predictive analytics predicts "potential future outcomes", turning the results of descriptive and diagnostic analyses into actionable insights for decision making. While predictive analytics predicts future outcomes, the goal is to try to identify a trend, correlation, causality, or probability.

Prescriptive Analytics: Prescriptive analytics help identify recommended actions based on potential anticipated or desired outcomes and help shipyards achieve their business objectives. Such analytical models constantly have learning mechanisms to suggest the most appropriate solution by constantly analysing the event relationships. Artificial intelligence, machine learning, and neural network algorithms support prescriptive analytics to make specific recommendations.

Each of the four analytics types helps shipyards understand and derive new insights from historical data and performance to improve forecasts and actions for the future. Both big data and data mining techniques are often used to analyse this data. At this stage, the data collected is analysed by data mining and meaningful information is reached, if the data does not have any information value, it is discarded and concluded that this data is worthless [33]. A large amounts of industrial data are produced in shipyards, most of which are not currently collected electronically, but have not yet been analysed [11]. The arrangement and analysis of this information will allow for improved decisions in project scheduling. Shipbuilding projects take longer than others and resource constraints are significant, so the speed at which big data is processed is crucial to making unpredictable changes in the production environment. The type of data to be collected at each level of the shipyard varies widely. The lack of methods to analyse and classify all this data in shipyards creates difficulties in the implementation of big data platforms. For this reason, Industrial IoT is considered as a new architectural approach that includes computing technologies in the shipyard [34]. Visualization is an essential step in using and analysing big data within the value chain. The visualization of big data supports the discovery of the value of data [11]. Big data analytics and visualization integration with Industrial IOT performs better in business decisions.

3.5. Visibility in Shipbuilding

Modern shipbuilding is carried out in the assembly style, and due to the complex nature of the product, sequential shipbuilding complex assemblies involved complex planning and processes [36]. Shipbuilding technology and shipyard layout largely determine the product structure and material flow [37]. With the expansion of assembly lines in parts and subgroups, in assembly and transportation automation, the necessity of the Industrial IoT made increased. General shipbuilding operations such as marking, turning, bending, CNC machines for cutting, and welding are a standard in all modern shipyards. The visibility provides transparency of the flow of parts for shipbuilding, control of resources, rapid response to problems experienced in the process, effective use of production capacity, and savings in processing times [38]. In other words, visibility plays a critical role in detailed monitoring of projects, costs, resources, and tasks in shipbuilding in a complex environment such as a shipyard. Above all, the success of shipbuilding begins with creating a good offer.

The quotation, also known as forecasting, is to obtain accurate and timely cost estimates of material/parts/sub-components from a subcontractor. This means that quotation can be disruptive or constructive, as the customer's marketing time depends on it. Subsequent projects allow making an informed decision, as an understandable price quote gives a real picture of the costs. At this stage, visibility is crucial as experienced data helps to learn and calculate costs based on best practices. In addition, visibility into real-time costs can help prepare the offer quickly, deliver it to the customer, and thus estimate a fair profit margin that can be earned. After the quotation is agreed upon, the design and building stages begin. The design stage is to understand the production stages in detail. Revisions can be made at this stage and require very close participation of the customer. This stage involves many aspects, such as managing resources correctly, estimating the capacity of resources to be used. Clear visibility helps optimize these resources and ensure timely delivery. In some cases, deliveries can become impossible on set dates when bids are performed without revision. In such cases, visibility minimizes risks and reduces the likelihood that something will go wrong. The construction phase begins with the customer approving the final design. At this stage, it takes into account two aspects - the use of the equipment and the use of resources. Visibility of equipment efficiency is an important factor for the realization of the project. Visibility allows to conduct data-driven conversations with customers at the above all stages. Thanks to improved visibility, shipyards can achieve various advantages in resource and cost savings.

3.6. Industrial IoT-enabled Shipyard Visibility and Traceability

Different technologies are used to monitor the status of objects in real time. Traceability is based on the collection of data, which includes records of the time and place of occurrence of events [17]. Therefore, visibility considers a large number of disparate events occurring at different times and places [39]. Industrial IoT aims to increase efficiency and safety in a dynamic environment and tries to reduce waste. Investigation of how to do this in the shipyard is evaluated in this study. First of all, the processes must be monitored instantly in order to be under control and to be carried out in safety. Therefore, efforts to implement IoT in the shipyard should be based on monitoring processes and resources, and necessary data should be collected for this purpose [40]. When this is done, communication and interaction between people, machines and tools increase, and processes gain advanced control and monitoring capabilities. Also, how automatically a process can be controlled is less prone to human error, and this can not only increase productivity by reducing downtime or maintenance costs, but also improve quality. Industrial IoT also provides support in shipyard logistics. All assets such as workers, machines, tools, materials or shipbuilding processes are monitored in real time by an interconnected network of sensors. This gives operators complete visibility across the entire production chain. It ensures that resource utilization and internal logistics are realized or optimized at maximum capacity.

The potential of the resources is determined by the collected information [41]. At the shipyard, data is delivered to the right place at the right time in the production chain, without the need for a human supervisor. In this way, it enables machines and vehicles to be used with higher efficiency. However, another point is that data from different environments should not only be collected, but also integrated and well analysed to provide meaningful insights. Industrial IoT creates a powerful data analytics environment for this purpose. This in turn develops a preventative maintenance mechanism that will keep processes running, even if there are defects associated with regular equipment use and wear and tear. It further provides support in creating strategies to reduce material and energy consumption and optimize asset use. Industrial IoT creates a more employee-friendly environment because it is self-directed. The more controlled and predictable the production environment, the less threat it poses to workers who monitor, operate and maintain the system. With data analytics, it is possible to provide direct and immediate insight, identify bottlenecks and respond proactively in case of adverse events. Thanks to IOT, employees are also monitored by the system, and employees are warned about possible dangers if they enter some predefined risk zones.

3.7. Benefits of the Industrial IoT to Shipyards

Shipyards can benefit from greater end-to-end visibility with the Industrial IoT [42, 43]. One of the foundations of the Industry 4.0 is undoubtedly visibility. It would be useful to explain some use cases at the shipyard site that can help understand the benefits that the Industrial IoT brings to shipbuilding. The purpose of studying these use cases is to help start thinking about how Industrial IoT can be integrated into shipyards.

The Industrial IoT provides shipyards with benefits such as monitoring assets, providing proactive health and safety, improving customer experience, shortening project times, increasing productivity, and decision support for. IoT encourages shipyards to reshape and offers them new opportunities to develop new business strategies. One of these advantages is predictive maintenance support. Real-time data from the IoT enables the company to take action in advance to fix the problem before a machine breaks down. With Industrial IoT, potential machine breakdown issues in shipyards are resolved before they escalate, and errors are prevented before they reach customers. Asset tracking is another advantage, and workers can effectively use this system to monitor the location and status of resources at the shipyard. The Industrial IoT System also sends instant alerts to stakeholders in critical situations; it enables employees to rectify the situation and take immediate or preventive action. Another advantage is that IoT provides greater customer satisfaction. IoT also contributes to the creation of an advanced facility layout. Industrial IoT provides decision support in monitoring the condition of aging machines and determining the wear and tear of equipment. Industrial IoT immediately detects non-standard situations and provides alerts for non-standard vibrations, temperatures. It also enables the monitoring of any negative situation that may occur in non-optimal conditions.

The development of the Industrial IoT has had a profound impact on building smart shipyards and monitoring applications, but the trend towards increasing amount of data generated from huge, heterogeneous and bottom-up production resource objects still poses challenges for centralized decision making. Visibility is particularly useful in optimizing resource use in intralogistics. The Industrial IoT solutions provide shipyards greater insight, control and data visibility in the management of resources and assets in intralogistics. By leveraging resource management capabilities, shipyards can provide services with shorter lead times, lower costs, and better quality to gain a competitive advantage.

The Industrial IoT solutions give shipyards the ability to predict that potential problems will arise before they occur [44]. When there are no IoT systems in the shipyard, for example, preventive maintenance takes place routinely or time-bound. Such processes can be much more automated and simplified with the Industrial IoT. Systems can detect when problems arise or when machines need to be repaired, and can assist in solving potential problems before they develop into bigger problems. Predictive analytics, "what happened?" or "why did it happen?" Like. Not only are they asking reactive questions like "what will happen" but "what can we do to prevent this from happening?" It also allows them to ask such proactive questions. This type of analysis can enable shipyards to switch from preventive to predictive maintenance. Through the Industrial IoT solutions that provide asset tracking, assets in shipyards are more efficient. As an auxiliary effect of this, internal logistics activities are improved and inventory, quality and optimization opportunities are better understood. Those working in a factory with IoT can better see their presence in the world. Standard asset management tasks, which are asset transfers, divestitures, reclassifications and adjustments, are performed more effectively. In the context of shipbuilding operations, visibility can be defined as perception better [45]. First, let's take a look at the four areas of the Industrial IoT technologies and how each add value along this way.

Asset Visibility: Lack of presence visibility in the shipyard site causes costs. Employees spend time searching for welding machines or tools, causing a waste of time. This slows the cycle time, leading to a decrease in efficiency. To solve such problems, sensors and tracking technologies will make it easy to know where everything is at any given time. Therefore, the acquisition of such technologies and their effective use in shipyards provide significant contributions.

Visibility of Processes: In this case, visibility seeks to answer the question: Where is the product now in the process? To find an answer to this question, new technologies must be found in the shipyard. It is achieved effectively by getting feedback from machines and business processes or physically monitoring the movement of products within the factory. For this purpose, location information needs to be much more detailed and precise. This can be achieved with the Industrial IoT system.

Error Prevention: By understanding errors before they happen with visibility, shipbuilding can encourage workers to do safer work and prevent them from making mistakes. By having precise information about the location of the tools, full control over where the task will be performed is provided. Integration of device controllers allows tools to be disabled instead of doing wrong job.

Providing flexible working conditions: Thanks to responsive control, it helps to go one step further in preventing error by understanding the current situation and responding accordingly. In some cases, workers often have a short time in certain operations, and if the job is not completed within a certain time, this can overwhelm other areas, creating a costly situation or disrupting work. Responsive controls, thanks to real-time job monitoring, provide more flexibility to give employees a few extra time if needed.

Ensuring Employee Health and Safety: One of the goals of digital transformation is mainly to ensure the health and safety of employees. Industrial IoT will have a major impact on the workforce, predicting a radical change in the entire product value chain, as well as many innovations that will bring on productivity and profitability and competitive superiority in the shipbuilding sector. Perhaps the most important of these is that employees as subcontractors can also increase their effectiveness. For safety, the sensors can be placed on wearable accessories such as watches and helmets, especially IIoT-enabled thematic cards. Thus, it can measure the pulse of the employee, his or her height from the ground, or the number of steps he or she takes. For example, if employees work in a confined space, their heart rate and temperature can also be monitored. An IIoT-enabled card can determine whether the worker is installing the relevant equipment in a mandatory personal protective equipment environment.

4. Conclusion

The Industrial IoT is an important digitalization strategy that helps shipyards achieve economic sustainability and gain ground as a way to address this rapidly changing landscape. However, understanding how and where digital technologies would be implemented in the shipyard environment can be a daunting prospect. In shipyards, by providing visualization using Industrial IoT and data analytics technologies, obstacles that limit productivity and cause breakdowns can be identified immediately before they occur. When data is visualized in real-time, the right people can make the right decisions to increase productivity and reduce costs. This provides new capabilities and business models that allow shipyards to thrive. All of these explanations are important in the digitization of shipyards, but how shipyards can get there are still issues to be explained. This can only be achieved through a comprehensive transformation process. By initiating a pilot study in a problematic area, creating large-scale CPS, a program can be followed that will allow it to spread to the whole organization. As the expected benefits of each pilot application emerge, this should be applied to other processes, keeping in mind the ultimate goal of end-to-end visibility. This transformation is accomplished by initially investing in the right infrastructure and creating CPS pilot islands throughout the operation. By including these islands in a true I4.0 system, it can be monitored how they will benefit the entire shipyard.

More visibility will be the key to identifying the problems a shipyard will face on the I4.0 transformation path and increasing efficiency. Gaining visibility at all stages of the shipbuilding process helps prevent waste in shipyards. With this increased visibility, shipyards achieve significant resource and cost savings and achieve significantly higher productivity. The widespread adoption of the I4.0 result in some significant efficiency changes. The most important point here is that visibility is the first necessary condition to enable the necessary changes and interventions. Knowing what is happening in the shipyards in real time will lead to a much faster resolution of problems. Since there are very few application studies in the literature regarding Industrial IOT applications in the shipyard, this study and the articles planned as a result of the realization of digital transformation applications in Sedef shipyard have to expect a significant contribution to the field.

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