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Whitepaper

Connected Machines in the Engineering & Construction Industry

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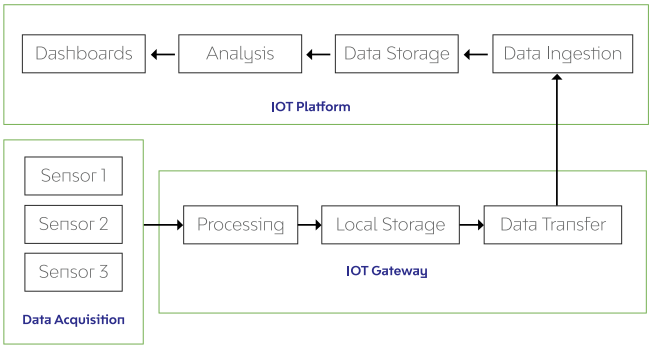
A Larsen & Toubro Group Company

What is IOT?

In its simplest form, the Internet of Things (IoT) is the connection of devices through the internet. As a concept, it implies that any IoT-enabled physical object/machinery can utilize the internet to communicate information about its condition, position, or any other attribute. It uses sensors placed on objects to track features such as pressure, motion, light, temperature, position, flow, etc. All these sensors are connected to a single IoT gateway which collects their data, stores it temporarily, and then transmits it via internet connectivity to remote cloud storage, where it is permanently stored and analyzed to give actionable and meaningful insights about the object. These insights can be viewed in the form of a dashboard via a mobile/web application even when miles away from the actual object.



Engineering & Construction (E&C) Industry Background

The Engineering & Construction (E&C) industry has a long-standing problem with productivity. Unlike other industries, the E&C industry has seen little or no improvements in productivity over the past eight decades, while the productivity of other sectors has increased close to fifteen times. Many projects run over time and over budget.

Cost and time overruns are often directly dependent on equipment availability and utilization. Equipment downtime can lead to the shutdown of an entire construction site, costing thousands of dollars. Similarly, scheduled preventive maintenance also impacts equipment availability, although in a more controllable manner. The utilization of equipment on construction sites also depends on the ability of project planning and execution teams to spot interdependencies among various resources, such as front availability or material availability, and accordingly plan equipment deployment, so as to optimize utilization and minimize idling. In order to increase Return on Investment (RoI) on expensive construction equipment, it is essential to optimize their availability and utilization.

Another cause of concern for E&C companies is wastage and pilferage of diesel. The diesel spends of these companies are a significant proportion of their costs. For sites spread over several hundred kilometers, it is practically impossible to manually keep an eye on all equipment and their fuel usage, resulting in losses to business, due to lack of enough vigilance.

Other industries such as manufacturing have turned to IoT and other new technologies to drive productivity improvements, but challenges specific to the E&C sector have a role to play in the slow pace of digitization. Rolling out any solution across construction sites which are in diverse sectors and geographically dispersed compared to a manufacturing unit like automobile

manufacturing is not an easy task.

Having said that, what is going to disrupt the E&C industry is the application of IoT to 'connect machines', thereby driving site productivity, optimizing equipment utilization and availability, and improving fuel efficiency.

Predictive Maintenance of Equipment

Machine performance has a huge bearing on the performance of projects in the E&C industry and hence, their effective maintenance and repair are crucial. Proper equipment maintenance is essential to maximize returns on capex investments on heavy machinery. IoT can help in detecting and communicating maintenance requirements, preventing downtime and cutting down on the unnecessary scheduled preventive maintenance plan. This enables the business to minimize downtime, control costs, lengthen equipment life, and increase its resale value.

Nowadays a large portion of equipment used in the construction world has IoT sensors installed by the Original Equipment Manufacturers (OEMs). These sensors capture important parameters like hydraulic and engine oil pressures, temperatures, cylinder movement, RPM, torque, etc. Data is the engine for predictive maintenance and once a steady stream of data is available from these sensors, data science and machine learning can be applied to this data to gain meaningful insights. By monitoring patterns in real time and by analyzing historical data, analytics and AI models can be built, and rules can be created for predicting equipment failure. These rules are adaptive and keep improvising as more and more data and scenarios are encountered. As shown in Fig. 1, a dashboard can be used to view, monitor and act upon key equipment health indicators, alerts, and notifications regarding predictive maintenance, from any remote location via a handheld device. Once the prediction of machine failure becomes more accurate, this predictive maintenance data can be linked to ERP data to ensure procurement of the right spare parts, support services, etc. at the right time.

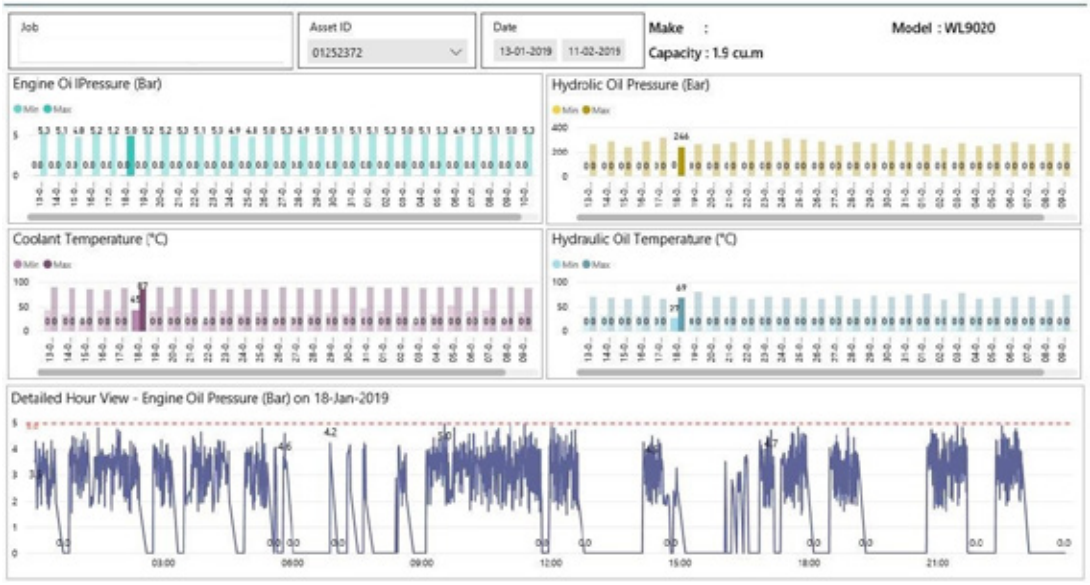


Fig 1. Dashboard displaying key maintenance parameters

Increased Site Productivity

On a construction site, IoT allows tackling of the problem of low equipment productivity head-on. IoT can help track asset movement, preventing assets from getting lost or stolen which could happen on large construction sites. Basic IoT sensors installed on equipment can provide information such as the distance traveled by the equipment and the engine-on hours. This information, apart from tracking the movement of equipment, also helps site engineers check on the productive working hours of the equipment.

One of the biggest challenges for project managers is gaining real-time visibility into productivity KPIs of equipment, to be able to intervene. The managers primarily rely on site engineers to fill them in on basic productivity KPIs. This is a manual process and is highly prone to inaccuracy. What IoT can do, is track different production KPIs for different types of construction equipment and make them available to project managers and site engineers in real time on a handheld device. The availability of low-cost mobile connectivity, via tablets and handheld devices, has ushered in a new generation of cloud-based mobile apps that can be deployed even at remote construction sites, with real-time updates. These are commercially viable for contractors and project owners of all sizes. A few examples of productivity KPIs that can be measured and tracked using IoT, are quantity of concrete carried per trip and number of trips per day for transit mixers; for batching plants, metrics like quantity of concrete produced per hour and in a day; and for tower cranes, metrics like weight lifted and number of lifts per day.

The real-time availability of these different KPIs with project managers and executives at headquarters allows them to take necessary interventions to drive productivity. For one of our clients, an engineering conglomerate, this helped increase the productive hours of their critical equipment by 65% and decrease idle hours by 33% which resulted in an increase in monthly production by almost 40% across various project sites.

Improved Utilization of Equipment

Optimal utilization of equipment is essential to cut down on project costs in order to compete in this industry with low profit margins. As utilization of equipment increases, the requirement of multiple pieces of equipment of the same kind doing the same work decreases, thereby reducing the total number of equipment deployed at a site. Basic IoT devices transmitting data such as engine-on hours give project managers the ability to view real-time utilization of equipment at their project sites, make necessary changes in equipment allocation, and take decisions around de-hiring/de-mobilizing of equipment based on consolidated data over a month. A simple view on equipment utilization helped one of our clients save USD 4 Million annually through de-hiring of equipment.

Driving productivity also makes a case for the effective utilization of equipment. During a recent study for a construction major, IoT data on connected equipment showed that ~40% of

equipment was heavily underutilized, with an average utilization of less than 45%. Although there was a justified rationale in some cases for low utilization (for e. g. periodic nature of activities such concrete pours, linear nature of large projects), for a vast majority of equipment, there was significant potential to increase utilization, and thereby, drive site productivity. For example, equipment usage patterns from the IoT sensors helped identify that some of the poorly utilized excavators were used for boulder placement and brought to light the low availability of boulders at crushers as the root cause of this low utilization. Interventions were then made to address this material availability issue, thereby increasing both excavator utilization and crusher production, and reducing delays in project activities.

Reduction in Fuel Consumption

IoT sensors on equipment can help tackle poor fuel efficiency of equipment and pilferage/theft of fuel at project sites. High fuel consuming assets such as diesel power generators, motor graders, boom placers, etc. can have fuel level sensors installed and connected to the IoT gateway. These sensors track the consumption of fuel on a continuous basis and highlight any spikes in consumption patterns, potentially signifying theft. Auto alerts can be sent out to concerned site engineers on the occurrence of such spikes to further investigate these fuel drops.

Sensors capturing parameters such as distance traveled, on-hours, work done, etc. can also help in estimating the amount of diesel consumed by the equipment and in deciding how much diesel needs to be refueled in order to cater to the future requirement of the equipment. This thus enables real-time reconciliation between fuel issued and fuel consumed, instead of monthly reconciliation, as is the practice in many E&C companies today. IoT sensors can also provide usage patterns of different equipment i.e. hours spent on marching, idling, and production. As different kinds of usage result in different consumption patterns, this data allows fuel to be dispensed more accurately based on the nature of the activity the equipment was used for.

Diesel power generators that are used as a source of power on many remote construction sites and usually account for the highest portion of fuel spend amongst all equipment categories. Fuel efficiency is a critical KPI for these assets. The fuel efficiency of generators drastically reduces when high KVA-rated generators are subjected to a lower load and when there is high variability in the load. At the same time, the cost of renting/buying higher rated generators is significantly higher. Tracking of load patterns and fuel consumption on a real-time basis using IoT sensors gives Plant & Machinery (P&M) managers the ability to take decisions on decommissioning and reducing the KVA rating of diesel generators, and thus improve fuel efficiency and reduce P&M spend.

Challenges to Implementing IoT in the E&C Industry

For IoT to truly disrupt the E&C industry, it needs to be backed by reliable connectivity. If an IoT device loses connectivity and cannot send data in real time, it loses its ability to track assets and, more importantly, provide insights into actual productivity and maintenance needs. As many hydel, nuclear, ports & harbors, and transportation projects are based out of remote locations with limited mobile & network connectivity and most IoT solutions rely on mobile networks for transmitting data from gateway to cloud storage, this could render the usage and performance of IoT data unreliable. But by leveraging a multi-network roaming Subscriber Identity Module (SIM) that can switch between service providers, robust connectivity and data quality can be ensured.

Construction equipment manufacturers like Case, Komatsu, Caterpillar etc. are providing consumers with packages of telematics sensors along with software to view the data generated from their machines. Currently, only the machines manufactured in the past few years have telematics solutions, but even for machinery manufactured before that, it is possible to have a retrofitted solution which is readily available for installation. All that is required is an API from the OEM's telematics software and an entire equipment fleet can be integrated on a single platform with auto alerts highlighting potential pilferage, low productivity, maintenance alerts, etc. Although a major concern that still remains with retrofitted solutions, is the problem of scalability – vendors providing these solutions are new to the market and are often small-sized vendors with resource constraints, impacting speedy scale-up.

Conclusion

It is quite evident that IoT is a key ingredient in driving site productivity and ensuring construction companies have access to real-time data that can improve asset performance, decrease downtime, and unleash predictive maintenance. By leveraging IoT, business leaders can ensure swift operations and timely completion of projects. Advanced analytics on IoT data from machines can also provide insights that can shrink project cycle timelines and reduce project risk. Given this huge opportunity, many leading construction companies with an eye on having an early mover advantage are spending millions of dollars to realize this potential and achieve the tremendous benefits that connected machines can offer.

About the Author

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Nishant Srivastav is a consultant working with strategy and value realization vertical of the consulting and thought partnership (CSTG) BU of LTI. He has helped clients in the construction industry realize sustainable business impact in their digital transformation journey. He also has a six-year experience in operational excellence working for a manufacturing company. Nishant completed his master's in business administration from IIM Calcutta.

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