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Automation In Pharmaceutical Industry and Global Regulatory Compliance

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Abstract:
India pharmaceutical industry is increasingly adopting automation technologies despite the fact the sector has traditionally been based largely on manual operations. It is now adopting new automated operational technology (OT) and information technology (IT) to remain competitive in a connected world. Only through continuous innovation and judicious adoption of new technologies will companies in this sector, domestic and global, succeed in surmounting today's challenges. These include: Global regulatory compliance; Quality issues; Inconsistent manual manufacturing workflows; Human errors; Cost pressures; and Increasing global competition. Automation is the use of various control technologies in sectors with little or no human intervention to carry out a variety of procedures. Automation has been implemented in the departments of production, packaging, labelling, and warehousing. Following the implementation of automated machines, the production of personalised medicines has become a reality. As a result, these systems may be able to replace human inspectors. This technology provides greater flexibility and repeatability at a lower cost.

Keywords: automation; packaging; and robotics, India pharmaceutical industry.

Introduction: Automation is the use of machines to perform the majority of the repeatable and important functions in the pharmaceutical industry. The industries have been developing at a faster rate, and the pharmaceutical industries are no exception. The regulatory requirements are becoming more stringent than ever.[1] Automated functions can assist industrial management in meeting ever-changing regulatory requirements. For many years, various industries around the world have had a tradition of implementing newer technologies that replace human labour. Work unions and other communities have always been opposed to this tradition, arguing that new technologies can always have a significant impact on job opportunities in industries.[2] Automation aids in increasing productivity and achieving consistent product quality. It is possible to do so at various stages of the manufacturing process. Handling raw materials, semi-finished goods, or finished goods during the manufacturing process, as well as inspection and quality control operations. Many significant advances have resulted from advancements in both computer hardware and software technologies.[3] This technology provides greater flexibility and repeatability at a lower cost. This allows for increased plant throughput without sacrificing product quality. These systems are currently being developed as an integral part of pharmaceutical manufacturing plants for online and real-time quality evaluation.[4]

Considering India's continuing strength in the IT services space, pharmaceutical companies should leverage this local expertise to modernize operations and implement new Industrial Internet of Things (IIoT)-related technologies and approaches such as smart sensors, Big Data, predictive analytics, and cloud computing. In addition to helping improve the patient experience through connected healthcare, these could enhance R&D, manufacturing, and regulatory compliance. Significantly, the successful implementation of these technologies requires the convergence of multiple skillsets, industries, and domains. To leapfrog to the next level, the pharmaceutical industry must aim for end-to-end systems from the plant floor to the boardroom, across the supply chain, and ultimately out to the end consumers.

This insight highlights some technology trends that are shaping the new business environment with specific reference to India's pharmaceutical sector. Clearly, technology implemented at the micro level will impact the macro level. When deploying new technology brings quantifiable benefits for one domestic company, other domestic companies will also adopt it; then companies in other countries adopt it and the global reach expands.

Deploying technology in India pharma sector

The pharma sector in India needs to take a closer look at both new operational technologies (such as wireless sensors and automation) and new information technology (ERP, EAM, MES, SCM, IoT, etc. Increased automation can help the pharmaceutical industry make more efficient usage of energy and raw materials; improve safety in working conditions; enhance regulatory compliance, and improve both product quality and consistency. Information technology brings in the much–needed interconnectivity between equipment, operations, and people.

Connected devices in pharmaceutical manufacturing facilities help improve business and manufacturing efficiency and reduce risk by enabling:

- Remote access to equipment
- Proactive maintenance
- Real-time plant floor visibility
- Ability to quickly recognize and respond to compliance issues
- Alleviate and prevent human errors
- Monitoring, control, and safety.

In a digital world, pharmaceutical companies must deploy these types of next-generation technologies to streamline and improve their manufacturing and business processes. They need to strive for real-time transparency of their R&D; smooth sales and operations planning in the supply chain; as well as meet new standards and expectations in efficiency and agility. The IT-OT (operations technology) convergence is now becoming a reality.

Many Pharma Industries took an integrated approach using a "galaxy of systems" with the core focus on manufacturing surrounded by a layer of manufacturing execution systems (MES). These include laboratory information management systems (LIMS), quality management systems (QMS), building automation and control systems (BMS), and warehouse management systems (WMS). According to the presenter, this IT-OT convergence approach resulted in world class manufacturing and a total business transformation.

For owner-operators

- New technologies and ways of doing business are reshaping the business landscape. Adopt or lose the race
- The initial investment in new technologies may seem high; but the long-term benefits typically justify the investment
- Learn from the strategies and best practices of your competitors. If it has worked for them, it could for you too
- Automation and information technologies can work together to help reduce costs, reduce errors, and improve manufacturing and business processes.

For technology providers

- Create awareness about the new technology and how it will help streamline processes
- On-site pilot demonstrations of the product/process will be more effective in convincing the prospective user
- Develop and document case studies of successful implementation
- Update existing customers
- Provide prompt after-sales service to nurture customer relationships
- Offer built-in cybersecurity, where possible, and do everything possible to simplify the validation process for your customers.

Automation in packaging

An increase in the use of robots is particularly significant in dispensing, sorting, kit assembly and light machine-tending. The advantages include greater speed and accuracy, more flexibility and more reliability.

As the use of the robotics in the pharmaceutical industry increases rapidly, it's important to consider the benefits of the latest technologies for manufacturers, researchers and scientists.

Filling, inspection and packaging

The pharmaceutical industry produces millions of tablets each week, all of which must be carefully scrutinised before being packed and shipped to distributors. During this inspection, drug manufacturers must ensure that the correct amount of medication, with the exact chemical composition and weight are precisely packed into the appropriate containers.

Most pharmaceutical packaging systems use automation to manage bottle orientation, capping, labelling and collation systems. Automation of packaging also requires a system that monitors the operation on a supervisory level, checking for low hopper levels, fallen bottles and low-level supplies.

Until recently, Raman spectroscopy was not widely applied in the pharmaceutical industry. However, in the last few years, developments within the industry coupled with improvements in Raman instrumentation have generated increasing interest in the technology. Raman spectroscopy measures the molecular vibration and rotational energy changes of each tablet, ensuring their chemical compounds are correct before distribution. This is just one stage of pharmaceutical inspection - automation and machine learning is also applied to ensure that products are packed in the correct bottles and boxes with the correct labelling affixed.

Personalised medicines

Despite differences in genetics, age and gender, most people receive identical medical treatment when diagnosed with the same condition. This is because even the world's best scientists and doctors don't fully understand how individuals develop diseases and respond to treatments. This has resulted in a one-size-fits-all approach to medicine that is based on broad population averages.

More recently, the pharmaceutical industry has seen the advent of personalised medicine, bringing the industry closer to more precise, predictable healthcare that is customised to the individual patient. Powered by our increased understanding of genetics and genomics, more doctors are providing better disease prevention, more accurate diagnoses, safer drug prescriptions and more effective treatments.\

Robotics in laboratory

The pharmaceutical industry is increasingly making use of robotics to automate specific processes in drug development, including drug screening, anti-counterfeiting and manufacturing tasks. Today, processes such as nuclear magnetic resonance (NMR) and high performance liquid chromatography (HPLC) can have sample preparation carried out by robotic arms.

Additionally, structural protein analysis can be done by automatically using a combination of NMR and X-ray crystallography. X-ray crystallography is an important technique used in drug discovery and involves the detailed analysis of crystal structures of protein-ligand complexes. This allows for the study of specific interactions between a particular drug and its protein target at the atomic level. This process often takes hundreds to thousands of experiments to create a protein crystal suitable for X-ray crystallography. An automated micropipette machine can allow nearly a million different crystals to be created at once and analysed using X-ray crystallography.

Technological advances in automation and robotics are enabling the pharmaceutical industry to increase the speed and accuracy of their processes such as filling, packaging and inspection. Deploying automation can help pharmaceutical companies to follow stringent regulatory and compliance standards, in addition to reducing operational costs.

Automated process techniques can ensure the precise weighing, blending and tableting of solid dosage forms and filling of liquid pharmaceuticals.

Leading process automation and pharmaceutical packaging equipment manufacturers

Pharmaceutical Technology has listed the leading contractors and suppliers of process automation technologies and packaging equipment based on our intel, insights, and decades-long experience in the packaging and pharmaceutical sectors. The list includes suppliers of powder and material handling systems, pharmaceutical mixing equipment, crushers, clamps and clamp fittings, bulk solids processing solutions, fittings and valves, pumps, compacters and processing equipment.

The information contained in the download document is designed for pharma analytics engineers, process engineers and technicians, process automation engineers, pharmaceutical process managers, laboratory technicians, purchase executives and packaging process managers.

The download contains detailed information on suppliers and their product lines, alongside contact details to aid your purchasing decision.

Advantages of process automation technologies in pharma

Automation technologies help in improving the efficiency of the pharmaceutical development and production by streamlining the processes. The technologies enhance efficiency as robots can easily perform repetitive tasks such as filling and packing at high accuracy and speed compared to human workers. They are also highly accurate and eliminate the possibility of human errors in the weighing, blending and packaging of pharmaceutical products.

Automation solutions facilitate the tracing and tracking of pharmaceutical products through technologies such as electronic batch records and radio frequency identification (RFID) solutions. Pharmaceutical companies can also apply technologies such as data analytics to improve processes and determine the efficiency of potential process changes.

Pharmaceutical mixing equipment and processing solutions

Pharmaceutical companies use a range of equipment and automation solutions to optimise their production processes. Some of this equipment includes:

Processing systems such as blending, extrusion, drying, milling, and micronisation systems

- Dryers and granulators
- Tablet compression and coating systems
- Conveyor and sorting systems
- High-speed bottle filling and capping solutions
- Agitators
- Coaters including spray coating machines
- Tanks and mixers
- Centrifuges
- Boilers
- Inspection machines
- Packaging equipment

Ease of use, operational costs, quality control, cost-effectiveness and digital capabilities are some of the factors that should ideally be considered when choosing pharmaceutical mixing equipment and processing solutions.

Significance of automation in pharmaceutical industry:

Automated Filling, Inspection, and Packaging: Millions of dosage forms are manufactured in their respective pharmaceutical industries, and each one must be thoroughly inspected for safety before leaving the facility. Most manufacturers use automated systems to manage a variety of activities such as capsule, vial, and container filling, dosage form and container inspection, and so on. All automated processes are monitored by a centralised computer. The centralised computers efficiently monitor all critical process parameters to ensure consistent product quality. Automated filling machines can also efficiently fill capsules, containers, and vials.They can inspect the level of filled containers and vials and effectively reject specific products that haven't been filled.

Such automated systems can be used to carry out such tasks in a large-scale manufacturing facility. Because data about the batches is continuously logged in the computer memory, all batches with non-compliance issues can be easily identified[5].

Making Personalized Medicines a Reality:

Despite having many genetic differences, people are treated in a one-size-fits-all manner. Because of their effectiveness in curing ailments, personalised medicines have become increasingly important in the medical field. Automation is critical for personal medicines to become a reality or reach their full potential. More advanced systems can pave the way for more efficient and faster drug discovery. Various modern computational technologies can be used to run multiple tests in order to find the best combination of drugs and dosages. In a world with such a diverse population, it is difficult to develop personalised medicines and with the existing traditional methods; the concept of personalised medicines may be considered impossible. As a result, advancements in automation can lead to significant advancements in the medical field. The potential of modern medical treatment can be targeted to maximise efficiency and assist outpatients in remote parts of the world in receiving the best medical treatment possible. With further technological advancements, medicines can be produced for individuals based on their susceptibility to the drugs. Manufacturing processes can be easily optimised to produce different concentrations of drugs based on the amount required. Traditional/current manufacturing practises are such that they cannot be modified to produce different concentrations of drugs as needed. Automated machines will be effective at controlling process parameters in order to produce the required concentration of drugs in the required quantities as and when needed. As a result, this particular advantage of automation can only be used to produce personalised medicines for patients all over the world.[6]

Involving Robotics in the Laboratory:

Robotics is widely used in the pharmaceutical industry for drug development, drug screening, various manufacturing processes, and so on. Most analytical instruments can be automated, making the time-consuming analytical procedures easier. The QC department's workload has been significantly reduced. In cases where production is high and the analytical department is unable to obtain results on time, automated systems can assist. The use of robotics and automated systems allows for timely sampling and testing of all batches. Because of the continuous testing, the chances of missing out on batches are extremely low. Analytical systems are designed in such a way that all test results are properly stored or handled. Most systems never modify the data, which complies with the FDA's guidelines for maintaining data integrity. An automated HPLC system, for example, would be capable of automatically collecting samples, analysing them, and transferring the results to a centralised computer. A QC team's involvement is not required in this case. In this way, robotics and automated systems can have a significant impact on pharmaceutical laboratory systems.[7] Continuous, Uninterrupted Manufacturing: Industrial robots can work indefinitely until they experience a technical failure. All it will require is a constant power supply and regular maintenance. As a result, such continuous processes can provide financial benefits to industries. When it comes to asking humans to work long hours, there are certain constraints, such as the workers' physical and mental health. This is not a problem in the case of machines. With proper maintenance, all machines will operate efficiently and without hiccups for extended periods of time. This could be immediately attributed to unemployment. Manufacturers and regulators will have to investigate this issue because the labour community does not want this to happen. This could have an impact on the economy as well. Continuous, uninterrupted production can be viewed as a boon for manufacturers.[8]

Automatic Control:

A variety of integrated sensors are available to sense the process variables at each step, allowing the processes to run in a controlled system with minimal errors. The automated systems are so sophisticated that they can even shut down or record if a noncompliant batch is detected. The sensors are distributed throughout the automated systems in order to continuously monitor the process variables. This data, on the other hand, is transferred to the computer, which analyses it before making important decisions such as rejecting batches, shutting down the system, and so on. Human intervention will be minimal in such cases, as they will only need to ensure that the various systems involved are functioning properly. Proper understanding of automated systems would give personnel an advantage in dealing with automation.[9] In some cases, businesses integrate all of their critical systems, such as WFI systems, pure steam systems, air handling units, and manufacturing systems. This is advantageous because every quality-related attribute can be monitored. If there is a problem with any of the systems, the personnel are notified. Such integrated systems are important in the manufacture of parenteral, etc., where great care must be taken because even minor deviations from the required conditions have an impact on the product's quality.[10]

Control Systems and Software's used in the pharmaceutical industry: Almost every aspect of the pharmaceutical manufacturing process is automated. Automation is used throughout the manufacturing process, from raw material handling to finished goods packaging. Rockwell Automation is a major provider of software for the pharmaceutical industry. Quality Management Systems (QMS) and Manufacturing Execution Systems (MES) are important pieces of software. Plant Pax MES and Pharma Suite MES are software products offered by Rockwell Automation. Both of these applications enable pharmaceutical manufacturers to update their

operating systems with minimal downtime and training. Master Control is another company that specialises in software for the pharmaceutical automation industry. This company sells Master Control Manufacturing Excellence software. This software combines QMS and MES to automate a factory and make a process or processes more operationally efficient.

Roles in the Pharmaceutical Industry after Automation Implementation:

The quality assurance department will have to deal with cutting edge technology. Ensuring the quality of products and processes, the lives of quality assurance personnel have undoubtedly become easier than they were previously. To keep up with the automated systems, personnel must learn new skills. Among the new abilities are: Handling and Interpretation of Digital Data because all data in the automated world is digitalized, personnel must be adequately trained to handle and interpret it. The execution of procedures for analysing information in order to reach an informed conclusion is referred to as information interpretation. Data interpretation gives meaning to information and determines its meaning and implications. The importance of interpretation is obvious, which is why it must be done correctly.[11]

Innovative Thinking to Design Better Automated Systems It is necessary that the personnel be prepared and knowledgeable enough to design efficient, hassle-free automated systems. Since the QA team have adequate knowledge regarding the critical quality attributes, they'll be able to position the necessary probes and sensors needed to monitor the same. Their knowledge will be needed by the engineers involved in constructing the automated systems. Also, having enough knowledge about the process can help in designing the equipment in a particular way so that the manufacturing processes happen without any hassles. [12] Developed Computer Handling Skills The personnel must have the necessary computer handling skills. The personnel must have adequate knowledge about handling computer software necessary for data handling and monitoring the automated systems. [13]Adequate training must be provided for the personnel so that they can cope up with the changing work environment. Various software used includes Processor, Batch master, Response Pro, Cecum manufacturing, etc. Since most complicated functions are taken care of by this software, having enough knowledge to handle them will give the QA personnel an advantage in coping up with the automated systems. [14] Confidentiality With all the data getting digital, the questions regarding the confidentiality of these data to arise. The automated systems come compliant with the latest regulatory requirements, and hence the data are stored such that they cannot be transferred without proper authorization. The related personnel are well trained so that they don't perform actions that could lead to a breach in data from the servers. Hence, the queries regarding maintaining the confidentiality of data after implementing the automated systems can be put off. Data Integrity Just like how the confidentiality of data can be questioned, queries related to data integrity can also arise. The manufacturers must see to it that the automated technologies implemented are 21 CFR PART 11 compliant.

It states the importance and requirements for electronically recording data in food and drug industries. During quality audits, one main spot of concern for the auditors is data integrity. The automated machine store data in the respective servers, but this alone won't be enough. The personnel having access to all these data must be limited, and they must be responsible for the careful handling of data. The data should not be such that anyone from the industry can access it and make changes to it. All the CFR 21 part 11 compliant systems are even capable of recording the number of times data has been changed or modified. Hence, as such, data integrity would not be a problem with the implementation of CFR compliant equipment's, but it relies upon the QA management to see to it that the data are only accessible to responsible personnel.

The QA personnel involved in the same must have undergone training in CFR 21 part 11. This eliminates the possibility of data integrity in a fully automated plant. Because most of the latest technologies use digital data collection, the need for all of the industry's paperwork will be eliminated. The quality assurance department will need to be trained to use digital data collection systems. Personnel work will be drastically reduced in the absence of all paperwork, as extensive documentation becomes easier. Automation may not have a significant impact on the roles of QA personnel in the pharmaceutical industries as a whole, but in the near future, as technologies advance and various industrial revolutions emerge, there is a good chance that the reliance on manual Q.A personnel will decrease. [15]

Conclusion: In the pharmaceutical industries, automation would give a number of theoretical advantages such as enhanced productivity of technologists, reduced radiation dose, and enhanced general image quality. Pharmaceutical industries are intently seeking ways to reduce their expenses, increase their efficacy. The use of automation not only reduces the chance of human error but also it reduces the workload on workers. It also boosts productivity and profits. Developing computer-based QA algorithms to detect and quantify QA deficiencies, deriving QA information to create universal QA norms and structured databases will enhance the QA department's effectiveness. The pharma industry has reached a point where it is now reliant on robotics and automation to achieve a greater competitive advantage and increased profitability. And this is only set to increase as the pressure remains on the industry to continually improve its manufactured and distribution capabilities. There are now numerous examples of how robotics and automation have allowed the industry to make major leaps in terms of efficiencies. We look forward to a great many more examples in the near future of how robots will allow the pharmaceutical industry to be flexible and reactive in such challenging times.

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