Dissertation Training

At

Deloitte-US India Consulting Pvt. Ltd.

Study By

Meghna Puri

On

"Cost Pressures on Life Sciences and Pharmaceutical Industry"

Under the Guidance of

Dr. L.P. Singh

Post-Graduate Diploma in Health and Hospital Management

2013-2015

International Institute of Health Management Research

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The dissertation is in fulfillment of the course requirements.

I wish her all success in all his future endeavors.

Dr. A.K. Agarwal

Dean, Academics and Student Affairs

IIHMR, New Delhi

Dr. J.P. Singh

Director

IIHMR, New Delhi

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The following dissertation titled **Cost Pressures in Life Sciences and Pharmaceutical Industry** at **Deloitte Consulting U.S India Pvt. Ltd.** is hereby approved as a certified study in management carried out and presented in a manner satisfactorily to warrant its acceptance as a prerequisite for the award of **Post Graduate Diploma in Health and Hospital Management** for which it has been submitted. It is understood that by this approval the undersigned do not necessarily endorse or approve any statement made, opinion expressed or conclusion drawn therein but approve the dissertation only for the purpose it is submitted.

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Director

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Feedback Form

Name of the Student: Meghana Puri

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Area of Dissertation: Life Sciences & Pharma

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Objectives achieved: ① Understanding of Revenue cycle Maganement support systems in Deloitte.
② Cost Pressures in Life sciences & Pharma Sector.

Deliverables:
- Dissertation Presentation
- ADT Fundamental internal training & assessment

Strengths:
- clarity in the module topics.
- understanding of HealthCare domain.

Suggestions for Improvement:
- Devote more time towards ADT as the organizations expects really good deliverables

Signature Team Lead/Organization Mentor (Dissertation)

Date: 15/05/2015 **Place:** Bangalore

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Abbreviations

ACA: Affordable Care Act

AM: Additive Manufacturing

CAPA: Corrective and Preventive Action

CDISC: Clinical Data Interchange Standards Consortium

CMOs: Contract Manufacturing Organizations

COGS: Costs of goods sold

CRAs: Clinical Research Associates

CRF: Case Report Form

CTD: Common Technical Documents

CP: Consumer Products

DDR: Drug Development Record

DDSN: Demand Driven Supply Network

DDVN: Demand Driven Value Network

DTTL: Deloitte Touche Tohmatsu Limited,

eCTD: Electronic Common Technical Documents

eCRF: Electronic Case Report Form

EDC: Electronic Data Capture

eDDR: Electronic Drug Development & Management

EPA: Environment Protection Agency

ePRO: Electronic Patient Reported Outcome

EQM: Enterprise Quality Management

ERP: Enterprise Resource Planning

EY: Ernst Young

FDA: The Food and Drug Administration

HL7: Health Level Seven

IND: Investigational New Drug

IP: Intellectual Property

IT: Information Technology

KPI: Key Performance Indicators

LIMS: Laboratory Information Management Systems

LSH: Life Sciences Data Hub

LSPI: Life Sciences and Pharmaceutical Industry

M&A: Mergers and Acquisitions

MES: Manufacturing Execution Systems

NDA: New Drug Approval

NME: New Molecular Entity

PLM: Product Life-cycle Management

PPACA: Patient Protection and Affordable Care Act

PWC: Pricewatercoopers

QbD: Quality by Design

R&D: Research and Development

ROI: Return On Investment

SEC: U.S. Securities and Exchange Commission

S&OP: Sales and Operations Planning

U.S.: United States

1.1 Organization Profile

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1.2 Abstract

The study is about the increasing cost pressures and the impact of the same on life sciences and pharmaceutical industry. The constant efforts that the sector is making to sustain their growth and margins, contest with existing and new competition, there is a need to enable agility in product innovation, design, delivery and service in a scalable way across global markets. Cloud technologies, advanced analytics and newer capabilities, such as product innovation platforms are making an impact. The purpose of this study is to determine the key pressure

areas, their impacts on the industry and provide solutions and recommendation as to what the industry can improve and innovate in terms of technology, business intelligence and analytics, mergers and acquisitions, cutting down costs, supply chain management, enterprise resource planning and many more.

The general objective of the study is to determine cost pressures on life sciences and pharmaceutical industry. The methodology used to derive the same is secondary data of qualitative type.

1.3 Introduction

The life sciences sector comprises of pharmaceutical, biotechnology, and medical technology. The growth of the sector depends on these three. Life sciences companies have demonstrated their ability to survive and thrive amidst recent periods of economic recession, health care spending cutbacks, geographic market swings, and changing population profiles. If history is any indication, 2015 will again test the sector's ability to adapt in an era of transformation. Aging populations, chronic/lifestyle diseases, emerging-market expansion, and treatment and technology advances are expected to spur life sciences sector growth in 2015. However, efforts by governments, health care providers, and health plans to reduce costs, improve outcomes, and demonstrate value are dramatically altering the health care demand and delivery landscape. It is becoming increasingly evident that

the global life sciences sector is operating in an era of significant transformation. A dynamically changing clinical, regulatory, and business landscape is requiring that pharmaceutical, biotechnology, and medical technology companies adapt different modals rather than sticking to the traditional research and development (R&D), pricing, supply chain, and commercial models. Many countries' public and private health care systems are moving from volume-based to value-based payment models. Governments and other payors are instituting price controls and increasing their use of generics and biosimilars to contain drug and device costs.

A growing list of regulatory requirements and expectations are imposing new challenges on the sector. Slowing revenue growth in developed countries is prompting entry and expansion in new, up-and-coming markets.

The global pharmaceuticals market is worth US$300 billion a year, a figure expected to rise to US$400 billion within three years. The 10 largest drugs companies control over one-third of this market, several with sales of more than US$10 billion a year and profit margins of about 30%. Six are based in the United States and four in Europe. It is predicted that North and South America, Europe and Japan will continue to account for a full 85% of the global pharmaceuticals market well into the 21st century. Companies currently spend one-third of all sales revenue on marketing their products - roughly twice what they spend on research and development. As a result of this pressure to maintain sales, "an inherent conflict of interest between the legitimate business goals of manufacturers and the social, medical and economic needs of providers and the public to select and use drugs in the most rational way." This is particularly true where drugs companies are the main source of information as to which products are most effective.

1.3.1 Life Sciences Scenario in United States

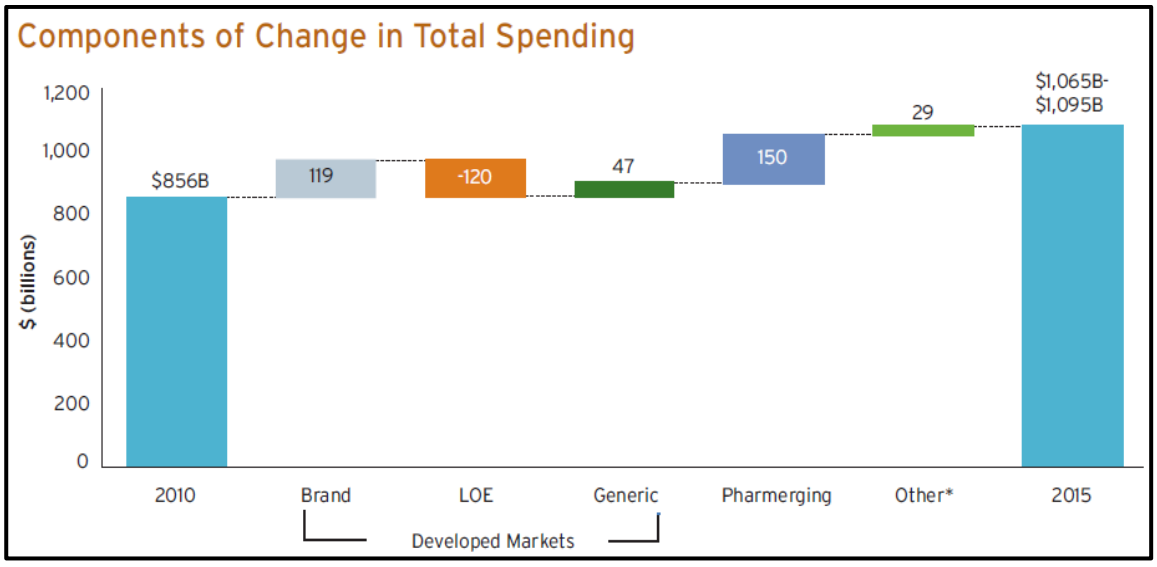
The US life sciences companies despite their size and resources operate in a dynamic environment that presents numerous challenges to revenue and market share growth. Two powerful megatrends — dramatic deceleration in U.S. market growth and significant restructuring of the healthcare system — are at play in the U.S. pharmaceuticals industry. On the one hand, market growth in "developed" markets (mostly the U.S., Western Europe and Japan) are significantly lagging the "pharmerging" markets (mostly China, India, Brazil and Russia), exerting enormous margin pressure on global pharma companies. On the other hand, the U.S. healthcare market is fundamentally restructuring how healthcare is cost-effectively developed, delivered and reimbursed to improve the overall health of the population.

For an industry whose business has sustained decades of respectable growth and margins, the new environment is testing the resilience and ingenuity of pharma companies across the sector. Some business models lack the adaptability to survive the imminent end of the "blockbuster drug" era, even while resource constraints and

sluggish innovation hinder the development of new capabilities needed to thrive in a rapidly evolving market. These are indeed disruptive times for the U.S. pharma industry.

The future of U.S. pharma will depend on whether companies can overcome structural shifts and adopt operating models aligned to new business priorities. For example, some companies are implementing strategies that respond to structural shifts by diversifying products and services to address global demand, and others are rethinking their operating models by leveraging externalization as a means to boost R&D productivity. Regardless of whether one follows a single or multi-pronged approach, it is imperative for U.S. pharma companies to develop strategies in response to these megatrends and take steps to sustain their next phase of growth and competitiveness in the global market.

According to a report by IMS Institute for Healthcare Informatics, the global pharmaceutical market is expected to reach $1.1 trillion by 2015. In absolute terms, this number presents a rosy outlook for the U.S. pharma industry; however, the anticipated growth is mostly driven by spend in pharmerging countries and on generics (see Figure 1).



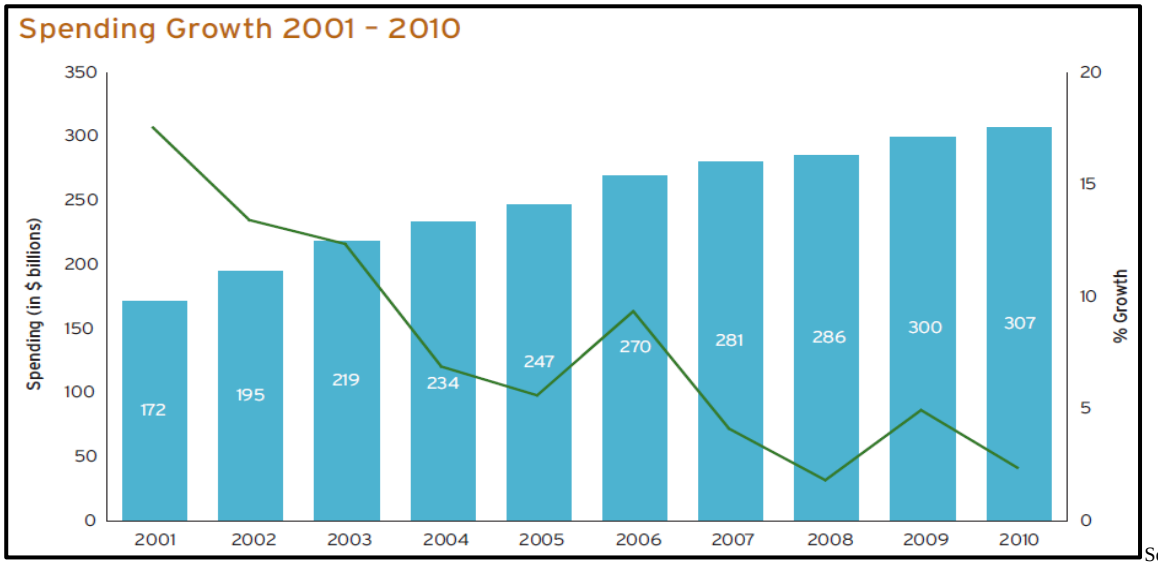
Source: IMS Market Prognosis, April 2011

Figure 1

Components of Change in Total Spending

Today, the U.S. pharmaceutical industry is facing a challenging business environment and slowing growth. This is in stark contrast to the double digit growth rates it experienced in the first half of the decade (see Figure 2). Further, over the next five years the U.S. market is expected to grow only 0% to 3%. Despite the stagnant growth,

the U.S. segment will continue to be the single largest market, reaching between $320 billion and $350 billion in 2015.

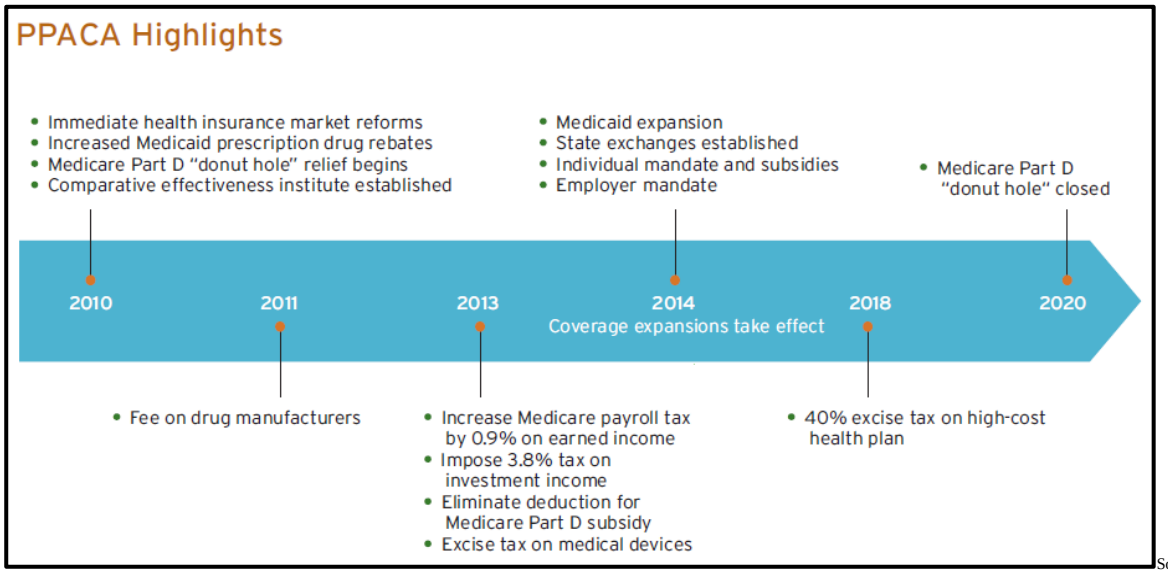


Source: IMS Health, National Sales Perspectives, December 2010

Figure 2

Spending Growth 2001 – 2010

With its position of prominence, winning in the U.S. healthcare market is a priority for global pharma companies. Consequently, the changes to the U.S. healthcare system, triggered by the passing of the Patient Protection and Affordable Care Act (PPACA), are a top priority for the pharma industry. While major portions of the legislation do not take effect until 2014 (see Figure 3),3 the bill has put in motion several important changes that the industry has already begun to address, such as coping with imminent price reductions, greater transparency, comparative effectiveness and health IT. A slowdown in U.S. pharma spend was expected, but the combined forces of a looming patent cliff, a rapid switch to generics and a prolonged economic malaise have precipitated a much steeper decline. Also, the 2010 PPACA bill gave impetus to a much-needed restructuring of the healthcare system, setting priorities for a favorable regulatory environment, a focus on patient-centric healthcare and the use of IT to enable cost-effective and quality healthcare.



Source: Ernst & Young LLP

Figure 3

Patient Protection and Affordable Care Act (PPACA) Highlights

This study examines the current state of the life sciences sector; describes the cost pressures impacting markets and organizations; and suggests considerations for stakeholders as they seek to grow revenue and market share.

(The Future of Pharma - A U.S. Sector Review, 2012)

1.4 Objective

General

- To determine the cost pressure on life sciences and pharmaceutical industry

Specific

- To identify the key focus areas of cost pressure on life sciences and pharmaceutical industry
- To determine the impact of cost pressures on life sciences and pharmaceutical industry
- To recommend on reducing the cost pressures on the life sciences and pharmaceutical industry

1.5 Literature Review

1. **2014 Global Life Sciences outlook Resilience and Reinvention in changing Marketplace, Published: 2013**

Analyst(s): Deloitte

The life sciences sector – comprised of pharmaceutical, biotechnology and medical technology segments – remained less impacted by the recent global economic uncertainty in certain parts of the world; however it is facing reimbursement pressure from escalating costs and overwhelmed health systems across the world. Among drivers of growth are aging population, rising incidences of chronic diseases, technological advancements and product innovation, and certain anticipated impacts from healthcare reforms provisions including increases in government funding and insurance coverage. Opportunities in emerging markets could continue to be a driver, although many companies are looking more cautiously at these markets due to slowing growth and other pressures. The major issues faced by the Life sciences industry are navigating global healthcare reform, delivering innovation and value, complying with regulatory changes and operating in a smaller and connected world. (Global Life Sciences Outlook Resilence and Reinvention in the changing marketplace, 2014)

2. **Planned Research for Life Science Manufacturing, 2015, Published: 13 February 2015**

Analyst (s): Stephen Davies, Michael Shanler

Life sciences companies must innovate, diversify, acquire, and reorganize to address revenue challenges impacted by pipeline, regulatory and competitive pressures. Gartner's life sciences manufacturing research will target top priorities in R&D, sales, marketing, PLM (Product Life-cycle Management) technology trends and applications. The digital era continues to impact life sciences industry through 2015. Life sciences manufactures face an ever-increasing influx of data types, data volume, digital opportunities and threats. Digital business affects life sciences across R&D, operations and commercial groups, and especially the IT organizations, as new initiatives spring up in unforeseen areas. A strategic business approach is critical and will connect the business and IT while the strategy is formulated and opportunities are identified. Customers will drive the life sciences industry to adopt digital engagements channels, since they are accustomed to dealing with companies using these methods in most other areas of their lives. Wearable technology will impact the life science industry as manufacturers integrate new data streams from these devices into their product development life cycles. Whether it is because of patients, healthcare providers, suppliers or vendors, the industry will need to move to the digital era. Leading companies will embrace this change, and adopt flexible and agile business and organizational strategies, to allow for digital business to deliver business value. They will gain insight from their customers and learn how to improve therapies, deliver enhanced value and accelerate innovation. New business ideas will become apparent, with the ultimate winner identifying how to translate life science digital information into business value. (Davies & Shanler, 2015)

3. **The Future of Pharma is Digital, Published: 5 June 2015**

Analyst(s): Hussain Mooraj, Roody Martin

Pharmaceutical and life sciences organizations must increase profitability while developing new products, balancing supply and demand, and meeting ever increasing regulatory demands. We examine how companies are improving operating inefficiencies, such as excessive inventory and the high cost of developing and launching new products, by embracing demand-driven concepts. (Mooraj & Martin, 2015)

1.6 Methodology

- **Key Research Questions**
    - What are the cost pressure on Life Sciences and Pharmaceutical Industry?
    - What are the key focus areas of cost pressure on LSPI?
    - What is the impact of cost pressures on LSPI?
    - What are the way outs to reduce the cost pressures on the LSPI?

- **Research design**
    - Research Type – it is a descriptive study conducted to determine the cost pressures arising in the United States LSPI industry
    - Research Location – US Life sciences and healthcare industry
    - Data Type – Secondary data of qualitative type
    - Data Source – Gartner, White paper published by PWC, Deloitte, EY, Accenture, Oracle, IMS, IBM and Cognizant

1.7 Results

After decades of growth, the heightened competition, increased generic drug production, and pressure from managed care and government agencies to curb costs put extreme pressure on pharmaceutical and life sciences companies. They are still being plagued by poor operational performance, a legacy of the high margin/low costs of goods sold (COGS) days. Manufacturers may not have seen the implications of this weakness in the past, but with compliance, competition, expiring patents, and pipeline and commercial growth becoming ever more pressing factors, manufacturing and product supply excellence is evolving as a cornerstone strategy for the future.

Among the set of intertwined, critical issues that life sciences and pharmaceutical companies face cost pressures, four rise to the top:

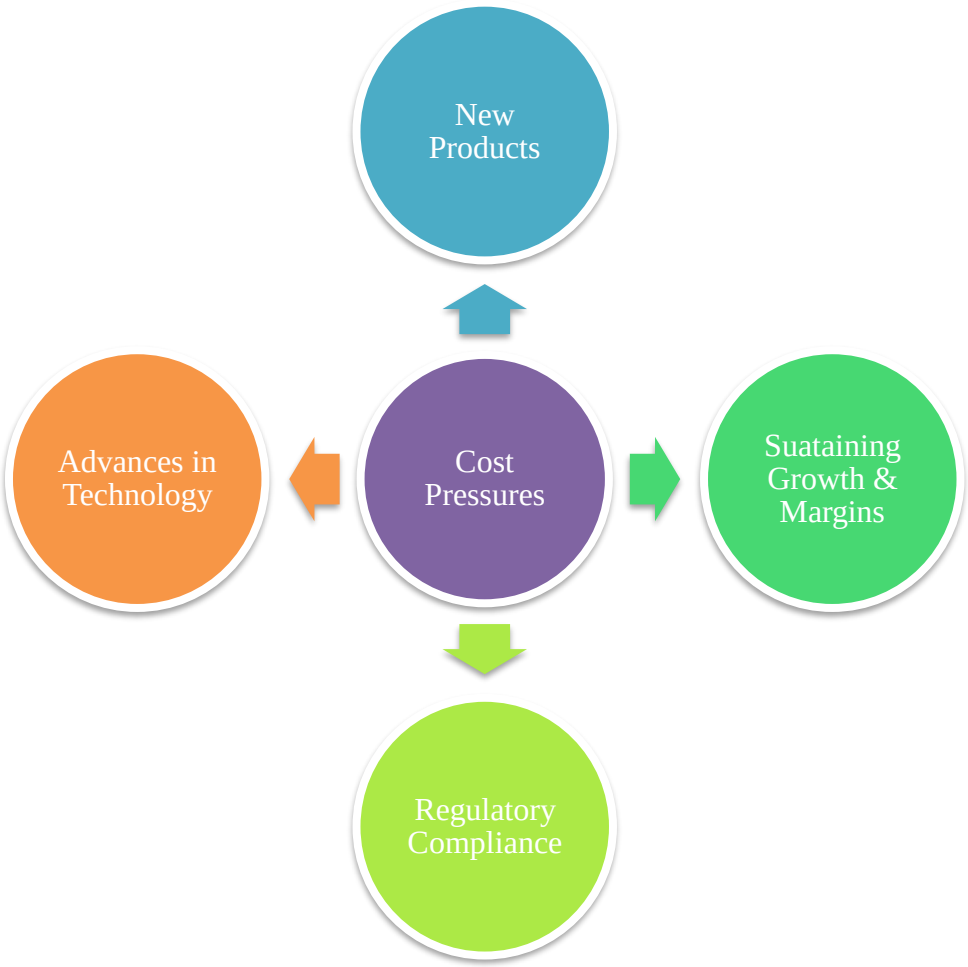


Figure 4

List of Cost Pressures on Life Sciences and Pharmaceutical Industry

1.7.1 New Products

Faced with organizational and investor demand to grow and a portfolio of expiring patents, companies look to new products to fuel future growth. However, the complexity, testing, and regulatory demands of pharmaceutical and life sciences products result in an extended and expensive new product development process. For example, the cost of a new molecular entity (NME) is over $800M, and the time from investigational new drug (IND) to market is 8 to 10 years, with less than 20% of INDs for NMEs making it to the new drug approval (NDA) stage.

With such high costs, drug companies are dropping compounds that exhibit a marginal probability of success before they enter clinical trials. Thus, it's no surprise that the number of NDAs with the FDA has declined over the past few years. At the same time, the number of biotech and big pharma collaborations and partnering has grown considerably, with more than $17B in deals in 2005.

The global landscape for R&D has been changing as European companies relocate a large number of facilities and researchers to the United States, a trend attributable to its more favorable governmental policies and attitudes toward biopharmaceutical research. As a result of these high costs, R&D efforts are concentrated on products for chronic rather than acute diseases. The top pharma R&D dollars are going to the following therapeutic classes: anticancer, neurological, anti-infective, and metabolic.

In order to reduce time to market, companies are starting to foster a closer relationship between their R&D and manufacturing functions. In leading companies, technology architects are building a process language that facilitates a design-to-manufacture process in order to exchange information between the heavily siloed functions of R&D and manufacturing.

1.7.2 Sustaining Growth and Margins

The push to reduce healthcare costs is putting pressure on the high margins traditionally enjoyed by the industry. Our benchmarking and interactions with manufacturers show continued inefficiencies, including high inventory levels and cycle time waste in the existing product supply model. Even with total inventories as high as 200 to 300 days, 7% to 10% stockout rates persist, which is a bane to the bottom line. Compare this to the consumer products (CP) industry, where inventory management has slashed total inventory to 60 to 70 days with minimal stockouts.

Of course, this has to be tempered with the fact that CP's demand forecast error rate, which averages 40%, is generally higher than that of pharmaceutical companies. This is attributable to inherent demand variability that life sciences companies do not necessarily see, for example, seasonality or promotions that affect forecasts. In comparison, leading CP companies are delivering more perfect orders and significantly fewer stockouts than pharma firms—even with lower inventories. Life sciences doesn't have such excuses, given the fact that demand variability is not as volatile as it is in CP.

As pressure on productivity and costs increase, manufacturers are moving to demand-driven business models for help. In CP this is happening as the demand-driven supply network (DDSN) strategy, which is based on consumer demand. The DDSN model can also be applied to pharma and life sciences, except that the mechanics for the moment of truth are different. Instead of product availability and usage, the moment of truth in pharma and life sciences is the consumer-centered flow of safe products.

1.7.3 Regulatory Compliance

The Food and Drug Administration (FDA), U.S. Securities and Exchange Commission (SEC), and Environmental Protection Agency (EPA) have increasingly imposed rules and regulations on the way manufacturers must operate. To compound these regulatory demands, different departments and sites within a business are responsible for various aspects of the enforcement of regulatory rules and regulations. The compliance execution differences, gaps, and duplication across departments and sites have added cycle times, risk, and cost to operations.

Executive leadership teams do not typically regard manufacturing and supply chain abilities as an important strategic risk in the company. However, quality and compliance can quickly scuttle acquisitions or result in failed product launches.

As a result, smart manufacturers are seeing compliance as a way to improve business performance. The irony is that, even with the flurry of regulatory-driven spending in IT and focus on operations excellence, applications such as manufacturing execution systems (MES), laboratory information management systems (LIMS), and corrective and preventive action (CAPA) still tend to be bolted-on components. This results in a fragmented information and application architecture that is difficult to use as a basis for improvement.

Merging quality management and production execution applications into a common process architecture lets manufacturers mitigate the risk to the business by creating predictable and compliant product supply.

1.7.4 Advances in Technology

Life sciences companies should look to other industries and non-traditional players for advancement in technologies that could be applied to health care and foster product innovation, market expansion, and revenue growth. The proliferation of digital technology has dramatically increased the amount of information available to patients, putting more power in their hands. This makes patient engagement and patient experience a more important lever for life sciences companies, especially in light of downstream consolidation in the ecosystem.

For example, mobile health (mHealth) is expected to be a valuable partner in health care's shift toward a patient-centered, value-based delivery model. mHealth has the potential to improve workplace efficiencies, increase patient safety, better coordinate care, facilitate payments, and engage patients. Additive manufacturing (AM), often referred to as "3D printing," also has disruptive potential in health care. The prospective benefits of AM are numerous — it can spur additional innovation, improve patient access to life-saving devices, simplify and

accelerate the supply chain and production process, and achieve considerable savings. The medtech industry already stands at the forefront of this transformative change — medical applications account for about one-sixth of AM market revenues.

Finally, Artificial Intelligence, through exponential increases in data, computing power, connectivity, miniaturization of hardware, and advanced software capabilities at lower costs will rapidly accelerate the development of next-generation "smart" medtech devices and could cause profound disruption in the way health care is delivered in the future.

The table below (Table – 1) shows the list of cost pressures, the reasons for the pressures on the life sciences and pharmaceutical industry and what the industry needs to do in order to reduce these pressures.

Cost Pressure	Why is this a pressure?	What needs to be done?
New Product	Loss of patents and exclusivity and threats of generics and biosimilar are forcing new products to fuel future growth Expensive R&D , sales and marketing process, and declining rate of New Drug Approval (NDA) are driving up costs	Need to align R&D with manufacturing processes Need to find opportunities in emerging/developing markets
Profit Growth and Margins	Higher inventory levels Cycle-time waste Push to reduce healthcare costs is putting pressure on the high margins traditionally enjoyed by Life Sciences companies	Production needs to be demand-driven Need to improve operational efficiency
Regulatory Compliance	FDA regulations have increased cycle-times	Need to improve compliance

	Illegal marketing has resulted in expensive lawsuits	Need to improve security and implement preventive measures to avoid legal issues
Advances in Technology	Leveraging value from IT investments	Need to invest in IT to streamline processes

Table 1

1.8 Discussion

In order to reduce cost pressures the Life sciences and Pharmaceutical industry needs to improvise on a number of aspects. Now the question arises that how can they improvise, the table below (Table – 2) shows the same.

Cost Pressure	What needs to be done?	How can it be done?
New Product	Need to align R&D with manufacturing processes Need to find opportunities in emerging/developing markets	Merges and acquisitions (Healthcare value chain) Perform market research before launching a product (new or existing product) Social Media Analytics Focus on niche products (orphan drugs)
Sustaining Growth and Margins	Production needs to be demand-driven	Demand Driven Value Network (DDVN) Process Standardization (trackability and

	Need to improve operational efficiency	traceability, Manufacturing Execution Systems,) Performance metrics
Regulatory Compliance	Need to improve compliance Need to improve security and implement preventive measures to avoid legal issues	Scalable and secure IT platforms Work with regulators, collaborate with providers and payers to perform continuous trials
Advances in Technology	Need to invest in IT to streamline processes	Integrating applications to help reduce cost IT technology investments to streamline data management and reporting (E-clinical environment) Virtualize R&D

Table 2

The above table describes what the life sciences and pharmaceutical industry needs to do and how can it be done. Again the question arises what new tools, innovations and mechanisms can be used to further reduce the cost pressures.

1.8.1 New Products - How it can be done?

Most large organizations in the industry are the results of M&A's from the past 10 years. Manufacturers are still consolidating the new organization, rationalizing product and IT portfolios, and integrating applications to help reduce costs and remove complexity from product supply networks and IT operations.

A large number of emerging life sciences companies are expected to launch their first drug in the next five years. The high cost of launching a drug and the synergy and cost savings created by merging means that these companies are prime targets for a takeover by bigger companies.

With its patent situation, big pharma is also scrambling to repack its drug pipelines with new products; expect a spate of M&A's in pharma and life sciences as a result. The recent activity with Boston Scientific and Abbott for Guidant as well as the bids by Bayer and Merck for Schering are cases in point. Business integration is going to continue to trouble IT and the organization.

As growing economies stabilize, such as those of China and India, opportunities are created for low-cost manufacturing and worldwide product sourcing. This also adds risks as supply chains are extended and protecting intellectual property management becomes more difficult.

Global pharmaceutical companies are investing heavily in countries like China, with investments in R&D a priority. Companies like Wyeth, GlaxoSmithKline, and Novartis are taking advantage of large pools of inexpensive local talent by establishing development centers in these regions.

Manufacturers also see great selling opportunities in developing markets. As branded drugs are manufactured in these markets, they will become cheaper and compete with locally produced generics and traditional medicine. These areas also show great promise because of their large aging population and rapid economic growth. However, weak patent protection laws, high cost of drug distribution, and government pricing are still significant barriers.

In recent years the pharmaceutical industry has faced declining R&D productivity, a rapidly changing healthcare landscape and fierce competition from generics resulting in lower growth and profit margins. Historically, drug development focused on clinical trials management and outcomes. Now however, the industry is looking at more holistic approaches to improve processes of bring new products to market that can accelerate product development while lowering operational costs. This is challenging because of the complex value chain and business processes required in this highly regulated environment. Additionally, it has proven difficult for the industry to effectively adapt as many pharmaceutical companies are simply not optimized for cross functional collaboration which is so desperately needed to support these changing market conditions.

One meaningful and holistic approach to today's current challenges within the pharmaceutical industry is to focus on Product Lifecycle Management (PLM), which is a business transformation approach to manage products and

related information across the enterprise. In recent years PLM has provided many pharmaceutical organizations with the ability to increase their ability to get products to market quicker, ensure greater regulatory compliance and efficiencies while reducing development costs.

This study identifies some key business metrics that benchmark a company's performance and key strategic business processes required to improve R&D performance through a PLM business transformation approach.

Management of the Lab to Launch Process

The Pharmaceuticals Industry faces three key challenges today:

1. Complex Drug Development Process
2. Large Gaps Between R&D Operational Performance and Strategic Importance
3. Difficulty in managing Clinical Trial Inventories

Complex Drug Development Process

The drug development process is complex, consisting of many interrelated business activities and functional constituents participating in the "Lab to Launch" of any given product (Figure 5).

Figure 5

Real-time synchronization of these activities is critical for achieving improved performance and regulatory compliance in the R&D pipeline. Effective management, knowledge re-use and accurate monitoring across these core activities requires automation. Automating will also enable standardization based on best practices and consolidation of content across the R&D pipeline, forming a compliant dataset for Quality by Design (QbD) based submissions.

(Oracle, 2012)

Large Gap between R&D Operational Performance and Strategic Importance

To address the development process, the pharmaceutical industry has identified key R&D functions that are considered important in optimizing R&D pipeline effectiveness. The research indicates significant gaps exist between R&D operational performance and strategic importance resulting in the industry operating at less than 50% effectiveness (Figure – 6).

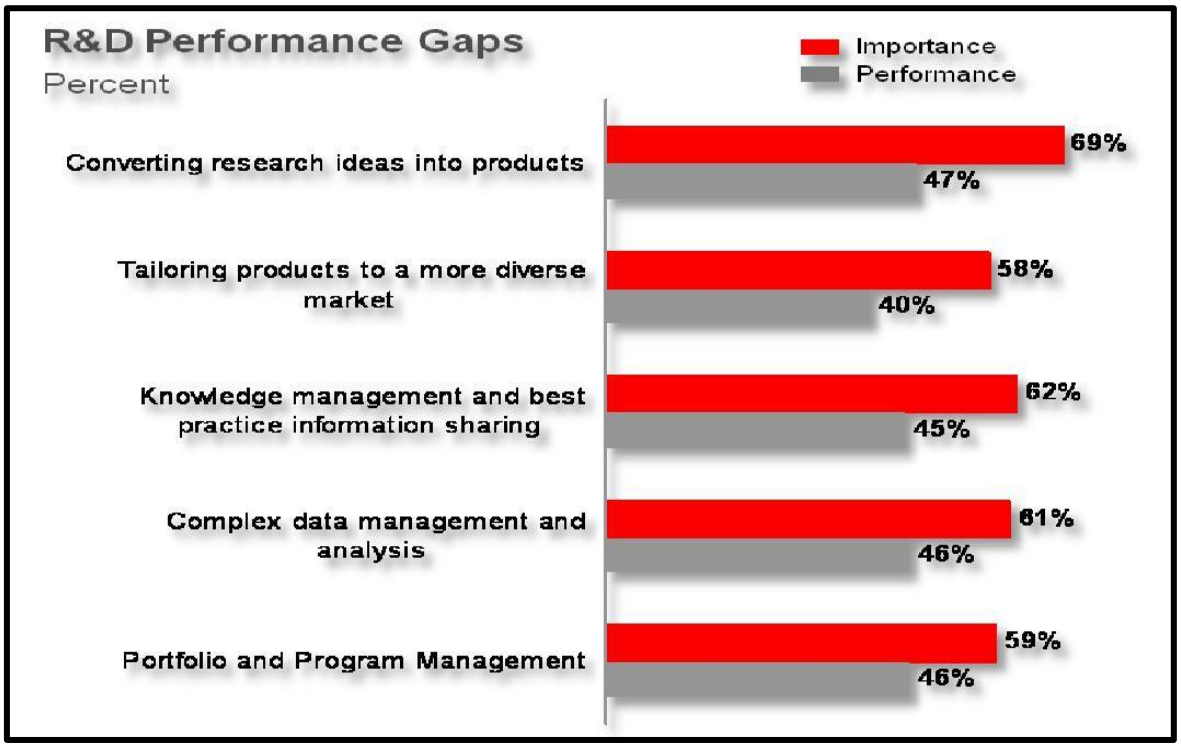


Figure 6

R&D Performance Gaps

Finally, some of the key influencers that have commonly impacted profitability, risk and growth can be traced back to three fundamental issues within the industry itself:

- **Increasing internal and external complexity** in managing the entire product lifecycle from product inception to phase out due to the simple fact that many pharmaceutical organizations suffer from silos of information across the different functional areas. In the case of R&D organizations this is typically based on therapeutic areas whereby cross-functional information flow is either lacking or non-existent.

- **No single data source for products and related information** due to a variety of different data sources and lack of collaboration across the organization. This often results in disparate, redundant and in worst cases inaccurate product information depending on functional area.

- **Gap between R&D and Commercialization:** Historically R&D processes have been largely viewed as independent of product launch and subsequent commercialization efforts within the industry thus resulting in a fundamental gap for coordinated and transparent collaboration.

Hard to Manage Clinical Trial Inventories

A critical element of the drug development process is the production and management of the clinical trial inventory. Effective management of the "chain of custody" of this initial clinical inventory is difficult and becomes more complex as Contract Manufacturing Organizations (CMOs) and other external partners are utilized in this strategic process. Traditional inventory automation tools such as ERP or MES systems do not provide the flexibility needed at this stage of R&D production. Instead manual disjointed processes supported with desktop tools such as xcel® are often utilized resulting in unnecessary process and coordination complexity. Lack of precise coordination of the clinical trial inventory within the trial management plan is disruptive, adding considerable cost and time to this phase of product development. Consequently, key clinical supplies metrics routinely result in less than 25% of their targeted performance objectives (Figure – 7).

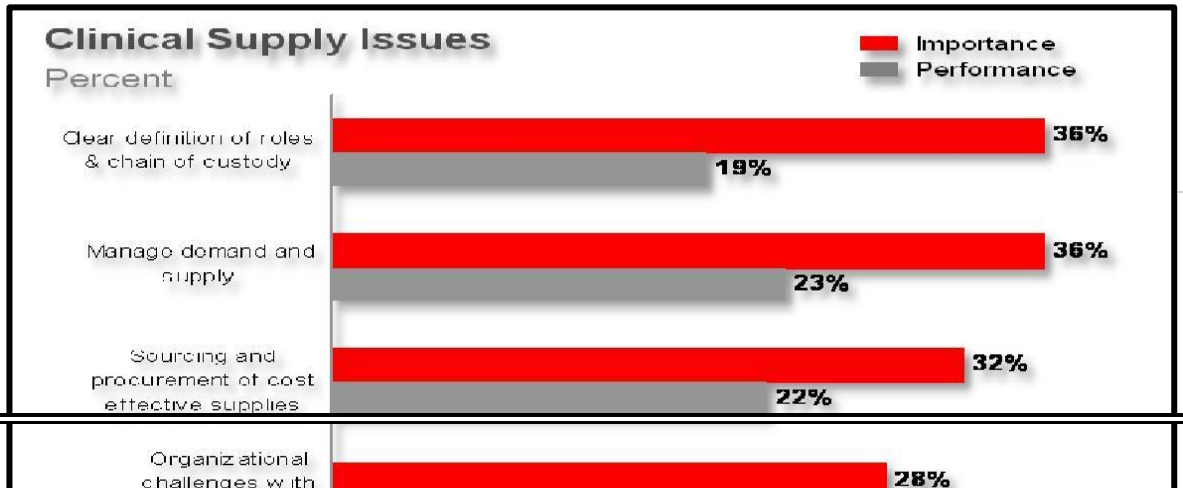


Figure 7

Clinical Supplies "Chain of Custody"

This combination of poor execution of the R&D pipeline and compromised production efficiency of the initial clinical supply process results in inadequate R&D results (AMR). Industry metrics based on project timeline performance, project cost, expected financial margin, and market share capture, show that approximately only 1 in 3 programs achieve their expected performance targets (Figure – 8).

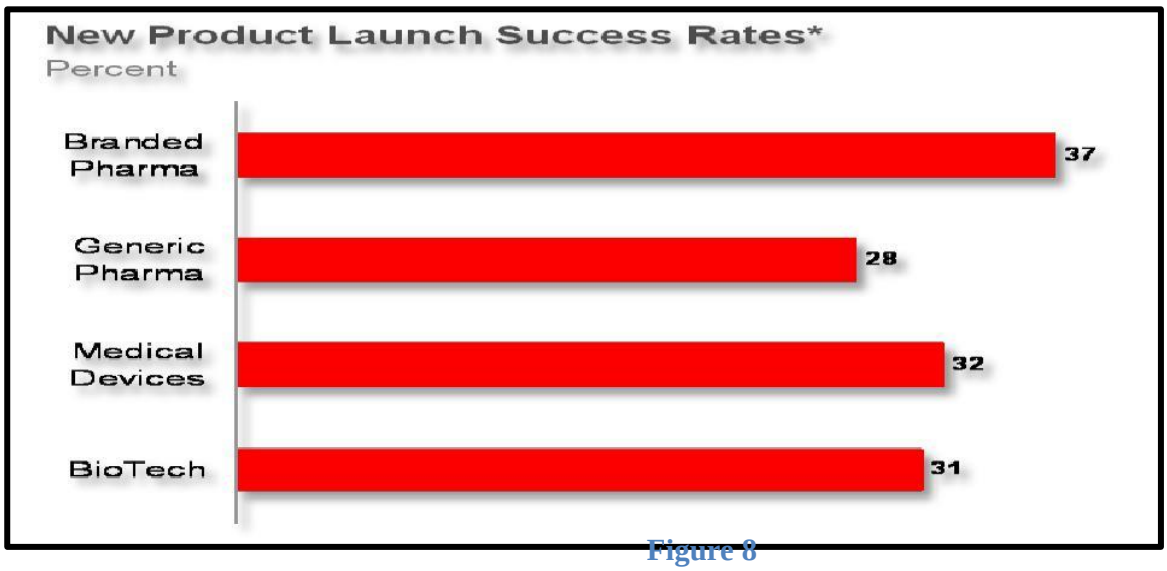


Figure 8

Current R&D Pipeline Performances

Transforming the Pharmaceutical Industry

An Opportunity to Improve R&D

While there are significant challenges within the pharmaceutical industry, opportunities exist in this increasingly competitive landscape for innovative companies looking for ways to transform their business that lead to profitability and growth. Companies that successfully manage the transformation process to address these challenges will realize improved business performance and differentiation in the market place as a result. As companies look to speed up the process by which new products are brought through the development pipeline to commercialization while supporting new therapeutic areas, a business transformation focused on cross functional collaboration whereby product knowledge can be uniformly leveraged will result in both productivity and revenue gains. It is also important to appreciate that even small incremental improvements can produce significant results in both revenue growth and margin. For example, for every day a company can reduce from the overall development cycle, they can realize significant reductions in cost and provide significant returns in both profitability and margins (Figure 9).

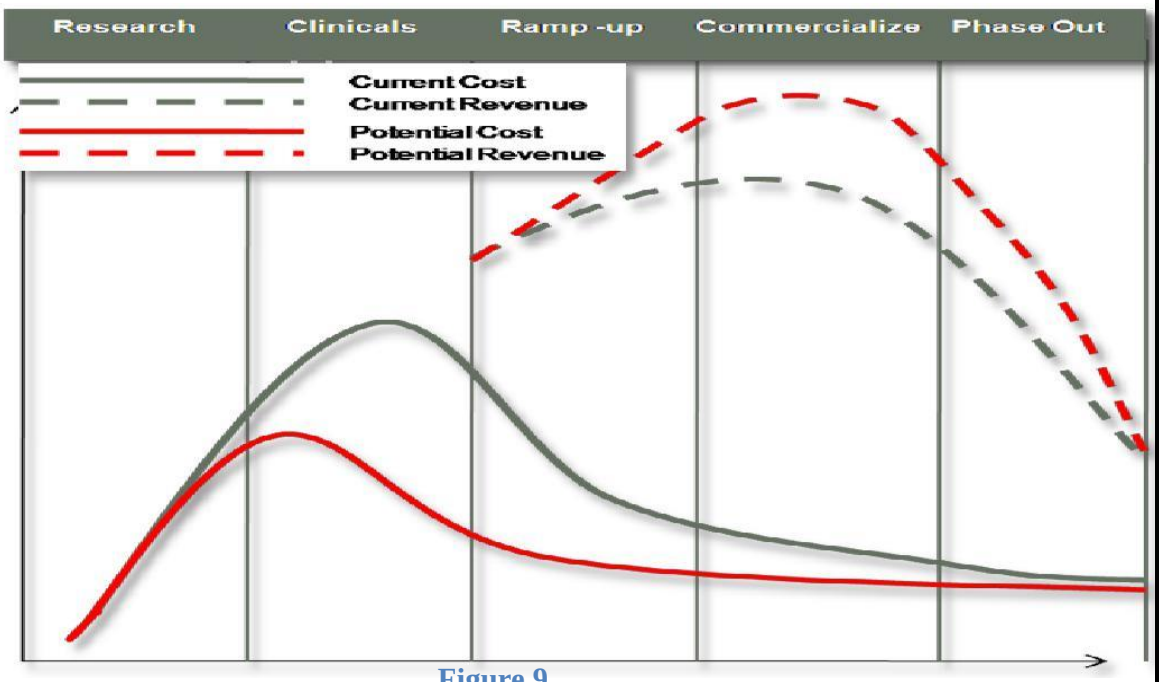


Figure 9

R&D Pipeline Potential Improvements

Achieving R&D Improvement

To achieve this, companies should apply the mantra of "think big - start small - scale fast" for any initiative related to improving development and manufacturing of clinical supplies. This will allow the enterprise to prioritize on a few key initiatives, standardize on those processes, and expand through a process of continuous improvement across the development organization. Further, the initiative should have executive sponsorship

across the entire organization, as this should be viewed as a business transformation and not a departmental project.

Some common characteristics have been identified for successful transformation initiatives. First, it is important to model the current R&D process and how it impacts clinical supplies.

Understanding the functional requirements of each of the "swim lanes" and the inter-relationship across these constituents will define challenging areas to focus on for initiating this activity. A template of common drug development activities and constituents supporting this activity provides a starting point for many organizations beginning a business transformation process. (Figure – 10)

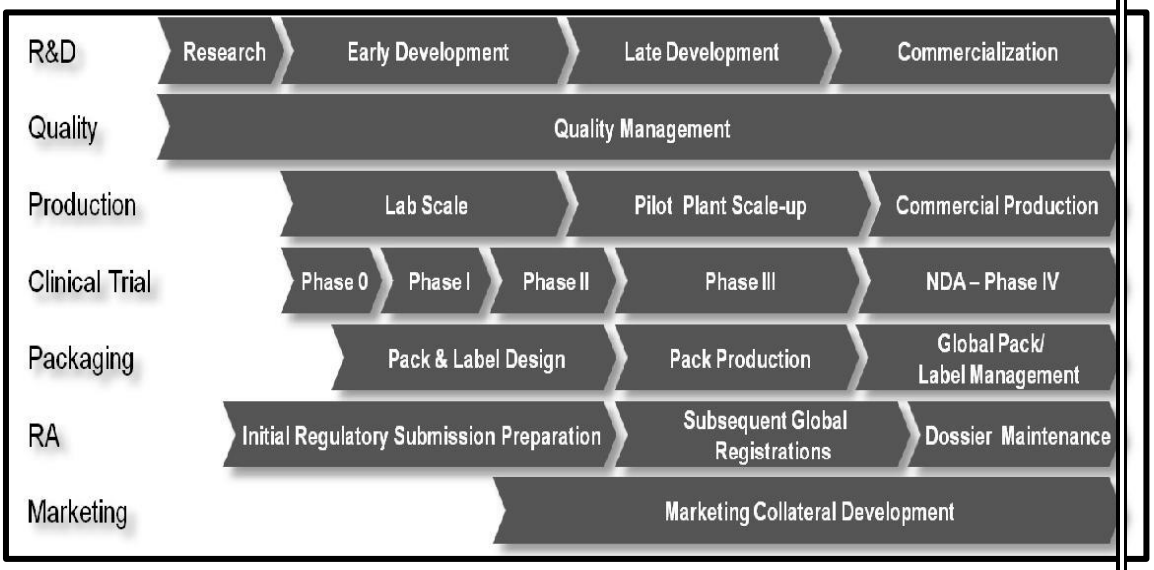


Figure 10

R&D Pipeline Cross Function Participants

Second, with a common development model outlined for the enterprise and key challenges identified, a business case can be developed to prioritize on which initiatives are most critical to address. A business case also helps justify the investment and provides metrics to measure realized business improvements such as ROI and operational performance for each specific initiative.

Third, for the initiatives that have been prioritized by the development challenges and justified with a business case, specific transformation requirements need to be defined. To define requirements, a review of the current IT landscape supporting these activities and the content managed in various systems must be compiled. This activity

will establish base line processes to improve and help define requirements, plus define historical content that needs to be migrated/integrated to support the transformation.

The final step is to define a deployment plan to manage the transformation of these key objectives. It is critical that functional constituents who own these business processes are members of the deployment team in addition to executive sponsorship across the organization. With a well-represented cross-functional team supporting the transformation, concrete objectives will be defined and expectations clearly outlined for success. This approach also provides the foundation for "think big - start small – scale fast" for ongoing enterprise transformation.

Strategic business processes required to support transformation

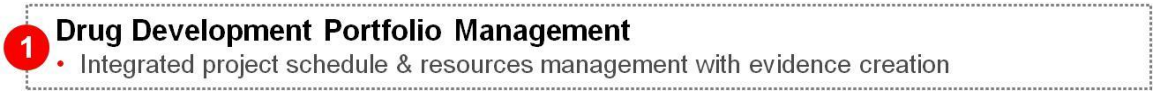
7 Ways to Transform Your Business

Several companies are actively pursuing transformation initiates to address these challenges. Benchmarking of these initiatives helps identify common business processes required to enable this transformation. Based on input from 15 leading pharmaceutical companies who are members of the Oracle Pharmaceutical Strategic Council, seven common enabling elements have been identified to support this transformation (Figure – 11).

Figure 11

Key transformation Elements

An operational review of each of these elements can be used to determine what functional requirements need to be deployed to support the transformation roadmap.



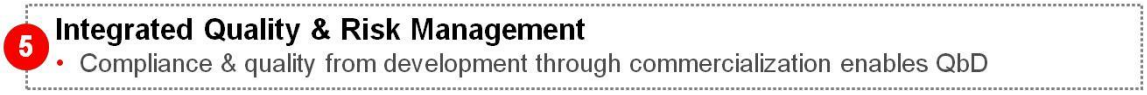
The complexity of individual drug development programs is further complicated as there are typically multiple programs occurring simultaneously in the R&D pipeline at any given time. Traditional drug development program management has focused on general program metrics such as schedule, and cost performance. To improve drug development execution, program management that synchronizes cross-functional collaboration and archiving of critical program deliverables is required. Integration of the decisions and approvals of these deliverables provide the regulatory evidence needed to confidently advance the drug development process through each phase. Management of each program and required deliverable evident in one system can also enable standardization of best practices to improve pipeline performance.

With the volume of program deliverables and regulatory evidence required in the development process ever increasing, a structured drug development archive is needed to effectively manage all of the associated content. This highly iterative development record must be automated to capture historical developmental information to support product claims and regulatory audits. Creating a structured archive for each individual design dossier in one unified system can also facilitate re-use of the Common Technical Documents (CTD).

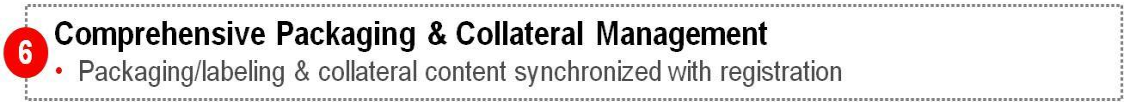
Clinical trial management is a pivotal phase in the drug development process that has become more complicated with global and adaptive trials. As companies look for ways to reduce costs while significantly increasing

profitability, externalization of clinical trials to CROs for example has become increasingly common and impacts everything from pre-clinical to post marketing research. The supply chain for clinical trials has also become increasing complex with multiple manufacturing sites and CMOs engaged in supporting the scale up for the required clinical inventory. For all supplies dispensed to each clinical site, a complete lot history of the campaigns producing the product must be archived. Synchronizing the approved manufacturing evidence of the clinical supplies with trial activity is required for clinical trial integrity to be maintained.

The production of drug product is highly iterative and controls must be established for each lot from scale-up through commercialization of the final approved product. Effective scale-up of drug production requires collaboration across many interrelated activities and dependences. An enterprise solution that enables the analysis of the drug product value chain including suppliers, materials, equipment, and processes will not only provide individual lot control but also facilitate the scale-up to commercial drug production volumes.

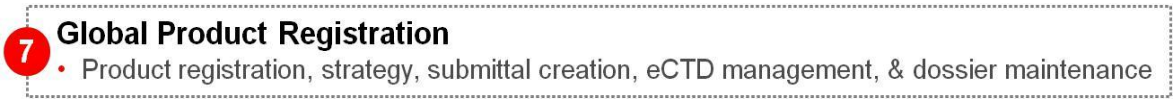


Quality and risk management continues to be a challenge creating significant business impact when deficiencies are identified during regulatory audits. Furthermore, with the industries transformation to QbD practices for product development, the need for an Enterprise Quality Management (EQM) solution is further justified. An effective EQM solution requires the integration and management of quality beginning at product development through commercialization. Early awareness of quality events and immediately assessing the impact across the enterprise will provide the foundation to leverage quality management resulting in improved business performance.



The integration of packaging, labeling and associated marketing collateral into the drug development process provides a significant business opportunity in the pharmaceutical industry. Often the creation of these assets is deferred until late in the drug development cycle creating delays in market launch and increased cost. This disconnect from the drug development evidence also creates the potential for misleading off-label claims that can be devastating for a product. Creation of a global repository for all packaging components, digital assets such as

logos and artwork, and marketing collateral that references development evidence will improve the regulatory integrity of all the associated commercial content. Re-use of this commercial product content, and common translation services are just a few of the business benefits companies like GSK and Bayer have realized by the enterprise management of this critical asset.

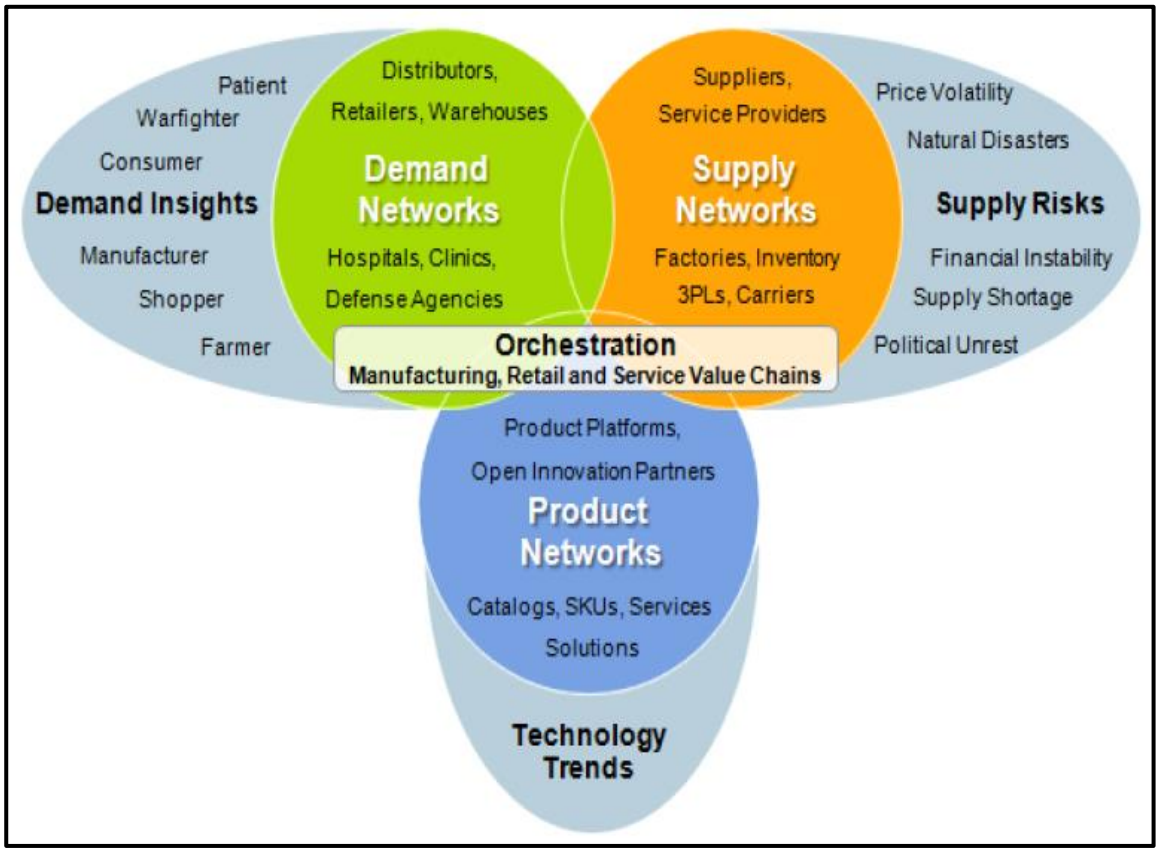


The ultimate successful outcome of any drug development program is regulatory submission and approval for commercial distribution of the product. Global product registration is complex and constantly evolving, making registration management increasingly difficult. As a result, this creates delays in market launch and significantly impacts the anticipated product revenue. Leveraging the evidence captured in the previously described use cases provides the content to support regulatory submittal requirements. This content also can be used for on-going global product proliferation through re-use of this registration process significantly improving ROI for each new product developed. (Product Lifecycle Management for the Pharmaceutical Industry, 2012)

1.8.2 Sustaining Growth and Margins – How can it be done?

1.8.2.1 Demand Driven Value Network (DDVN)

Orchestration of DDVN delivers better business results than isolated mastery of individual supply chain functions.



Source – Gartner

Figure 12

DDVN Overview

DDVNs integrate processes and data in the supply chain to enable collaboration, as well as orchestrate a response to demand that creates value and mitigates risk. Organizations orchestrating DDVNs perform better in the long term than peers with traditional, cost focused supply chains. These companies grow revenue faster, achieve more than 15% higher perfect-order rates and reduce inventory levels by as much as one-third. They leverage an outside-in view based on insights about customer value to deliver a demand response that is sustainably profitable and provides the desired customer experience. Orchestration involves the management of cross-functional processes that integrate and synchronize product, demand and supply networks to optimize joint value. Critical capabilities for orchestration include collaboration with key trading partners, real-time value network visibility and demand management that includes sensing, shaping and translation.

The four broad strategies for pursuing this vision: becoming market-driven, building value into supply networks, driving innovation through products and services, and orchestrating the profitable response. The detailed tactics to pursue these strategies will vary based on the position of a business within its industry value chain.

The following considerations can help organizations to evaluate their readiness to orchestrate DDVNs:

- Demand — Develop your understanding of demand characteristics, including volatility and profitability, and increase demand visibility though integration and collaboration.

- Value networks — Manage networks that are equipped for visibility, agility and collaboration to support innovation and growth, while mitigating risks and overcoming constraints.

- Processes — Recognize that integrated processes that connect strategy, planning and operations enable demand sensing, shaping and translation capabilities that distinguish DDVNs.

- Industry context — Use the DDVN framework to support the business strategy, and account for industry-specific drivers, constraints, and network details. These can include product life cycles, supply lead times, regulatory constraints, or volume and price volatility.

Strong core functional capabilities, flawless execution and data visibility are the foundation of DDVNs. However, isolated functional excellence has limitations in volatile and risky global markets. Leaders in functional areas, such as planning, sourcing, manufacturing and logistics, must work together to align key performance indicators (KPIs) across functional areas and emphasize customer value.

The following considerations can help functional supply chain leaders evaluate their organizations' readiness to orchestrate DDVNs:

- Planning — Manage and support sales and operations planning (S&OP) processes that mitigate risk and make conscious value trade-offs. Align S&OP with short-term, midterm and strategic planning horizons.

- Global sourcing — Use procurement, manufacturing strategies and execution, and global platforms to deliver local, scalable innovation.

- Alignment and collaboration — Create forums and mechanisms for cross-functional awareness, cooperation and influence. Ensure that product management strategies and service offerings are consistent with the strengths and limitations of the supply network.

- Execution excellence — Balance functional processes, such as sourcing, manufacturing and delivery, with the orchestration of cross-functional processes to create and deliver end-to-end value.

DDVN orchestration requires strategic framework, diligent execution and continuous performance management. Research associated with this Key Initiative is organized around the following principles:

- Strategize and plan — Review trends and predictions that will impact supply chain strategy and operations within your industry. Understand how its market dynamics and network constraints impact the application of Gartner strategic frameworks.

- Execute — Learn from Case Studies and examples that illustrate how leaders operating supply chains across industries apply the principles of DDVNs to achieve superior business performance.

- Measure and improve — Review profiles of the best supply chains in each industry, and benefit from practical advice and Toolkits that support the journey to improved orchestration.

(Demand Driven Value Network, 2012)

1.8.2.2 Manufacturing Execution Systems (MES)

Global pharmaceutical manufacturers must aim to achieve better control and increased transparency of their manufacturing processes across all sites. Here, MES comes into play. These systems control and trace all processes connected to the research and manufacture of pharmaceutical products using seamlessly integrated enterprise resource planning (ERP) systems, automation, and other components in the value chain, for targeted production and real-time transparency. MES are indispensable technology solutions for optimum operational procedures at paperless production sites, as they guarantee reliable traceability and cover all pharmaceutical processes.

From product development to clinical batches to commercial production, our MES offerings provide modular, integrated, and flexible solutions that

- Guarantee compliance with legal regulations

- Minimize risks and increase transparency

- Shorten production cycles and optimize the use of resources
- Control, monitor, and optimize the production steps up to the batch release

(SIMATIC IT for the pharmaceutical industry, 2012-2015)

1.8.2.3 Performance Metrics

Performance Metrics are required tool in evaluating and monitoring the performance of an organization, especially a business organization and productivity of its workforce. When directed at specific issues and problems, productivity measures can be very powerful. Managers are concerned with productivity as it relates to making improvements in their firm. Proper use of productivity measures can give the manager an indication of how to improve productivity: either increase the numerator of the measure, decrease the denominator, or both.

Managers are also concerned with how productivity measures relate to competitiveness. If two firms have the same level of output, but one requires less input thanks to a higher level of productivity, that firm will be able to charge a lower price and increase its market share or charge the same price as the competitor and enjoy a larger profit margin.

1.8.3 Regulatory Compliance - How can it be done?

U.S. life sciences companies operating in today's global marketplace are at increasing risk of product safety issues, security and privacy breaches, intellectual property (IP) disputes, whistleblower complaints, and corruption incidents, each of which may result in financial and reputational damage. Concurrently, the U.S. and other governments are tightening regulations to address these risks and working more collaboratively to enforce them. Among important developments are calls for greater transparency in life sciences companies' business and clinical operations — executive pay, financial information accuracy, manufacturing processes, transfers of value to health care practitioners and institutions as well as clinical trial quality. Under the ACA, for instance, pharmaceutical companies have to declare all payments to physicians.

Companies in pharmaceutical, biotechnology and medical devices industries are constantly pushing the boundary of innovation to develop new products. In addition, the industry is regularly being challenged to meet the rising standards of quality and to comply with rigorous regulatory requirements. For Life Sciences companies,

regulatory requirements such as FDA GXPs, reporting mandates, international quality and safety standards and other compliance issues are evolving from isolated departmental initiatives to an enterprise level challenge.

Legacy and homegrown systems, stand-alone applications or even paper or spreadsheet based systems have been used to manage product and process quality and compliance. Such point-solutions, while designed to track product and process quality data, fail to address systemic quality problems as they lack a broad enterprise reach. Additionally, these systems do not have the mechanisms to manage by exceptions - as a result issues slip through the cracks.

Leading Life Sciences companies are taking an integrated approach to quality and compliance management and leveraging technology and automation of key business processes to improve operational efficiencies, lower the cost of regulatory compliance and create a transparent environment for proactively identifying, tracking and resolving quality and compliance issues. Comprehensive quality and compliance management software solutions are required for managing quality programs within an organization, streamlining quality processes involving suppliers and customers and managing operational and regulatory compliance.

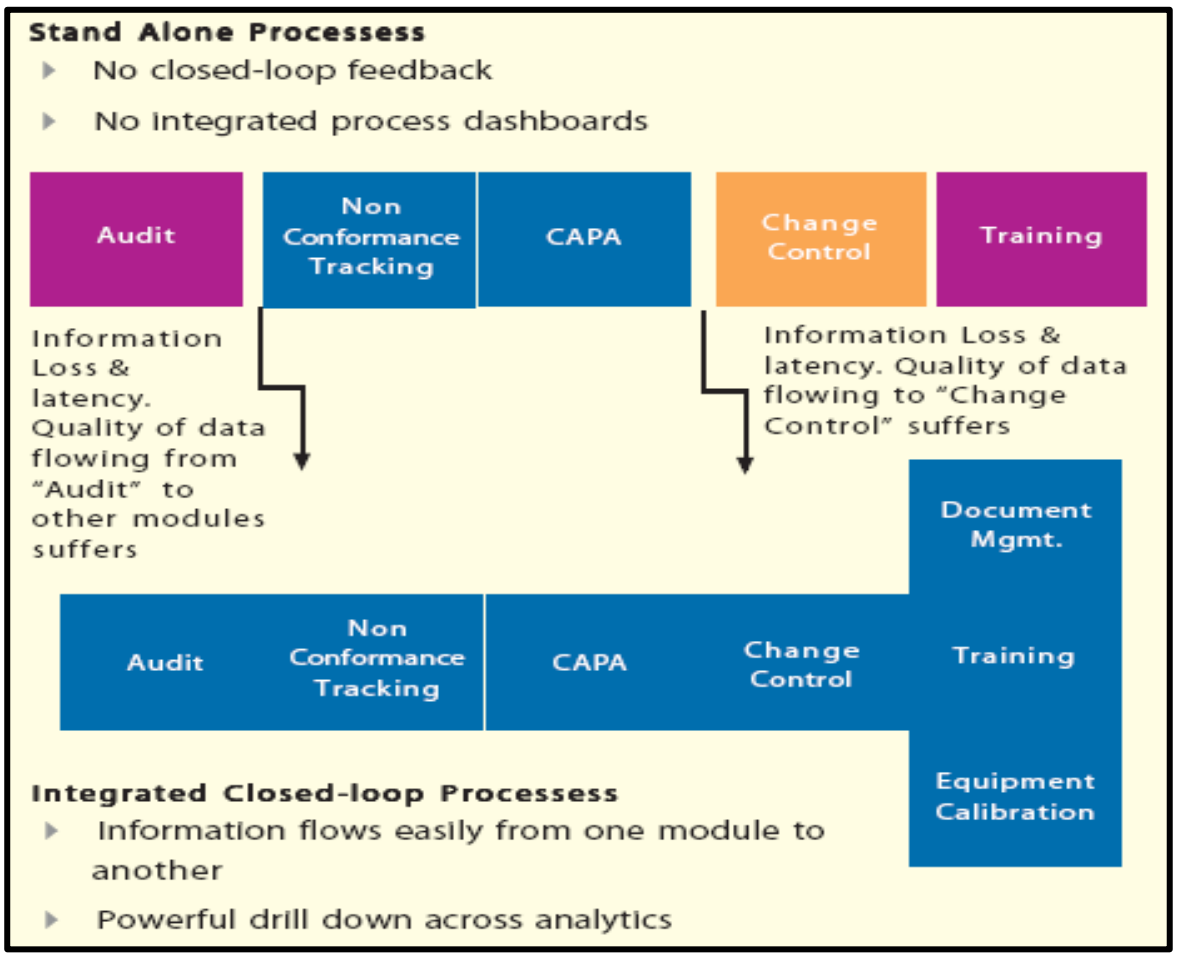


Figure 13

Standalone Process and Integrated Closed-loop Processes

Besting Class Solutions for Quality and Compliance

Life Sciences organizations across the globe are turning to software systems and support that rid them of the bureaucratic burden of compliance, enabling them to meet their regulatory commitments in a streamlined manner, whilst unlocking the latent business and quality improvement opportunities within their management system Metric Stream enables companies to take a risk-based approach to quality and compliance management and provides a common framework and an integrated approach to meet FDA regulations through risk management, document control, compliance training, ongoing auditing, as well as recording and reporting of exception events and the resulting corrective actions.

Metric Stream's advanced and comprehensive suite of FDA regulatory compliance software solutions for automating GXP compliance processes has embedded best practices that ensure ongoing compliance with FDA regulations. By improving operational efficiencies in quality systems, Metric Stream lowers the cost of regulatory

compliance and creates a transparent environment for proactively identifying, tracking and resolving quality issues.

Metric Stream uniquely combines software and content to deliver FDA compliance software solutions for effective and sustainable compliance with embedded best practices templates, access to training content from an expert community, and integration of business processes with regulatory notifications or industry alerts.

Metric Stream compliance solutions are widely being used in the life science industry for supporting key processes and requirements compliance such as:

- **Closed Loop Process**

  Ensuring that all quality processes are well integrated to create a unified and seamless environment for quality related issues and data. Metric Stream solution tracks events as they move from one stage to the next, even across departments and groups, to ensure a closed loop quality management process. For instance, a document change can initiate a training request and CAPAs triggered as a result of audit findings are tied to the audit.

- **Streamlined Corrective Actions**

  Engaging teams to collaborate on development and implementation of corrective action plans. Metric Stream enables triggering CAPAs, performing root cause analysis, assigning follow up actions while effectively tracking and routing cases from initiation to closure to closure.

- **Efficient Audit Management**

  Conducting frequent internal audits to ensure that the established product and processes quality requirements are being followed. Metric Stream provides capabilities to efficiently plan, schedule and conduct audits, allows audit findings to be reviewed and analyzed by a team, enables initiation of follow-up activities such as corrective/preventive actions when needed, and provides the ability to monitor the entire process.

- **Implementing Document Control**

  Streamlining document management and control processes for documents such as SOPs, batch records, regulatory filing, and quality reports. Metric Stream enables companies to adopt an electronic and automated approach to managing and controlling documents across the enterprise with a centralized repository and tools for collaboration.

- **Tracking Nonconformance and Deviation**

Accelerating nonconformance and deviation review and approval cycles with automated workflow. Metric Stream supports recording and automatic rule-based routing of nonconformance issues for review, disposition, and closure.

- **Real-time Reporting**

  Tracking quality issue and processes in real-time on executive dashboards and reports for data driven decision-making. Metric Stream provides complete visibility into quality system database with comprehensive aggregate reporting as well as individual case status tracking. Graphical executive dashboards and flexible reports with drill-down capability provide statistics, analytics and trending.

(Integrated Quality and Compliance Management in Life Sciences Industry, 2015)

1.8.4 Advances in Technology

The life sciences and pharma industry is undergoing tectonic shifts. Introduction of the far-reaching PPACA in the United States and other similar regulations across the globe are not only changing the regulatory framework, but are also impacting the cost and revenue potential of the healthcare payers, providers and pharmaceutical firms, specifically around R&D productivity and the ability to drive growth and profitability. Additionally, the impact of digitization on the value chain is adding an additional twist to an already complex and tough industry. (2015 Life Sciences Outlook United States, 2015)

Advances in technology include the following –

1.8.4.1 E-clinical Environment

According to a report published by IBM, the e-clinical environment can be divided into two parts - Part 1 - Electronic data capture, describes electronic data capture (EDC), one of the basic components of an eClinical environment and Part 2 addresses how Pharma can build an interoperable infrastructure in which disparate sources of information can be aggregated and analyzed. That, in turn, will enable a better understanding of the clinical data Pharma companies already possesses, incorporate new forms of biomedical knowledge like pharmacogenomics (genetic factors contributing to patient variability in drug response) and unlock the insights that data sources collectively contain.

One of the biggest barriers to the resolution of these challenges is the current reliance on traditional, paperbased processes for recording patient data during trials. With paper-based data collection, the information recorded by a trial investigator is first transferred to a case report form (CRF). It is then entered twice into a central database

and screened for inconsistencies – usually weeks after the investigator saw the patient. This double entry process increases the number of errors that are made and this often results in a three- or four-month delay before the information can be accessed. Electronic data capture (EDC) – the capture and management of clinical trial data in an electronic format – is much more accurate and efficient. It enables investigators to record patient data into the database on site, using preconfigured software instead of paper CRFs. The software checks the information at the point of entry, flags any entries that are inconsistent with the study protocol or other data on the electronic CRF (eCRF) so that the investigators can correct them immediately, and then communicates the data to a central server – typically via the Internet (See Figure - 14).

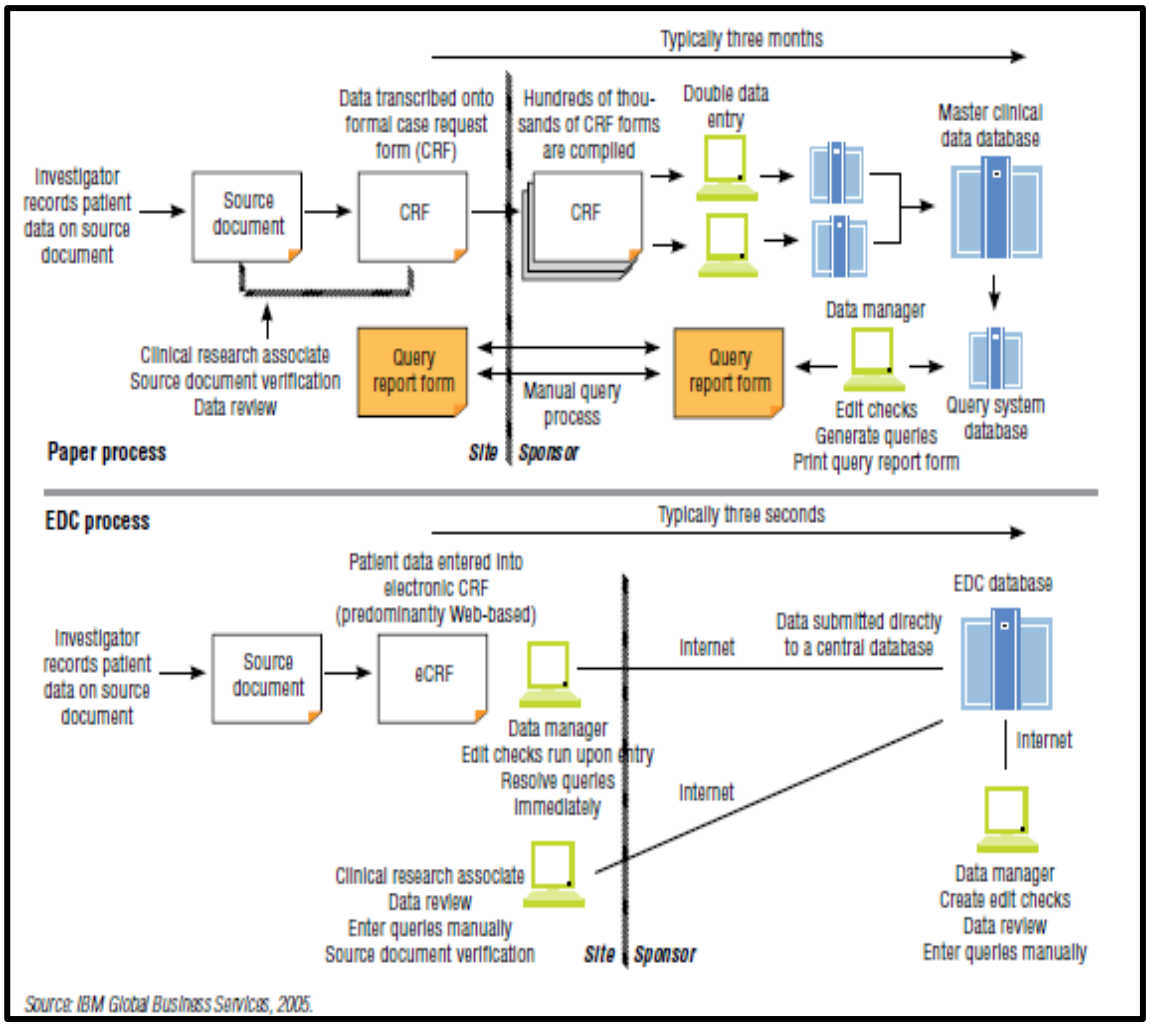


Figure 14

Using EDC is more accurate and faster than using paper-based methods to collect clinical trial data.

EDC thus improves the quality of the data that are initially entered by picking up omissions or inconsistencies, and ensures that the data are available on a realtime or near realtime basis. The relevant people within the sponsoring pharmaceutical company – including clinical research associates (CRAs), data managers and

management – can access the information instantly, without having to wait several months. And, the entire clinical team has a single version of the truth with which to work. The benefits of EDC are that it is less time consuming, gives you access to real-time or near to real-time data, incurs less cost, no errors, and minimizes manual work and many more.

(The E-clinical Equation - Part 1, 2005)

A lot of big pharma giants have already implemented EDC. What needs to be done is to innovate the existing systems in such a way that it links the health care value chain as a whole.

The shift from mass-market medicines to targeted treatments requires robust data management. As the development pipeline becomes healthier, so the number of submissions will increase. As the number of its data sources expands, Pharma will have to manage a growing amount of data across the value chain. The flow of information also will have to be aligned with the business processes underpinning the development, regulatory and manufacturing functions. The industry will thus need an integrated electronic environment, both to extract the "nuggets of gold" buried in the rapidly expanding body of biomedical and clinical data, and to facilitate the exchange of information among different documents, dossiers and business systems. More sophisticated document management systems will be necessary to help manage the anticipated increase in regulated and non-regulated activity. That environment must be able to support free-form text and structured data, as well as information that is actively in use and information in storage. It must also, of course, help ensure that the data are visible and traceable, in order to comply with the regulatory requirements.

Three factors are critical for creating an eClinical environment:

- Connecting multiple information sources - Pharma is already looking at how it can integrate its existing data sources and link them with new data – like the molecular sciences – to understand the role genetic variations play in determining why individual patients respond differently to the same treatment. In certain cases, that understanding can help to distinguish responders from non-responders and more accurately predict which patients are most likely to suffer adverse reactions.

- Using shared data standards - Semantic technologies are also crucial in making applications and data interoperable. Like languages, semantic technologies use grammar (a set of rules) and vocabulary (a list of terms) to relate terms from different data sources and find terms with similar meanings. In this way, they make it possible to perform seamless searches across multiple forms of data and re-use data from previous studies. Semantic technologies provide a standard meaning for describing data, its properties and the relationships among data items. But recognized data standards are also necessary to create an interoperable eClinical environment.

- Collaborating externally - Connected systems and recognized data standards are crucial if Pharma is to become more innovative. The final piece of the puzzle is external collaboration. The industry is thus slowly changing the way it does business and working more collaboratively with its suppliers (academia, biotech and CROs), customers (the regulators, healthcare payers and providers) and technology and service providers. This trend is likely to accelerate with the shift toward targeted treatments, since such products are very complex and few, if any, pharmaceutical companies possess the expertise to discover, develop and manufacture them in isolation.

(The E-clinical Equation - Part 2, 2006)

1.8.4.2 Virtualize R&D

The definition of the virtualization of R&D is essentially an externalization or virtualization of processes, with a multitiered network of innovation that traverses multiple entities—commercial and academic—with a coordinated research or development goal. Rather than confining creativity to one physical place where all the core activities are conducted, the new model is very much a kinetic network of research centers or skill centers, together with a global network of clinical development sites.

The paramount question the industry is currently trying to answer is 'how do we find new products now?' Many of the lower-hanging fruit have gone. The traditional R&D process has been to define the target by which a molecule, biologic, or diagnostic can be applied. However, in order to fully identify the targets and to dramatically increase the success rate of the molecules that do enter preclinical development, it is essential to have an intrinsic understanding of the pathophysiology of the disease under investigation. A better understanding of systems biology that underpins both the disease and the human body will also be fundamental to helping researchers develop a finer grasp of how to modify or reverse pathophysiologic changes. This is an enormous task, but this knowledge, gained through increased collaboration between the industry, academia, the regulators, governments, and healthcare providers, and facilitated by greater use of new technologies, will enable the virtualization of the research process and accelerate the development life-cycle.

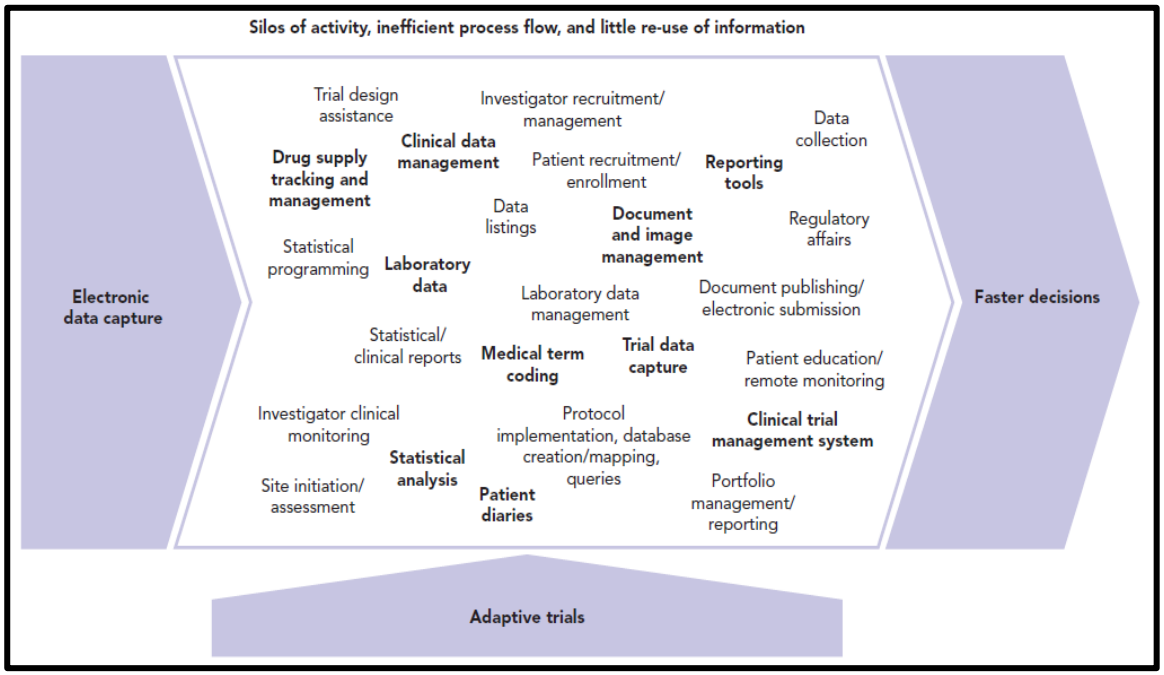


Figure 15

Clinical Development – The landscape today

A consequence of the drive to increase productivity that is affecting biopharmaceutical companies, research organizations, and academic centers alike is the tremendous volume of data that is generated and processed (see Figure – 15). The challenge is how to manage effectively these increasingly large volumes of data. Current bandwidth limitations can affect the ability to move large volumes of data and data types, such as electronic data capture (EDC) and electronic patient-reported outcome (ePRO) data, laboratory data, trial supply information, and medical images, across global networks. However, this situation is generally improving across the world, almost on a weekly basis. Another important challenge relates to data governance, or data providence—ensuring that only the appropriate people can access and share these data across different companies or entities is critical. This is one of the largest challenges for the industry. Providing a good solid audit trail across several networks also presents a significant challenge. Finally, there is the issue of data integration. To be able to share data effectively and leverage vast information sources, semantic tools will be required to make sense of all of the data relationships. The utilization of such tools will certainly need open standards, such as those being developed by Health Level Seven (HL7) and the Clinical Data Interchange Standards Consortium (CDISC) projects.

With the increasing globalization and virtualization of R&D through outsourcing and offshoring, effective innovation can be achieved only with effective knowledge and technology transfer. The constraints of geographic distance and dispersed organizational structure can be overcome by the strategic deployment of IT resources. Traditionally, data have been locked in silos and enterprise-wide IT resources underutilized. However, efficient

management of disparate data sources, from data integration to the mobilization of information across various projects, will facilitate decision-making. As the data sets grow in size and thus value, semantic data management, reporting, and analysis tools together with advances in processing power could translate to a leaner, more efficient pipeline. Increased speed and the time savings in processes can translate to cost savings—if the go/no-go decisions are made more quickly across the sequential elements of the R&D pipeline, the overall pipeline will benefit from less costly failures in later phase II/III development. Currently, data aggregation and clinical data warehouse tools such as Oracle's Life Sciences Data Hub (LSH) allow the rapid consolidation of data from multiple sources into a single environment where they can be analyzed, visualized, and reported on (see Figure 16). The flexibility offered by clinical data warehouse tools is supported by strong identity management tools that allow for secure sharing of data across networks and between internal and external users and enable collaborative development. These tools will allow data to be integrated, aggregated, and processed more efficiently. Another benefit is the layering of business intelligence and analytic tools that will allow much more efficient, earlier, and stronger testing of hypotheses, which in turn will translate into more informed decisions. Results can be obtained in minutes or hours rather than days or weeks. IT infrastructure is evolving and advancing exponentially, from greater internet access through to superior hardware processing, intelligent software, and the extension of computing capacity by virtualization of computing resources. This will create a flexible, scalable technology platform that can be optimized quickly when business demands change while enabling the leverage of valuable data assets that will improve the quality and speed of processes within the R&D pipeline.

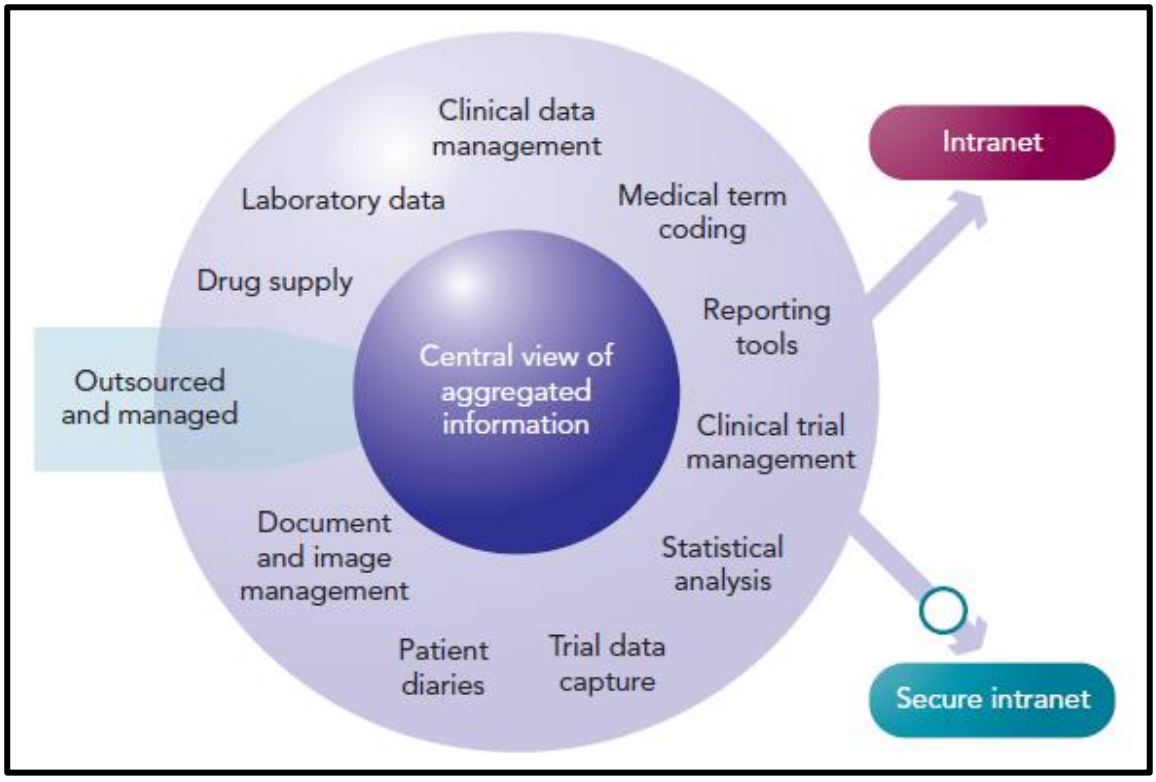


Figure 16

The traditional approach for many organizations has been to build data silos in separately owned domains. Applications were developed to serve these silo-ed data. The limitations of these legacy systems are a barrier to the virtualization of R&D because the inherent inefficiencies of silo-ed databases are counter to effective knowledge sharing. Moreover, historically, data have been aggregated centrally—the data warehouse approach—or handled by a federated approach, where data come through a set of dynamic links to disparate sources. Both options present data to the user as a single data source and both systems have their advantages and limitations. Data warehouses are built for queries based on static hierarchies; thus, if the nature of the queries changes as the data evolve, the system may not be optimized to meet these changing demands. The implementation of clinical data warehouse tools, such as the LSH, with robust communications layers based on open standards that can communicate with other applications will facilitate communication between formerly silo-ed databases as well as providing another option to the federated or data warehouse approaches to data aggregation. This third option is a process-based approach and is a hybrid of data warehousing and the federated approach. A process-based approach allows data views into source systems and scheduled copying of data to a central repository, and is designed to support changing environments through workflow to automate business processes. The integration of middleware-based messaging provides dynamic event-driven processes. The use of adapters allows integration with source systems and data structures and enables the intelligent loading of data. Support for interoperable data models enables organizations to adopt emerging standards such as CDISC and HL7. Moreover, these standards can co-exist and interoperate with company-wide standards.

Traditional R&D processes are too complex, too cumbersome, and too prone to expensive late- stage failures. Change has been relatively slow, although continuing scientific and technological advances are providing the momentum to transform the paradigm of drug development. The classic R&D model are transforming into new R&D processes that are more connected, iterative, and predictive. In the future, semantic drug-discovery processes, enabled by a comprehensive understanding of how the human body works at the molecular level, will help make the connections that identify the links between disease and pathophysiologic pathways. This knowledge will then be used to build virtual models. The ultimate goal will be the creation of the virtual human—a single validated mathematical model that is able to predict the effects of modulating a biological target on the whole system and is capable of reflecting common genetic and phenotypic variations. Current research, encumbered by our limited knowledge of physiologic processes, has been aimed at building models of different organs and cells or creating 3D images from the resulting data. Predictive biosimulation is already playing a growing role in the R&D process. The creation of a virtual model will be facilitated by the utilization of computer-aided or *in silico* design. Computational approaches can expedite hit identification and hitto-lead

selection, optimize absorption, distribution, metabolism, excretion, and toxicity profiling, and alleviate safety issues.

1.8 Conclusion

The biopharmaceutical industry to date has focused on the one size fits all approach, but one size medicines do not fit all patients, and the same is true of the R&D process. Many organizations find themselves managing their quality and compliance initiatives in silos – each initiative managed separately even if data, processes and reporting needs overlap. When systems and procedures to support these were put in place, the decisions were made in a tactical manner, without keeping the broader set of requirements in perspective. As a result, organizations have ended up with dozens of such systems, each operating in their own silo.

There is an immense need to improve, update and integrate the existing system as well as implement new systems and align them with needs of the life sciences and healthcare industry as a whole. A need to build a strong data base where all real-time data is available and the same is accessible by providers and payors as well. Digital health is a way for pharma companies to be more relevant in healthcare. Smart devices like using digital sensors, movement tracking gadget, wireless blood pressure cuff, food tracking app and many more will be useful for the customers. This would give pharma companies insights about the customer and link each other. The whole life sciences and pharmaceutical industry is on a transition to move from 'volume based to value based' and this would help the life sciences industry to think 'beyond the pill.' The life sciences and pharma industry should develop drugs according to the value it holds for the customer.

A Patient engagement tool rolled out in collaboration with the employer, health plans or hospital system would allow pharma to have a seat at the table in the design of real-world evidence. The life sciences and pharma industry should use multi-channel marketing. Standardization of process internally as well as externally.

Companies must create an integrated cross-functional approach that will require software vendors to expand their footprints through development, acquisition or partnerships to provide the needed functionality. Realignment of organizations and metrics, integration of technology, layer on business intelligence (BI) functionality. Product Innovation Platforms – it incorporates the Nexus of Forces (social, big data analytics, cloud and mobile) to continuous creativity, inspiring new and better products throughout full life cycles and across generations of a product.

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