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Pharma's Supply Chain Reset:
Working Capital, Technology and Regulatory Implications of Localised Manufacturing

As global trade pressures could prompt a shift from globalised to localised supply chains, the pharmaceutical industry faces a host of new challenges.

The move to relocate production from Asia and Europe to North America comes with significant operational, financial and strategic implications, including increased regulatory complexity, the technical demands of technology transfer, higher working capital requirements, and the need to rethink production economics.

To protect margins and liquidity in this environment, some companies are further enhancing their investments in advanced manufacturing, including disposable bioreactors, modular "factory-in-a-container" solutions, continuous manufacturing techniques, and AI-driven analytics engines. Historically slow to adopt such innovations, the biopharma sector may now be forced to accelerate change.

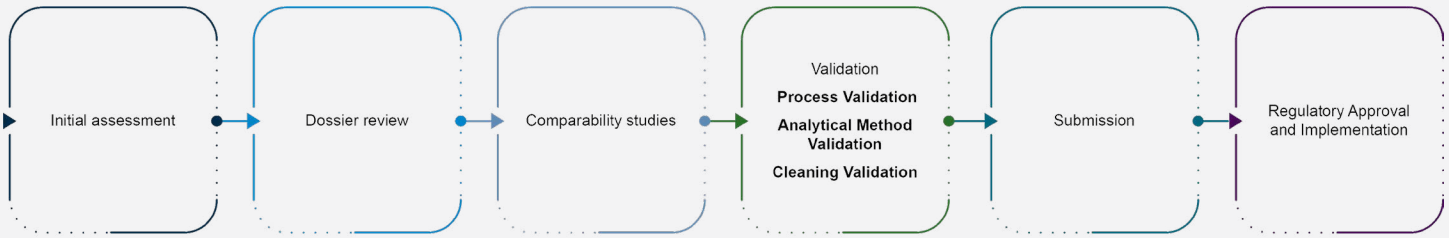
This paper, part of our "Navigating Global Pharma Policy" series, explores how revalidation requirements and site transfers impose regulatory burdens, how technology transfer magnifies cost and complexity, and why the future of pharmaceutical manufacturing may not always align with the nearshoring narrative.

To counter the impact of trade policies, companies are increasing their investments in advanced manufacturing.

Regulatory Risk: Revalidation and Compliance in a Shifting Landscape

Companies relocating manufacturing to North America will encounter additional regulatory requirements tied to site revalidation, dossier updates, and process comparability. These steps, critical for maintaining good manufacturing compliance (GMP), may introduce supply issues caused by transfer delays, as well as cost risks, especially for critical or lifesaving products. Older, mature brands may face even higher burdens as outdated data and changes to regulation expose vulnerabilities in their original dossier applications. The regulatory bar is particularly high for Indian and Chinese contract manufacturing organisations (CMOs), potentially nudging more firms to invest in onshore facilities.

Image 1: **Regulatory Revalidation Process: Step by Step**



Source: A&M

> A lack of planning creates risks of overstocking, leading to higher working capital requirements.

Technology Transfer: Internal Strain and Outsourced Complexity

Tech transfer is a resource-intensive endeavour and as such often exceeds the capacity of internal teams, particularly in mid-sized firms.

Specialised expertise for tech transfer processes is expensive and scarce, especially for complex modalities like biologics or oligonucleotides. Contractor markets can charge premium rates, while tech transfer teams (often fewer than 10 full-time employees) juggle multiple projects across regions. In addition, workforce retraining and the ability to bridge talent gaps are critical success factors, particularly for advanced manufacturing approaches that demand new technical competencies.

Another challenge is maintaining adequate levels of stocks during the transition. A lack of planning creates risks of overstocking – leading to higher working capital requirements – as well as understocking, which can result in obsolescence, supply disruption and lost revenues.

The hurdles associated with technology transfer can vary widely across modalities; reshoring complexity is typically higher for newer therapies, particularly cell therapies that require intricate, highly controlled manufacturing processes.

Image 2: **Tech Transfer Costs by Modality**

Modality	Costs (per drug product)	Timeline	Complexity
Small molecules	$500,000 to $2 million	18 to 30 months	Easier to transfer but still requires API-specific validation
Biopharma /biologics	$5 million to $15 million	12 to 18 months	Product-specific processes (e.g. cell lines, bioreactors); high regulatory burden
Advanced Therapy Medicinal Products (ATMPs)	$2.5 million to $10 million	24 to 36 months	Often infeasible to transfer without full system rebuild

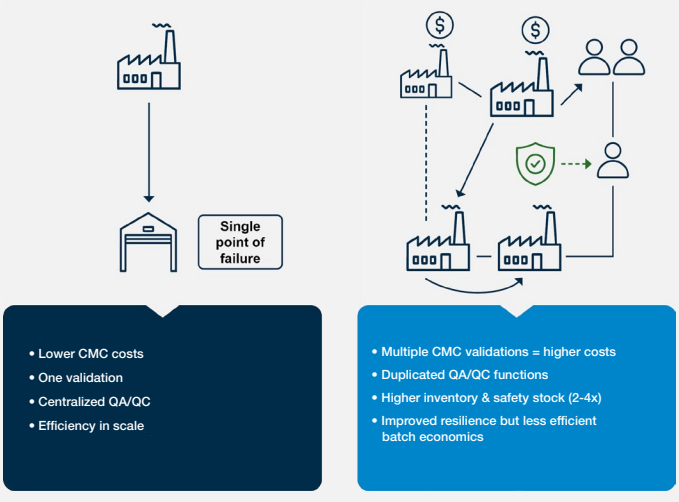
Source: A&M

Redundancy vs. Resilience: Multi-Node Uplift Comes at a Cost

Implementing multi-site (multi-node) manufacturing enhances resilience but introduces substantial complexity. Each new site must undergo its own validation, leading to increased chemistry and manufacturing and controls (CMC) expenditures, often cited as a significant percentage premium per product. Firms can mitigate full tech transfer burdens through strategies like in-process relief or postponement, deferring final production or packaging to locations closer to the point of demand. While such tactics reduce duplication of comprehensive transfer efforts, they require careful planning to uphold responsiveness across the network.

Moving toward smaller scale, in-market manufacturing may lead to elevated inventory levels, duplicated quality assurance/control (QA/QC) functions, and inefficiencies in batch economics. Based on A&M's analysis, smaller, localised supply chains may require a 2 to 4 times increase in safety stock due to increased variability and the bullwhip effect. This increase significantly amplifies inventory carrying costs, which typically range between 15% and 25% of the inventory's annual value. The resulting working capital burden is particularly pronounced for biologics and ATMPs that demand cold-chain management and just-in-time delivery.

Image 3: **Single-Node vs. Multi-Node Supply Chains: Key Features**



Source: A&M

Impacts of a multi-node uplift by modality:

- **Small Molecules:** Manageable shift; localised production slightly increases inventory cost but manageable with low capex.
- **Biopharma/Biologics:** High working capital impact; distributed supply drives batch inefficiency and cold chain challenges.
- **ATMPs:** Already small-scale and regional; working capital impact is high but structural, requiring process innovation rather than scale change.

Disposable Manufacturing, Modular Systems and Advanced Manufacturing

To counter tech transfer costs, manufacturers are increasingly turning to flexible, rapid-deployment technologies. These include:

Disposable manufacturing: Single-use bioreactors (SUBs) are widely adopted to reduce cleaning, sterilisation, and validation requirements. Unlike stainless steel systems, SUBs are disposable, which significantly reduces downtime between production cycles. Studies suggest SUB adoption can cut upstream manufacturing costs by over 60%, primarily through the elimination of water-for-injection (WFI) and clean-in-place processes. In one case, implementing SUBs generated annual savings of $250,000 in WFI costs and $60,000 in labour costs by removing the need for stainless-steel setup and cleaning.[1]

Modular systems: Modular "factory-in-a-box" facilities enable capex-light deployment within 14 to 18 months, compared to 24 to 36 months for conventional construction. Pfizer's deployment of a FlexFactory biomanufacturing platform in China[2] suggests that such facilities can be brought online nearly twice as fast as traditional builds.

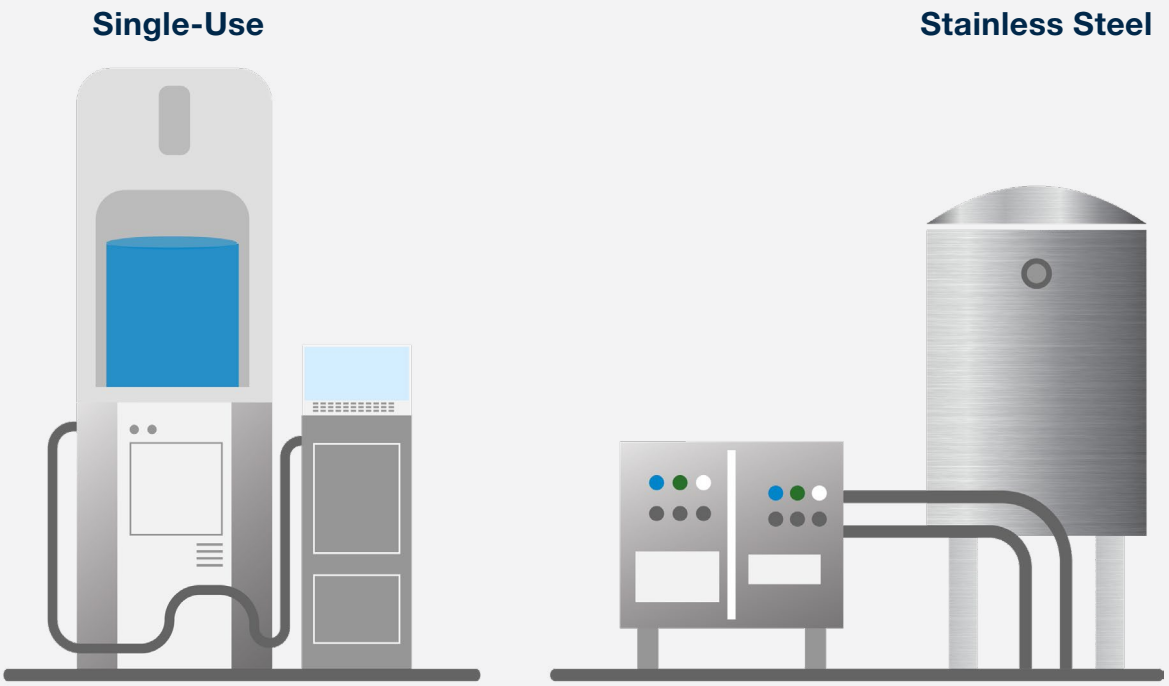
1 Addressing Industry Challenges with Single-Use Technologies | Contract Pharma
2 New KUBio box for viral vectors boosts gene therapy manufacturing | Cytiva

These platforms support smaller, faster-turnaround batches, making them ideal for low-volume, high-value biologics, and regionalised supply models. They provide the vehicle to rapidly onshore complex and costly manufacturing processes in response to tariffs, while also delivering cost efficiencies, enhanced service, and improved supply chain agility.

Advanced manufacturing: Amid pressures from pricing reform, inflation, and rising energy costs in recent years, advanced manufacturing has become a critical lever to reduce cost per unit and increase agility. With the added complexities of global supply chain disruption and trade uncertainties, the adoption of cutting-edge technologies – including continuous manufacturing, single-use systems, robotics, and AI-enabled batch control and real-time release testing – is expected to accelerate.

Together, these technologies are transforming production from rigid, capital-intensive models to nimble, digital-first operations. The benefits are significant: stronger cost structures, reduced working capital requirements, and lower transportation expenses, particularly for cold chain-dependent products such as biologics and advanced therapies.

Image 4: **Traditional vs. Modular/Disposable Plant Set-Up**



Source: A&M

> Large pharmaceutical groups have committed to ambitious decarbonisation goals to reduce carbon emissions within their supply chains.

Sustainability Considerations of Local vs. Global

Sustainability considerations are increasingly influencing localisation strategies as global pharma supply chains come under scrutiny for their heavy carbon footprint and high levels of plastic and packaging waste. The industry is a significant contributor to greenhouse gas emissions, with Scope 3 emissions (which include those from suppliers and vendors) typically accounting for around 80% of total carbon emissions for a typical pharmaceutical firm.[3] While regional manufacturing can mitigate that impact by reducing transport-related emissions, smaller-scale plants may increase per-unit energy use and waste. The environment impact of setting up new local facilities must also be considered.

Regulators are also tightening disclosure rules. The EU's Corporate Sustainability Reporting Directive (CSRD) mandates reporting on climate and waste impacts, including detailed disclosures on Scope 1, 2 and 3 emissions. Meanwhile, large pharmaceutical groups have committed to ambitious decarbonisation goals, with coalitions such as Manufacture 2030 pushing manufacturers to reduce their carbon emissions within their supply chains.

3 It's Time to Calculate the Carbon Footprint of... | BASF Pharma

What's Next? Five Strategic Pathways for Pharmaceutical Manufacturers

Manufacturers face a spectrum of viable strategic scenarios, each with distinct risk, capital, and operational profiles. The most prudent companies will proactively choose among the following pathways:

Strategy	Risks	Example
1. All-In on Traditional Build		
Invest in large-scale US manufacturing using established steel tank or multipurpose batch infrastructure. This approach emphasises proven compliance and operational reliability but demands high capital outlay and long timelines. It may suit companies prioritising product integrity and scale over speed and flexibility.	Demand uncertainty, modality obsolescence, regulatory delays.	Amgen's recent investments in US manufacturing facilities, including a $600m expansion of its Central Ohio facility, $1b to build a second plant in North Carolina, and $600m new innovation centre in its headquarters in California.[4]
2. All-In on Advanced Manufacturing		
Rapidly deploy modular, disposable, or continuous platforms ("factory-in-a-box," single-use bioreactors) to expedite market entry, reduce validation burdens and amplify operational agility. While capex-light, this scenario requires significant upskilling and recalibration of standard operating procedures.	Regulatory and quality concerns, upskilling and procedural rewiring, supply chain dependency and waste generation.	Companies like Cytiva, G-Con and Pharmadule have developed modular bioprocessing units that function as fully disposable, single-use systems within portable, self-contained trailers, or cleanrooms.[5] Modular systems such as "factory-in-a-box" units can be assembled and commissioned in months, rather than years.
3. Hybrid or Selective Reshoring		
Shift selected nodes (API production, fill-finish, packaging) stateside while maintaining global partnerships where strategic or cost advantages persist. This allows companies to optimise risk, working capital, and regulatory exposures, but increases complexity in supply, tech transfer, and network management.	Supply chain and network complexity, successfully maintaining global partnerships, capital and overhead inefficiencies, regulation standards across the globe, policy volatility.	Eli Lilly's plans to open four new US manufacturing sites over the next five years, with a focus on API manufacturing, reshoring of critical capabilities of small molecule chemical synthesis, and strengthening of its supply chain.[6]
4. Partnering with CDMOs		
Share cost, risk, and speed advantages through co-location or contract manufacturing with specialist partners (domestic or global). This scenario can offset capital requirements and access flexible capacity, but may encounter contract, IP, or quality hurdles. Implementing these partnerships are typically faster than traditional greenfield build, although timings will depend on project complexity and regulatory review.	Quality and compliance risk, scope misalignment, tech transfer complexities.	Moderna partnership with CDMOs to scale up mRNA vaccine production globally. The collaboration with Rovi in Spain enabled an additional 600 million doses per year, while Thermo Fisher supported with raw materials and manufacturing ramp-up efforts.[7]
5. Wait and Optimise		
For companies unwilling or unable to commit to significant capex, focus on price/cost management and operational efficiencies until greater policy and regulatory certainty emerges. While defensive, this approach may forgo potential strategic advantages in securing supply resilience.	Supply chain shocks, regulatory delays, missed strategic resilience, competitive gap.	Merck has launched a $3 billion cost-cutting initiative focused on strategically optimising its existing manufacturing network. This restructuring program aims to realign its global manufacturing operations to better adapt to evolving business needs.[8]

4 AMGEN INVESTING MORE THAN HALF A BILLION DOLLARS IN NEW, STATE-OF-THE-ART CENTER FOR SCIENCE AND INNOVATION AT U.S. GLOBAL HEADQUARTERS | Amgen Inc.
5 Pharma Manufacturing
6 Lilly plans to more than double U.S. manufacturing investment since 2020 exceeding $50 billion | Eli Lilly and Company
7 Moderna taps Thermo Fisher for 15-year mRNA production pact for COVID vaccines and more | Fierce Pharma
8 Merck's $3B cost-cutting initiative includes optimization of its manufacturing network | Pharma Manufacturing

Manufacturers should resist one-size-fits-all or reactive responses to supply chain disruption and regulatory shifts. Instead, leaders should approach manufacturing network decisions as part of a long-term, scenario-based roadmap that is evaluated in terms of risk appetite, product mix, capital constraints, and local market goals.

Whichever pathway or combination is chosen, success will depend on harmonising working capital, technology transfer, regulatory compliance, and workforce development; not in isolation, but as a resilient ecosystem that withstands volatility and unlocks sustainable value across the network. The industry's winners will go beyond isolated moves to masterfully align manufacturing strategy with advanced, flexible technologies, robust talent planning, and dynamic risk management to deliver resilience without eroding margins.

This is just one piece of the puzzle. There are several other looming policy changes that pharma companies must prepare for. Follow our *"Navigating Global Pharma Policy"* series for more insights on policy implications and strategic actions for pharma and biotech.

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