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2025 Pharmaceutical Packaging Market Prospects

Key takeaways

Key takeaways 1/2

Pharmaceutical packaging innovation takes place early in the development process

More and more, the pharmaceutical industry is realising that to achieve goals like sustainability, patient-centricity, and unique drug packaging and delivery solutions, packaging considerations must come earlier in the development process.

Regulators and legislation must enforce and harmonise pharmaceutical sustainability

In order to truly establish a sustainable industry, including pharmaceutical packaging, the industry will need harmonisation from regional and global regulators to incentivise and drive efforts towards sustainability.

Biologics demanding new packaging solutions for disease indications

The rise of biologics and their specialised requirements regarding cold chain and specific delivery needs are bringing new opportunities to the pharmaceutical packaging sector.

Key takeaways 2/2

Drawing inspiration from other industries could drive pharma packaging innovation

Industries such as cosmetics and FMCG, where packaging innovations have already been implemented, could serve as guidelines for the pharmaceutical industry looking to up their sustainability game or meet specific drug demands.

Pharma supply chain to remain increasingly complex, packaging included

The pharmaceutical supply chain remains a complex web, especially with the BIOSECURE Act and tariffs affecting partnerships across the globe. Pharmaceutical packagers are not exempt from this, and the effects of these shifting attitudes on future of strategic collaborations remains to be seen.

Introduction

Introduction

In 2025 and the years to come, the pharmaceutical packaging sector is bracing for marked changes and opportunities for all. By the end of 2025, the packaging market for the broader healthcare industry is expected to reach US$159 billion, with predictions putting the value at nearly US$400 billion within the next decade [1].

The pharmaceutical packaging industry plays a pivotal role in the larger healthcare market, ensuring product safety, integrity, and efficacy [1]. As the pharmaceutical industry contends with incoming regulations on sustainability and consumer demands for therapeutics including GLP-1 agonists and innovative treatments, pharmaceutical packaging will be at the forefront of new ideas and products.

This Trend Report explores the biggest trends affecting the pharmaceutical packaging sector, with a particular focus on the therapeutics demanding innovation and creativity in delivery and packaging. Continuing discussions around meeting sustainability objectives and partnership demands are also influencing the sector's activities in ways that are changing the industry as a whole.

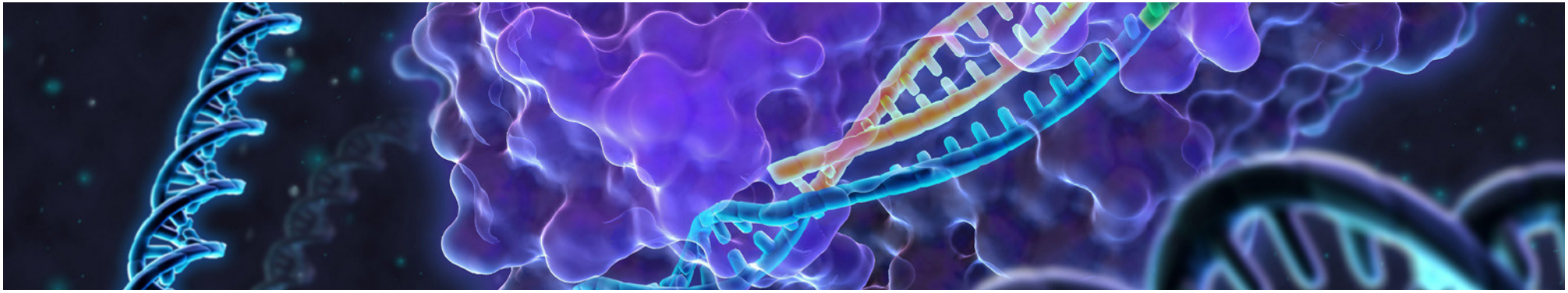
Innovations in packaging and drug delivery

Innovations in packaging and drug delivery

The pharmaceutical industry is seeing an unprecedented moment in history where consumer-driven demands are shaping the priorities of the pharmaceutical supply chain. Pharmaceutical companies are now looking for packaging solutions for all kinds of innovative drug products to meet consumer demand [2]. Increasing demand for certain blockbuster therapeutics, sustainability concerns, and drug delivery devices geared towards specific patient populations like geriatric patients and accessible designs are forcing pharmaceutical companies to take their therapeutic packaging considerations into account at the start of their drug development pipelines [2].

Top therapeutics demand packaging innovation

While sustainability and ESG practices are a continuing factor driving corporate decision making, patient considerations are now also playing a bigger role in dictating the packaging market. Now, a major driver for new forms of packaging is the response to increasing demand in particular therapeutics.



"What we are seeing in the industry today is a focus on bio-therapeutics (biologics and biological products)," explains **Asmita Khanolkar, Senior Director at SMC Ltd.** "A lot of these biological products are complex formulations with special storage and delivery requirements. With injectables in mind, delivery is typically via devices and the stability of biologics requires cold chain storage. This requires a different type of packaging strategy, including a patient-centric approach for self-administration ease. This is causing a shift from standard, off-the-shelf available packaging (that may not meet requirements) to a more strategic packaging solution for the biologics pipeline, cold chain management, and transport logistics. Another item to consider is the focus on 'one size does not fit all' approach. Unlike the blockbuster drug launches of the past, with targeted therapies and personalised medicines, patient populations tend to be much smaller. The cost-to-scale effectiveness and subsequent long-term therapy costs must be balanced with meeting the patient needs. There are a number of new nuances to consider when planning packaging strategies around biologics, personalised medicine, targeted therapies, self-administration, targeted populations that relatively smaller, and small-batch manufacturing."

Personalised drug delivery is playing an increasingly pivotal role in targeted therapies [3]. These targeted approaches can involve cell-specific therapy, controlled drug releases, personalised dosage forms, and wearable drug delivery devices, all of which call for specific delivery and packaging systems [3].

"Self-medication is becoming more and more important," comments **Edgar Pogna, Director, Life Science at L.E.K. Consulting.** "There's a new wave of products coming to market that have a high component of self-medication and that pushes innovation, especially in pen injectors. This is partly due to its ease-of-use, which is paramount for an aging population."

Khanolkar concurs, adding "Self-administration is one of the key components when transferring from hospital to home, and that may involve additional devices, including autoinjectors or on-body devices, and additional packaging and human factors considerations."

Additionally, attention is being shifted towards higher value packaging such as injectable drugs, as **L.E.K. Consulting Managing Director Karin von Kienlin** states.

> **"Injectables get a lot more attention and have higher packaging value per unit than, say, oral solid doses. GLPs and all these biologics definitely have an impact, but so do vaccines. These are all liquid doses, and some of them need controlled environments such as difficult temperature ranges or short shelf lives."**
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> 
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> **Karin von Kienlin**
> Consulting Managing Director, L.E.K.

"This gives opportunities to develop new packaging formats. We've also seen in the injector and pen markets a lot of innovation around dosage flexibility – to have one platform for different vials, whether to save on materials or make them reusable. This also impacts thinking around end-of-life usages, taking back and recycling the materials if they have not been in contact with the drug. These can be used for secondary packaging or other materials, for example. Given that these drugs are multi-substrate combinations, the packaging will be more complex. The therapeutic area that is really seeing innovation is the metabolic disorders market, where GLP-

1 drugs are a prime example. Obesity is a key driver of a lot of diseases and so through this, by getting overweight and obesity under control, you can solve quite a lot of subsequent health issues."

The fervour GLP-1 agonist drugs have on consumers and the wider pharmaceutical industry cannot be understated. According to the WHO, the number of people living with diabetes has risen to 830 million as of 2022, with increasing prevalence in low-to-middle income countries as food access develops[4]. Obesity can increase the risk of type 2 diabetes – diabetes itself can cause blindness, kidney failure, heart attacks, and strokes [4].

Additionally, almost 11% of cardiovascular deaths in 2021 were caused by high blood glucose [4]. GLP-1 agonists and similar weight-loss/diabetes drugs are forecasted the reach up to USD$105 billion by 2030, and up to as much as USD$144 billion, marking some of the highest forecasts for pharmaceuticals [5]. The soaring interest in such products marks an exciting yet competitive market for injectables, which may even extend beyond the weight-loss drug realm.

“Self-medication innovations in packaging and drug delivery are becoming more and more important. There’s a new wave of products coming to market that have a high component of self-medication and that pushes innovation, especially in pen injectors. This is partly due to its ease-of-use, which is paramount for an aging population.”

Edgar Pogna
Director, Life Science at L.E.K. Consulting

"If you look at a lot of the blockbuster drugs in recent years, such as Voltaren by Novartis, these were mostly oral solid doses," comments von Kienlin. "There not are lots of different line extensions around creams, sprays, and liquids etc. The dosages varied based on the type of pain being treated, and considerations towards things like clotting of deep vein thrombosis, but there were also lower dosages for long haul travellers as a means of prevention – all of these have different propositions, packaging, and shelf appearances. Particularly in the OTC markets, where companies are marketing more towards patients rather than doctors, how that drug is delivered and how its purpose is positioned can provide opportunities for more creativity when working with packaging."

Christoph Lewening, Manager Business Development at allpack, adds that "While much innovation focuses on biologics, GLP-1 agonists, and personalised medicine, I think it is important to acknowledge that conventional, commercially available tablets and capsules remain essential in pharmaceutical treatment. Additionally, the rise of orphan drugs – often requiring specialised formulations for rare diseases – drives the need for tailored pharmaceutical packaging solutions that ensure stability and regulatory compliance for small-batch production. Moreover, modified-release oral formulations (e.g. extended-release tablets) require specialised blister packaging to protect against moisture, oxygen, and light. High-potency APIs (HPAPIs) in oral solid dose forms demand specialised containment and protective packaging solutions to ensure safety during handling."

Pharma 5.0 and packaging success

The digitisation of the pharmaceutical supply chain remains a hot topic for all in the industry – and pharmaceutical packaging is no exception. While automation in the pharmaceutical packaging realm is nothing new, the surge in technologies around artificial intelligence and Deep Machine Learning are bringing new awareness to how technology can further innovation in pharma packaging. Importantly, AI-support digital technologies can also help support both patients and companies.

"The pharmaceutical packaging and drug delivery device sectors can leverage digital technologies and AI in several ways to drive innovation and enhance patient support," adds Lewening, including:

> **"Connected devices coupled with software ecosystem to improve patient adherence (e.g. reminders), treatment management (e.g., reporting/feedback to physicians) and improved patient experience are driving packaging innovation."**

Ana Kuschel, Principal Scientific Affairs, Europe at West Pharmaceutical Services

1. Smart Packaging for Enhanced Patient Adherence

Connected Packaging: QR codes, NFC tags, or RFID chips can provide patients with instant access to digital leaflets, instructional videos, or adherence reminders.

Electronic Dose Tracking: Smart pill bottles and blister packs equipped with sensors can track medication usage and send alerts to patients or caregivers to reduce missed doses.

2. AI-Powered Supply Chain Optimization

Demand Forecasting: AI-driven predictive analytics can optimize production planning and reduce shortages by accurately forecasting demand.

Counterfeit Detection: AI-enhanced track-and-trace solutions help authenticate products throughout the supply chain, preventing fraud and ensuring patient safety.

3. Personalized and Patient-Centric Packaging

AI-Driven Customization: Personalized packaging solutions, such as dose-specific packaging for individualized therapies, can improve patient outcomes.

User-Friendly Designs: AI-assisted design can help develop more ergonomic, easy-to-use drug delivery devices tailored to specific patient needs (e.g., seniors or those with dexterity challenges).

4. Advanced Drug Delivery Devices

AI-Integrated Wearables: Smart injectors or patches that adjust dosages in real time based on patient data can improve treatment efficacy.

Remote Monitoring: Connected inhalers or insulin pens can collect usage data, providing physicians with insights to tailor treatment plans.

5. Sustainability and Waste Reduction

Smart Inventory Management: AI-driven insights can help reduce packaging waste by optimizing material usage and reducing excess inventory.

Eco-Friendly Packaging Design: AI can model and simulate new sustainable materials, accelerating the transition to greener packaging solutions.

By integrating AI and digital technologies, pharmaceutical packaging and drug delivery companies can not only enhance patient adherence and safety but also optimize operations and sustainability, ensuring a more efficient and patient-centric future."

Moreover, other pharmaceutical sectors such as manufacturing and regulatory that are intrinsically linked to packaging can benefit from AI automation and analysis. However, the extent to which the pharmaceutical industry has implemented these technologies varies. "There's a broad range of skills on how advanced companies are with AI technologies," comments von Kienlin. "Some have put together their own central teams to look at how to benefit from AI. One aspect is to be better at commercialisation – getting a better traction of the market, competitors, and drug products coming to market – and the other aspect is to help with operations and structuring data in a way that saves costs. But this is all a rapidly developing space we still need to keep an eye on for packaging specifically."

"We see digitisation in aspects of packaging/labelling of pharma products such as in tracking, traceability, serialisation coding, readability, label design etc." Khanolkar adds. "You now see AI being used in pharma in the drug discovery side of things and machine learning in clinical trials. AI is still a nascent area for packaging. For packaging there is some use of automation of processes on the logistics/supply chain side considering manual versus automated processes, just due to the sheer number of components in the kit for some of the therapies – there is a balance of needs."

Formulation investment and research

Different formulations are also seeing an increase in interest regarding their packaging needs. With common primary packaging options including vials and ampoules for liquids, blister and strip packaging for tablets or capsules, the type of packaging will depend on the form and chemical composition of the drug product [6]. "Several key therapeutic trends and technological advancements will drive increased investment and research opportunities in pharmaceutical formulations in

the coming years," comments Lewening. These advanced formulations will inevitably demand similar investment and research into the appropriate packaging options, as Lewening lists:

"There is a growing focus on long-acting injectable formulations especially in areas like oncology, neurology, and chronic diseases. These formulations aim to enhance patient adherence by reducing the frequency of administration. Examples include long-acting biologics such as GLP-1 agonists and monoclonal antibodies, and hormonal therapies that require less frequent dosing, offering patients a more convenient and less burdensome treatment regiment. With the growing prevalence of biologics across therapeutic areas, there is an increased focus on innovative drug delivery methods to improve patient experience, like microneedles, implantable devices, and wearable injectors. Fill-finish technologies will also see significant investment as biologic therapies like those in cell and gene therapies gain traction. These technologies ensure that sterile formulations are safely packaged into vials, syringes, or cartridges.

The rise of personalised medicines and gene therapies, which require precise filling and packaging, will further

fuel investment in automation, sterility assurance, and scalability of fill-finish processes.

Additionally, although biologics and injectables are prominent, oral solid dosage forms including modified-release tablets, capsules, and orally disintegrating tablets, will continue to receive attention, especially in therapeutic areas where oral administration is preferred. The investment will focus on advanced oral solid dosage technologies including nanoparticles for better bioavailability, multi-layer tablets, and oral formulations for biologics (such as oral vaccines)."

Specialised formulations, advanced delivery systems, and targeted therapies are all expected to dominate investments in R&D, and subsequently demanding the appropriate packaging for these formulations.

Delivering on sustainability initiatives

Delivering on sustainability initiatives

Sustainability in the pharmaceutical packaging sector continues to be an ongoing discussion. Whether it is implementing the measures promised, recording and reporting to keep each other accountable, or even knowing where to start, it is more important now than ever for pharmaceutical companies and their partners to flesh out their sustainability strategies for business success.

Innovation opportunity or insurmountable challenge?

"Some of the biggest challenges faced by the pharmaceutical packaging and drug delivery device companies are around sustainability and regulatory pressures," states **Lengwe Sinkala, a Human Factors and UX Consultant at ClariMed, Inc.** "The pharmaceutical industry faces increasing environmental regulations and pressure to reduce single-use plastics and carbon emissions. For example, prefilled syringes, inhalers, and autoinjectors generate medical waste and pose recycling challenges. EU and US sustainability laws demand eco-friendly alternatives, such as France's ban on certain plastic packaging for medical use."

Initiatives such as the UK's Extended Producer Responsibility (EPR) are also being put into place to force organisations responsible for packaging to take accountability for the recyclability and lifecycle of their packaging products [7]. Regulations such as these, while a socially responsible step in the right direction, can also provide difficult challenges for companies affected [7].

"Stricter global regulations, such as the EU Green Deal, PPWR, and Extended Producer Responsibility laws, are pushing companies toward sustainable materials and reducing plastic waste," Lewening comments. "Developing fully recyclable packaging that still meets strict pharma requirements, however, is complex. Compliance with different regulations that frequently updated demand constant adaptation in packaging design and validation, while shortages in plastics,

aluminium, and glass due to geopolitical issues or energy crises and impact the cost of transportation, constrain supply chains, and impact pricing and profitability."

Lewening also comments on other regulations involving major markets such as Asia, like China's Green Packaging Standards that introduces restrictions on excessive packaging and promotes biodegradable and recyclable materials, and India's Plastic Waste Management Rules that bans certain types of plastics and requires higher recycling rates. In another vein, Kuschel mentions that "Proposed indiscriminate PFAS restrictions and unintended consequences in the medicines market are some of the biggest challenges affecting pharmaceutical packaging and drug device companies. Moreover, packaging and drug delivery companies will need to manage tertiary packaging suppliers in order to be in compliance with EU GMP Annex 1."

In a survey conducted by Packaging Europe of their Sustainability Award jurors, it was noted that reuseable and refillable packaging as some of the packaging options most in need of innovation [8]. Though they seem to be obvious choices in addressing sustainability concerns related to packaging, there are several

challenges that must be taken into consideration [8]. Existing policies and regulations across the globe are currently lack the harmonisation for widespread, global use of reusable and refillable packaging adoption, preventing collective action for companies [8].

Supply chain stability is a key issue for many experts in addition to sustainability, including von Kienlin. "Supply chain stability has prompted quite a lot of changes, and I still don't think it's entirely clear what will persist and what will revert back," she states. "The immediate response to shortages is to stock like crazy, which throws everyone into a volatile situation. But there are still big questions over how complex a supply chain can be. If a link breaks and something can't be delivered, that can be disastrous." Supply chain shortages ultimately could exacerbate price and profitability concerns, which could result in a gross underestimation of the factors needed to achieve what some conceive as unattainable goals [8].

"It's important to distinguish a couple of different elements of sustainability in the packaging industry," adds Pogna. "How packaging is produced, there's been a lot of progress in terms of using renewable sources and controlling emissions. To some extent, the biggest problem remains the type of materials being used for packaging, and the solutions created for these challenges. There's two major key barriers. The first is the passing of cost along the supply chain."

> **"The pharma industry continues to push back on any passing of cost – companies want sustainability but they don't want to pay for that sustainability. On the other hand, pharma is blocked in many legislations on raising prices for products, which creates a situation where nobody wants to pay for that sustainability until there is a broad alliance in regulations and decisions to account for that cost. Another key issue is barriers to innovation and creation. With many new, innovative products in the pipeline, there is a significant limit on how much you can put at risk with the quality of the barriers you create for their packaging."**

Edgar Pogna
Director Life Science at L.E.K. Consulting

“The pharmaceutical industry faces increasing environmental regulations and pressure to reduce single-use plastics and carbon emissions. For example, prefilled syringes, inhalers, and autoinjectors generate medical waste and pose recycling challenges. EU and US sustainability laws demand eco-friendly alternatives, such as France’s ban on certain plastic packaging for medical use.”

Lengwe Sinkala
Human Factors and UX Consultant, ClariMed, Inc

"So while there's a lot innovation around drug development and packaging, this still remains a substantial challenge regarding who is paying for the cost and how to reduce waste while not compromising quality."

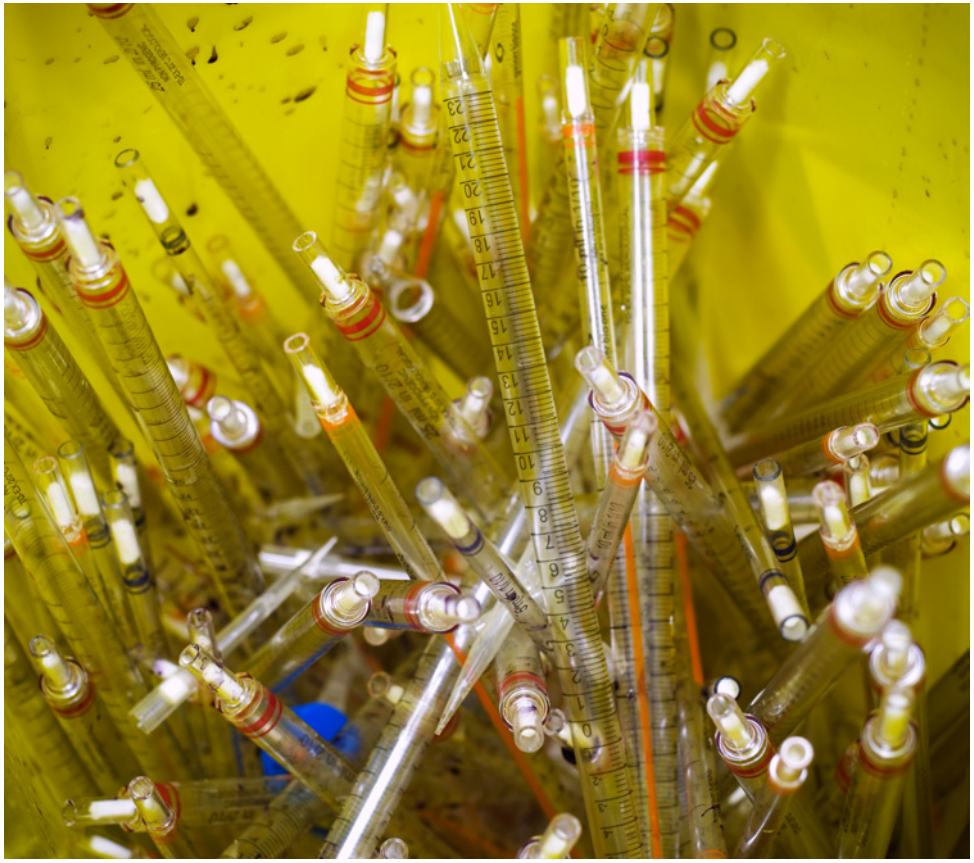
"One of the things that we have seen as trend in packaging is that while for existing drugs you can change the packaging, you also need to change the registrations for them, which is actually harder for existing packaging," adds **Carmen Morales Garcia, a Partner at L.E.K. Consulting.**

Designing sustainable packaging: the bare minimum?

Concepts such as sustainability by design signal a paradigm shift in how drug products are designed, manufactured, transported, administered, and disposed in a full lifecycle [9]. In a framework proposed by ISPE known as Sustainability by design (SbD), life-cycle assessment data and eco-design principles are used to inform and direct decisions regarding product design, including packaging [9]. In a vein similar to what many experts are seeing as a trend in packaging, the SbD framework – with up to 80% of a product's environmental impacts determined in the development phase, it is clear that determining sustainable and cost-efficient packaging solutions must happen earlier rather than later in the drug pipeline [9].

However, while designing sustainable packaging can be a part of a company's strategy towards achieving sustainability goals, some experts perceive this as the bare minimum that can be done.

"The low-hanging fruit is downgrading and using less material," comments von Kienlin. There's a big push to use as little PVC as possible, even though it is a very cheap and sturdy material, but it's not what people want anymore because of its hazardous production process and product properties. Beyond that, in flexibles, there's definitely a push for mono-materials, because that's what you need for recyclability. If you have multi-materials and multi-layered structures, those are difficult to recycle. In terms of rigid plastics, there's a trend towards recyclability but it should be noted that regulations, even in Europe, don't specify recycled content in primary packaging, only that by 2038 all materials must be recyclable. So that has prompted quite a lot of mono-material blister packs."



Some experts, however, see these trends as a positive reflection of an overall industry shift towards sustainable solutions that meet regulatory requirements and maintaining standards for drug safety and efficacy.

> **"Several key design trends are driving some transformation for sustainable pharmaceutical packaging, such as lightweighting and material reduction, recyclable and mono-material packaging, paper-based and bio-based alternatives, and refillable and reusable packaging, among others."**

Christoph Lewening
Manager Business Development - allpack

"These trends reflect the industry's shift toward sustainable solutions that meet regulatory requirements while maintaining high standards for drug safety and efficacys," states Lewening.

In any case, packaging and drug delivery device organisations and their partners will need to rethink strategies related to both emissions, material selection, packaging and delivery design, and recyclability and recycled content – a feat that will need to be strategised ahead of the implementation of zero pollution goals from the EU Green Deal [9].

Regional policies and shifting priorities for packaging

Regional policies and shifting priorities for packaging

Discussions of pharmaceutical contract organisations in 2025 cannot be had without mentions of the US BIOSECURE Act, first proposed in December 2023, approved by Senate and House committees throughout 2024, and passed by the House of Representatives in September 2024 [10]. While the Act specifically targets pharmaceutical manufacturers based in China, the wider implications for the pharmaceutical supply chain also holds packaging and drug delivery device companies in anticipation.

“When you look at flexible packaging, this used to be a market that was truly global 10-15 years ago,” explains von Kienlin. “You could produce anywhere and ship

anywhere. With oil and gas prices through the roof now, it is not so much the case anymore. Companies are now sourcing much closer due to prohibitive costs – this is just one example where the cost of logistics in shipping has prompted a regionalisation of markets."

Pogna adds a sustainability perspective to the topic: "There's quite a lot of varying regulations for waste management across countries, which creates further fragmentation. While there are some truly innovative packaging solutions that may seem like they have a competitive advantage, they might only work in an environment where waste is managed in a certain way, for example, how sample films are separated from blisters, or dismantling of injection pens. Even within Europe, there are differences in how this is regulated, creating further complications in managing logistics and supply chains."

In a survey conducted by L.E.K. Consulting in May 2024, 79% of respondents, with experiences ranging from process development, discovery research, clinical development, and commercialisation, stated that they had contracts supported by a Chinese CDMO, and changing vendors would be a challenging, time-consuming, and costly endeavour [11].

More supply chain considerations are being given under the second Trump administration. When asked as to the impact of tariffs on pharmaceutical packaging (which Trump has mentioned could be up to 25% or higher), experts were wary of how the already delicate pharma supply chain would be affected, but remained cautiously optimistic [12].

"The bigger problem with the current tariff situation is that they seem to be used primarily as a negotiation tactic," comments Pogna. "This raises a key question: will these tariffs actually remain in place? That uncertainty is the biggest challenge for various industries, including packaging and pharmaceuticals. An extreme example are the tariffs involving Canada. Many businesses operate across that border, and when tariffs were suddenly announced – only to be lifted less than 2 weeks later – it caused panic. Now, there is a negotiation around pharmaceutical tariffs as well. This raises a major concern around the disruption and putting the supply chain at risk. Once regional players realise that these tariffs are actually threatening access to essential medications, I believe they will be forced to reverse course quickly."

“The key questions will be how these changes will impact specific geographical areas, availability of manufacturing capacity, and sites in the region and risk mitigation.”

Asmita Khanolkar
Senior Director, SMC Ltd

"I think we're still trying to fully understand what the long-term impact will be," adds Khanolkar. "Generally speaking, pharmaceutical packaging – and the pharma industry in general – operates on long-term business outlooks and contracts, often spanning multiple years, global sites, and risk mitigation plans for supply continuity and costs. These are typically not short-term decisions and so each case needs to be assessed individually to determine the best approach. The key questions will be how these changes will impact specific geographical areas, availability of manufacturing capacity, and sites in the region and risk mitigation. It may propel addition of capacities or more preference of existing capacities in certain geographical areas. There are also considerations for different manufacturing models depending on the type of drug, manufacturing requirements – whether it is manufactured at a single site or multiple, internal or external manufacturing with CDMOs or CPOs etc. Each program will need its own supply chain assessment and strategy to minimise the geographical risks and costs for that specific product."

The pharmaceutical industry has traditionally been exempt from tariffs and other aspects of international trade disputes, with a general trend since a World Trade Organization agreement in 1994 to lower tariffs on global pharmaceuticals to promote better access to medicines [12]. Many in the industry are hoping such recognition will mean that the pharma industry will remain exempt when access to life-saving medications and drug delivery become apparent [12].

The future of industry collaborations for pharma packaging success

With M&A activity dominating industry news for pharma in 2024, some are anticipating continuing collaborative deals or further amalgamations of some of the biggest players in the industry, including packaging companies [8]. Packaging companies that saw landmark mergers or acquisitions include that between Smurfit Kappa and WestRock and Amcor's purchase of Berry Global [8]. While not pureplay pharmaceutical packaging companies, the sector can expect such partnerships to continue shaping how packagers are integrated to help the industry achieve innovation, sustainability, and business goals.

"Pharmaceutical packaging companies are working with biotech, material science, and sustainability-focused

organisations," comments Sinkala. "Partnerships with bioplastic developers, recycling firms, and healthcare providers are accelerating the adoption of sustainable solutions."

"To me, cross-industry collaborations are becoming essential in driving sustainable packaging solutions for the pharmaceutical sector," adds Lewening. "No single company can solve these challenges alone, and partnerships across the value chain are accelerating progress. Key areas of collaboration include partnerships with material suppliers, collaborations with regulatory bodies, joint initiatives with other industries, and collaborations with tech and digital firms. Working closely with polymer manufacturers to develop recyclable, bio-based, and lightweight materials that meet regulatory requirements, while also working with organisations like the FDA, EMA, and industry groups ensures that sustainable innovations align with compliance requirements. This proactive approach helps bring new materials to market faster while maintaining patient safety. These collaborations are driving meaningful progress, ensuring that sustainability efforts in pharma packaging are not just theoretical but result in tangible, scalable solutions."

Learning from other industries could also help drive solutions for sustainability and achieving innovative business goals, adds **Elvire Regnier, President and Founder of Regenerative-Advisory.** "Looking at cosmetics, we use a lot of aluminium in hand cream tubes. We were involved in a contract with a supplier to use 100% recycled aluminium. While pharma and cosmetics definitely have different safety and efficacy regulations, I think the margins are comfortable enough to potentially realise cross-fertilisation of ideas for advanced packaging designs."

Though some experts are more reserved regarding the possibility of implementing the more innovative packaging solutions used in other industries like cosmetics and FMCG, Regnier does comment on the fact that most patients, in emergency situations, will care little for the sustainability of the packaging material – it must be down to the regulatory bodies to enforce sustainable measures. "I agree, we need to have stringent regulations, otherwise I don't think pharma companies will really make any effort to really work towards sustainability. Pharma is perhaps the last industry where patients will demand, for example, recycled packaging, as opposed to cosmetics and FMCG."

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Putting patients first with packaging

Putting patients first with packaging

Patient-centricity in particular is at the forefront of innovative packaging opportunities, particularly with ageing populations across the globe demanding accessible packaging options for their medications [13].

“Pharmaceutical companies are prioritizing ease of use and accessibility in packaging,” states Sinkala. “This means:

- Ergonomic designs for those with limited dexterity (e.g., easy-grip bottles and inhalers)
- Larger fonts and high-contrast labelling for visually impaired and elderly patients
- Tactile markers and braille for non-visual identification
- Color-coded packaging to differentiate medications easily
- Pre-measured, single-dose formats to reduce dosing errors

Adherence improves when packaging is intuitive and supportive. Trends such as; Connected packaging with reminders and alerts, calendar blister packs to help track doses, personalized packaging with clear, patient-specific instructions and simplified opening mechanisms to reduce frustration are helping improve patient adherence."

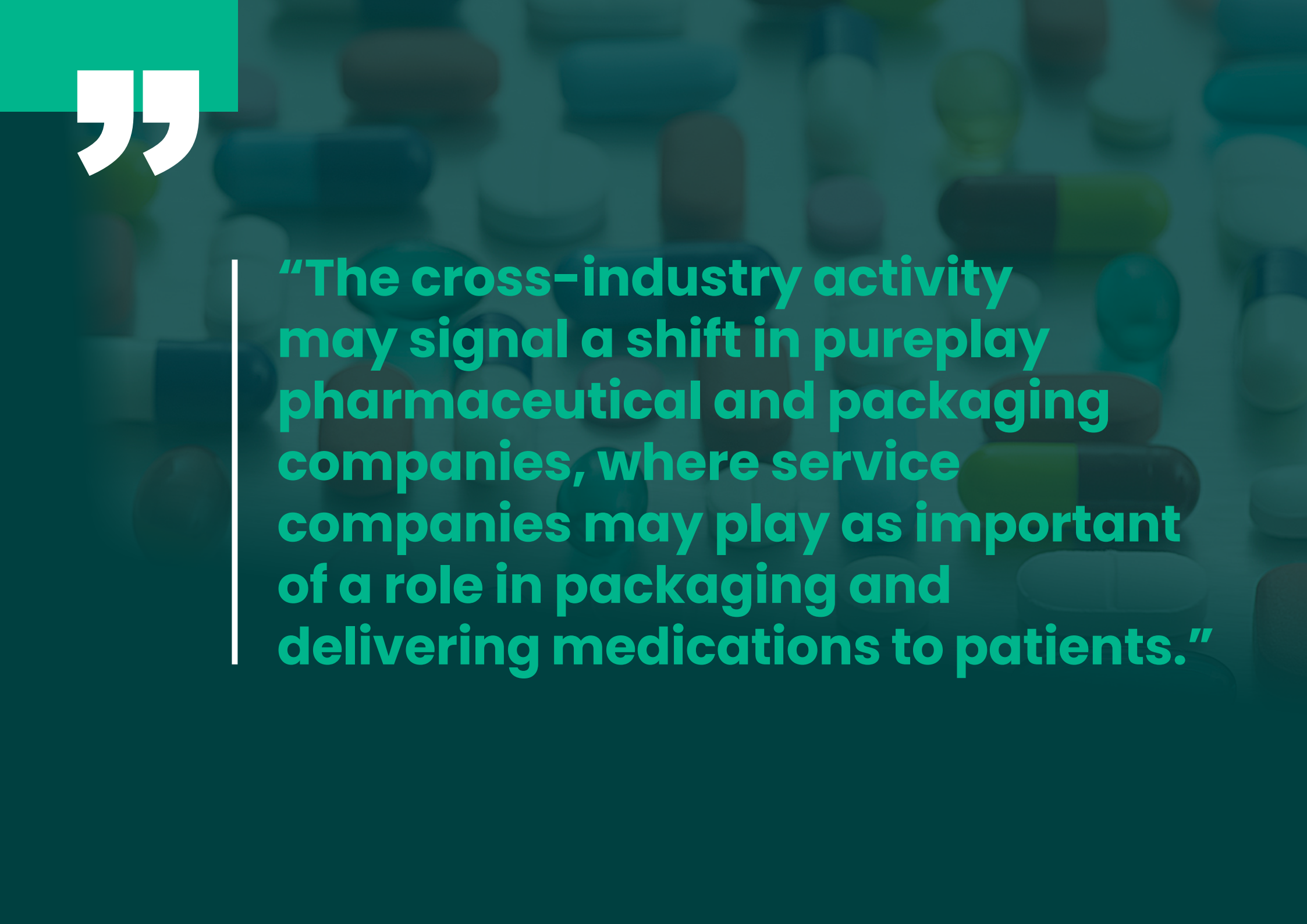
> **Technological innovations and digital solutions are driving much of this innovation forward in the effort to bring accessible packaging and improved drug adherence to patients.**

"From the device side of things, we see a tremendous benefit of how human factors studies play a crucial role in packaging design," explains Khanolkar. "Formative studies and usability testing drive packaging decisions, starting early in the development process for successful results of the overall therapy. There are many different avenues for customisation in packaging for patient benefits such as the presentation for intended use, dose/unit packaging for lifestyle, kitting for travel, simpler instructions for use, easy-to-read labelling, and expiration. Many value-added services are taking a patient-centric approach to ensure better accessibility, adherence, and usability."

Regnier also comments on how some companies like Amazon, whom are not typically involved in the pharmaceutical industry, are starting to see and address the gaps in patient-centric packaging and delivery.

"For those that use daily drug dispensers, it is easy to mix up or miss doses, even if someone else does it for the patient. At that point, a nurse will need to be involved in which their job is to dispense the medication, which is quite cost-prohibitive. In the US, Amazon can send your prescription to you in envelopes for each day. Though this hasn't been approved for use in Europe, it is interesting to see that companies which have almost nothing to do with pharma offering this kind of service."

Opportunities in smart packaging and connected devices are also seeing some key developments for packaging companies looking to address the gap in patient experience, adherence, and communication. "By integrating these digital technologies, pharmaceutical packaging is evolving beyond a protective layer – it is becoming an interactive tool that enhances



> **“The cross-industry activity may signal a shift in pureplay pharmaceutical and packaging companies, where service companies may play as important of a role in packaging and delivering medications to patients.”**

patient engagement, ensures medication safety, and strengthens communication between patients, healthcare providers, and drug manufacturers." Lewening lists several core technologies that packaging companies are offering their partners:

1. Smart Packaging with NFC & QR Codes
Pharma companies are integrating NFC chips and QR codes into packaging, enabling patients to access digital leaflets, instructional videos, and real-time medication reminders via their smartphones. This reduces reliance on paper inserts while improving accessibility and engagement.

2. Connected Devices for Adherence Monitoring
Smart pill bottles, blister packs, and auto-injectors now feature sensors that track when a dose is taken. These devices can send reminders to patients and notify caregivers or healthcare providers if a dose is missed, helping to improve adherence in chronic disease management.

3. Digital Authentication & Anti-Counterfeiting Measures
Serialization, blockchain integration, and scannable security features allow patients and healthcare professionals to verify the authenticity of medications instantly. This is critical for combating counterfeit drugs and ensuring supply chain integrity.

4. Real-Time Data Sharing & Remote Monitoring
Some smart packaging solutions can transmit usage data directly to healthcare providers, allowing for real-time monitoring of adherence and enabling timely interventions if patients are not following their prescribed regimen.

5. Personalized & AI-Powered Assistance
AI-driven digital assistants integrated into packaging solutions can provide tailored medication guidance, answer patient queries, and even adjust dosage reminders based on individual behaviour patterns.

6. Sustainability Through Digital Innovation
Replacing paper-based documentation with digital alternatives reduces waste while still meeting regulatory and patient information requirements. Additionally, digital tracking solutions optimize inventory management, reducing expired medication disposal."

Sinkala similarly lists the smart packaging technologies transforming patient experience, including "QR codes

to link to videos, instructions, and refill options, sensors and trackers detecting if a dose was taken and sending reminders, and companion apps syncing with packaging to monitor adherence and share data with healthcare providers."

From achieving pan-industry sustainability goals to working closer than ever with patients and healthcare providers to address concerns related to medication accessibility, packagers are more involved now than ever in lifechanging decisions within the wider pharmaceutical industry.

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