Improving MedTech Market Performance Using AI

VAMSTAR

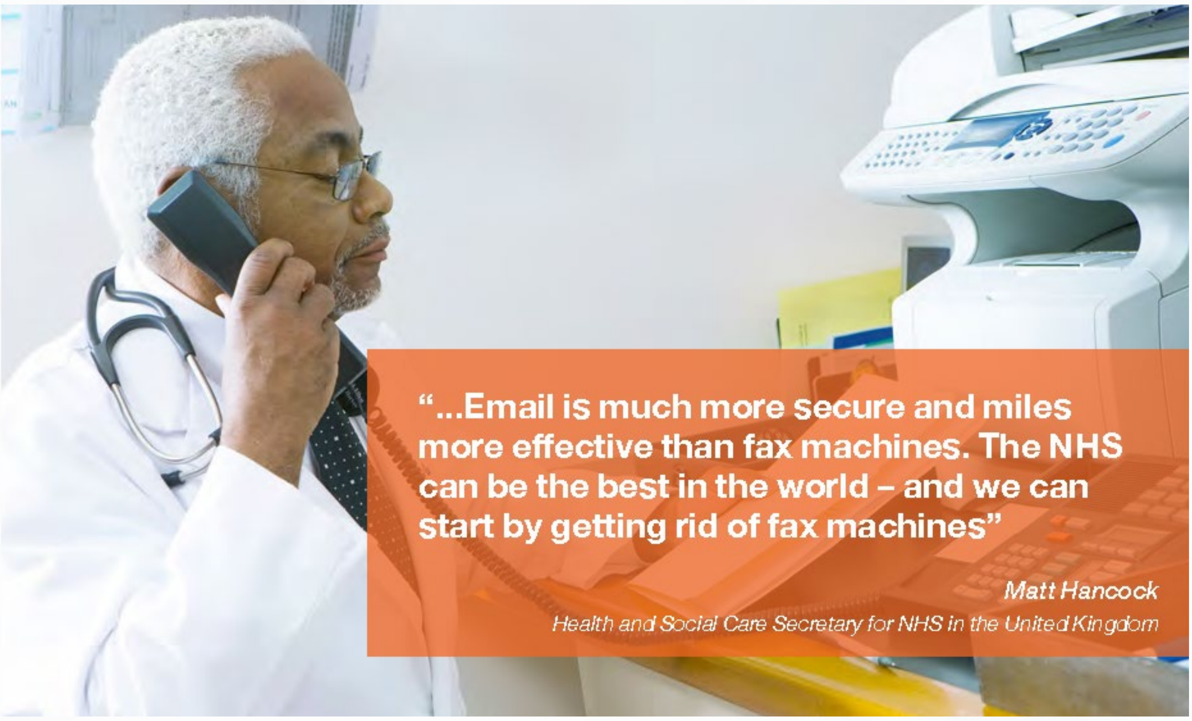
Improving tender performance

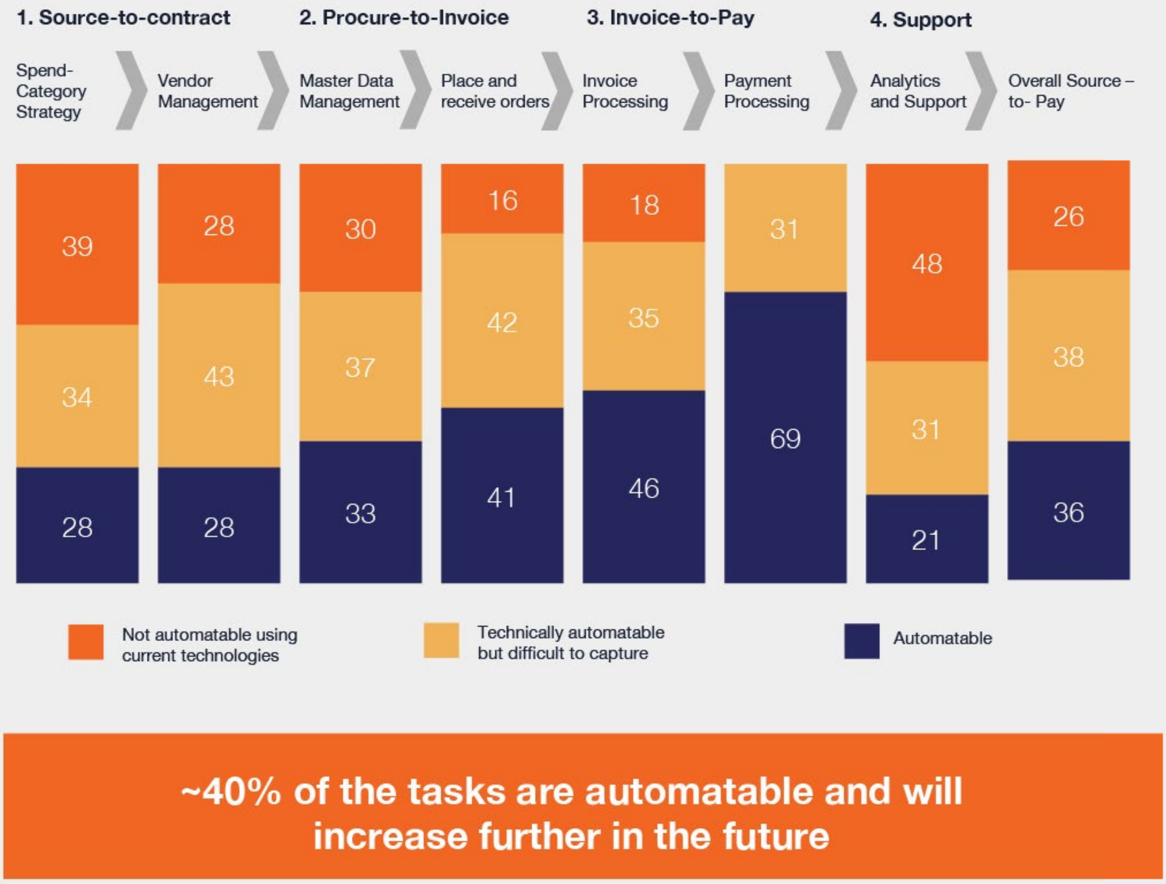
COVID-19 has highlighted the deficiencies in the current supply chain models and has exposed many healthcare organisations' critical vulnerabilities, particularly those with a high dependence on global suppliers. The immediate demand surge of various medical consumables, devices, and pharmaceuticals has led to a cascade effect as the components of complex global supply chains started to fall and the availability of necessary materials rapidly dried up. Indeed, some of the critical materials are still in short supply since the start of the pandemic.

While some processes have improved over the last 20 or 30 years, the fundamental business between healthcare buyers and suppliers has not changed. Undoubtedly, communication is faster and easier, but still, there are many parts of health systems, even in developed countries where we still need to send purchase orders through the post or use fax to send specification documents to suppliers. Within the industry, and especially within procurement, there are numerous opportunities to improve operational efficiency.

"2018: I am instructing the NHS to stop buying fax machines, and I'm setting a deadline for getting rid of them altogether. Email is much more secure and miles more effective than fax machines. The NHS can be the best in the world – and we can start by getting rid of fax machines - Matt Hancock, Health and Social Care Secretary for NHS in the United Kingdom."

In recent years, there has been some degree of digitalisation of procurement, especially concerning pharmaceuticals and medical devices. Nonetheless, public procurement is still administratively burdensome, costly, and time-consuming, with several complicated forms to be filled out, requiring significant human effort by both the contracting authority and the tenderer.





Source: McKinsey

Moreover, the core procurement processes such as source-to-pay (S2P) or sourcing management have not fundamentally changed. The S2P process is still executed as it has been for generations - an electronic tendering process still almost always follows the tendering 'rules' laid down years ago in the days of pen and paper. According to McKinsey's research, 56 per cent of the tasks associated with the source-to-pay process are entirely or largely automatable using existing technologies.

In this white paper, we highlight the use of Artificial Intelligence in tendering, focusing on supplier bidding strategies and the use of machine learning algorithms. This paper aims to highlight how AI can help improve the efficiency and competitiveness of organisations and is particularly suitable for both suppliers and public procurement agencies. On the one hand, it can help the suppliers identify the most suited tenders, i.e., those that they should prioritise and reduce their winner's curse. On the other hand, the contracting agency could automatically search companies with a compatible profile for the tender's announcement, e.g., selective tendering where suppliers are only allowed by invitation.

Tendering in the Healthcare Sector

The pharmaceuticals and the medical devices industry is ripe for many disruptions and is considered a highly competitive environment for bidders within the hospital sector, where the majority of the sourcing happens via tendering. One of the aspects of this competitive environment is the supplier selection process. While different bid allocation methods are used in the overall procurement, the lowest bid (and to a certain extent MEAT based procurement; Most Economically Advantageous Tender) approach is the most commonly used across many countries. The lowest bid means that the procurement contracts are allocated based on a competitive bidding process.

Competitive bidding is considered a legal requirement in the public sector, especially in markets that are primarily taxpayer-funded. For instance, in the public EU hospital and ambulatory procurement, such as those funded by the Department of Health or Regional Health Bodies, public bidding and procurement laws require the procurement to be allocated to the lowest price or MEAT based bidder to protect the public against the squandering of public funds and to prevent abuses such as fraud, waste, and favouritism.

It has often been emphasised that tender evaluation and contractor selection is "one of the most critical undertakings performed by buyers, the effectiveness of which is directly related to project success and the achievement of specified objectives". Making judgments about suppliers and their ability to deliver to the requirements comprises high levels of ambiguity, uncertainty and, sometimes, trade-offs in conflicting objectives. Therefore, criteria supporting the fair and practical assessments of the bids are of great importance (e.g., price, experience, capability, quality, performance).

In terms of pharmaceuticals and medical devices, specific considerations are to be made due to some of the products being under patent or other IP rights protection at the time of the tender procedure's launch. Public tendering entails that competing products are proposed to contracting authorities and are then compared in award criteria. Innovative, patented products can qualify as being protected by exclusive rights, which in certain circumstances allows contracting authorities to have recourse to the (less burdensome) negotiated procedures under the public contracts legislation. However, for this paper's purposes, we will focus on our efforts on competitive and multisource bidding contracts, including the ones for surgical consumables.

Suppliers reflect their desires to provide various pharmaceuticals and medical devices by submitting their proposals for an agreed price for an allocated volume. That said, one of the most complex decisions that suppliers face is the bid amount to offer for a given RFP (Request for Proposal). This critical decision significantly influences the supplier company because it needs considerable time and costs to be prepared, requires significant efforts to understand the total demand, and affects the firm's financial status. Suppliers aim to design and submit their bids so that they are the lowest price or the MEAT bidder. The lowest price bidder is the supplier who fully complied with all of the bid requirements and whose past performance, reputation, and financial capability is deemed acceptable, and who has offered the most advantageous pricing or cost-benefit, based on the criteria stipulated in the bid documents.

The suppliers aim to win tender contracts as much as their capabilities allow for many reasons, including:

1. Increasing earned profits.
2. Minimising losses because they need to keep the firm intact.
3. Minimising the gains of competitors to have a long-term good competitive position within the market.
4. Discovering new contracting opportunities.

As such, suppliers need to take different important bidding decisions, including (1) the bid or no-bid decision where the supplier weighs many factors that determine the expected benefits from a tender contract win; and (2) the bid value or the markup decision, which is determined based on the bidding strategy.

Suppliers quote a price during the bidding process when all the risks and costs are only partially known, and production delays, demand surges, policy changes, and plant/machinery challenges are not fully factored. Additionally, a supplier should figure out what bid values the competitors will submit to adjust their bid price to win the contract, which is difficult and even impossible to know in the competing marketplace certainly. This desire to be the lowest bidder creates the so-called winner's curse. The winner's curse is the situation when the bidder with the most optimistic (low) cost estimate wins the contract due to a submitted bid less than the actual cost and thus will most likely earn negative or, at least, below-normal profits. The winner's curse is very hard to avoid; however, it can be reduced using targeted strategies. Keeping this in mind, when choosing their bidding strategy(ies), suppliers weigh two objectives: (1) increasing the win-rate across tender contracts; and (2) reducing the winner's curse, but this could mean increasing the bid value and thus lowering the probability of winning the contract.

Based on the previously mentioned points, a practical and reasonable bidding model is needed to be used in the supplier's bidding decision-making process to overcome the inherent complexities and uncertainties in the competitive pharmaceutical and medical devices bidding environment. One practical and reasonable approach is determining the bid price based on competitors' historic bidding patterns. Therefore, we aim to provide a useful algorithmic game theory framework that helps suppliers in their bidding decision-making process by learning from historical bids within the market based on publicly available data.

Algorithmic Game Theory and Bidding in Tenders

Game theory is defined as "the study of mathematical models of conflict and cooperation between intelligent, rational decision-makers" (Myerson 1991). A particular area of game theory is algorithmic game theory, a field at the intersection of game theory and computer science to understand and design algorithms in strategic environments (Nisan et al. 2007).

Auction theory is a subdiscipline of game theory. Historically, auctions have been used to sell and allocate various types of goods and services to customers. In today's world, auctions are of great practical importance in both the public and private sectors. Governments usually use auctions to sell assets, purchase services, and fund their national debt in the public sector. Moreover, in the private sector, auctions are used widely in many areas, such as the utility market and the selling of items through internet auctions. There are two major types of auctions: (1) private value auctions; and (2) common value auctions. In private value auctions, the bidders know, with certainty, their valuation of the auctioned item. Conversely, in common value auctions, all bidders have the same value of the auctioned item, but no bidder knows it with certainty.

Pharmaceutical and medical device bidding is considered a common value auction. In the industry, the base unit cost is regarded as a common variable for different bidders. Suppliers have two sources of incomplete information at the time of submitting their bids: (1) actual (realised) cost; and (2) their competitors' estimates of the average unit cost. In common value auctions, bidders are subject to the winner's curse.

For creating a bidding framework and the following model, we need first to understand the different learning algorithms in the bidding decision-making process. These algorithms can help us design the model while allowing for exploitation based on historical bid sequences to decide the best bid value.

Multiplicative Weights Learning Algorithm

The multiplicative weights learning algorithm is one of the most commonly used methods in decision-making processes and prediction applications, and it is widely deployed in game theory and algorithm design. Indeed, this algorithm has applications across various learning and optimisation problems, which makes this algorithm a state-of-the-art learning method. The algorithm assigns initial weights to all possible actions (usually identical initial weights). It updates these weights multiplicatively and iteratively according to the feedback of how well the taken action performed, reducing them in case of poor performance and increasing them otherwise.

Exponential Weights Learning Algorithm

The exponential weights algorithm is considered a universal method used for learning, and thus it is perceived as a state-of-the-art learning algorithm. As compared with the multiplicative weights learning algorithm, the exponential weights algorithm uses a different update rule for the individual weights. In simple terms, given a set of possible actions, the exponential weights algorithm begins with equal weights for each action. For each iteration, the algorithm chooses an action proportional to the weights assigned to all actions. Afterwards, the outcome of each iteration is realised, and the algorithm updates the weights of the actions by multiplying their previous weights by an exponential factor; thus, it is known as the exponential weights algorithm.

Types of bidding strategies

In the current context within the industry, there are two types of bidding strategies at play. The first bidding strategy is winning as many tendering contracts as possible compared to the competitors, with little importance given to reducing the winner's curse. The primary reason for a supplier choosing this strategy is to maintain the market share, keep the labour force engaged in that market, form relationships with buyers, and deprive competitors from taking contracts to gain a long-term good competitive position within the market. This is a high-risk strategy and results in either supplier winning the business or losing out entirely. An exciting example of this is in display during the early launches of new surgical consumables tenders within Europe.

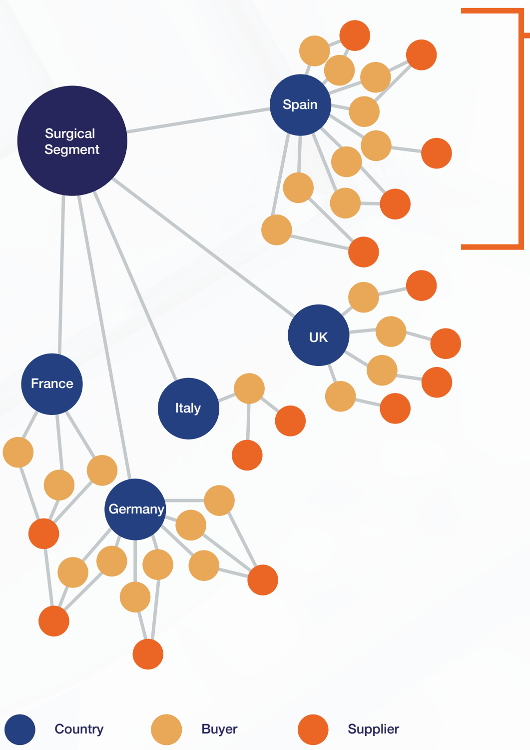
The second bidding strategy emphasises reducing the winner's curse while sacrificing winning as many tender contracts as possible. Suppliers use this strategy for different reasons, including increasing the total earned profits, minimising contract losses, and minimising dealing with unexpected events or risks during the contract implementation (volume supply or factory capacity) phase. Within this strategy play, the supplier receives a positive reward if they win the tender for a bid value higher than the actual value to deliver the contract (that is, positive profit), the supplier receives a reward of zero if they did not win the tender, and the supplier gets a negative reward (that is, a penalty) if they win the tender for a bid value less than the actual value to deliver the contract (that is, negative profit). This is a risk-averse strategy where suppliers following such strategy leverage not winning a tender contract over winning it with negative profits.

Developing the model

Based on the available knowledge base and the technology, the bidding models can be divided into probability theory and statistical models, multicriteria utility models, and artificial intelligence (AI) based models.

The probability theory-based models aim at defining probabilities of winning in competition, such as within a tender bidding scenario with a select set of competitors. These probabilities are typically estimated based on experimental distributions of the competitor's past bidding behaviour. However, certain assumptions need to made for these types of models to provide a simulated output, and these are: (1) there exists a pattern in each competitor's bidding defined by a particular probability density function; (2) the competitor's patterns are independent (thus the probability of winning in the lowest bid tender is a product of probabilities to beat each of the competitors); and (3) the competitors should be known in advance, though if the identity and number of competitors are unknown – as in real life – some more assumptions on the distribution on the number of bidders are to be made, and the "unknown" competitors' pattern of bidding is advised to be described by averaging patterns of competitors observed in the past).

Example graph of surgical segment



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Buyers	Suppliers	Predicted Bid Price per Unit (ó)
Servicio MadrileÐo de Dalud, Hospital Universitario Severo Ochoa	Johnson and Johnson	70%
Servicio MadrileÐo de Salud, Hospital Universitario la Paz	Medtronic	102%
Crea Sanitaria IV, Hospital Universitario Central de Asturias	Stryker	46%
Servicio ExtremeÐo de Salud de la Junta de Extremadura	Zimmer	87%
Osakidetza OrganizaciÑn Central, Servicio Vasco de Salud	Biomet	47%
ConsejerÕa de Sanidad de la Comunidad de Madrid, Servicio MadrileÐo de Salud, Hospital Universitario de MÑstoles	Boston Scientific	
Comunidad de Madrid, ConsejerÕa de Sanidad, Hospital General Universitario Gregorio MaraÐÑn		
Hospital Universitario Nuestra SeÐora de Candelaria, àrea de salud de tenerife		
ConsejerÕa de Sanidad, Empresa PÏblica Hospital del Norte Hospital Universitario Infanta Sofia		

For creating a more realistic tender evaluation model that is capable of simultaneously (1) compiling multiple decision-makers inputs, (2) incorporating risk and uncertainty and (3) offering computer interaction that makes a model flexible to any change in the situation, the multicriteria utility models were produced. They work on the theory of combining a utility function and a social welfare function. These types of model have two main steps: step1- evaluating supplier's ability and step2 - evaluating tenders; consisting of three main processes: (1) the supplier ability criteria selection process; (2) the supplier ability criteria balancing/measuring process; and (3) bid price and supplier ability balancing/ measuring process. Supplier's ability criteria across key dimensions include relevant experience, track record, quality, expertise, capability, cost, safety record, and capacity, to name a few. Moreover, based on our research across millions of tender documents (and RFP documentation), cost, quality, and delivery performance were identified as the most important criteria used during the evaluation and selection process.

As the competitors' bidding pattern may be difficult to capture by the statistical models, many factors are likely to affect bidding decisions in a particular case. Moreover, in some cases, the objectives of bidding might not necessarily be to maximise profits. In that case, new modelling approaches such as the ones that use fuzzy input to infer the most suitable markup size but base on a predefined range of the margin. Models that use neural networks can be more effective in finding the most optimal bid markup while accounting for more factors that characterise particular tender contracts and are likely to affect both cost and bid values.

Modelling framework

Several e-procurement systems have been designed and implemented by procuring entities to align and execute various procurement activities. To an extent, these systems have solved some of the challenges within procurement processes, such as prequalification and contractors' registration, including for consultants and suppliers, advertisement to tender (ITT), tender submission, the closing of tender, opening of tender, tender evaluation, and contract award notification. However, none of these systems can evaluate tender automatically, ensure conformity to security and legal requirements, and provide complete integration of the front-end and back-end processes.

In recent years, machine learning (ML) has been gaining popularity in aiding decision-making.

ML is a technique that applies algorithms in finding concealed trends that humans cannot recognise to make decisions using existing data. Due to the procurement process being data-rich, albeit requiring effective cleansing, it has the prospective to reap from ML.

Until now, there has been no web-based procurement system that considers the entire procurement lifecycle, which has its processes automated with the aid of machine learning. At Vamstar, we are building a system that recognises and adjusts itself when new (and cleaned) data is introduced and modifies its performance accordingly to have better efficiency.

One of the critical areas of AI gaining wide acceptance in procurement is machine learning (ML). ML deals with software agents' training to learn from the large and complex dataset and make an accurate prediction of the future. Specifically, ML uses learning algorithms (like the ones described above) to train a software agent to learn from a data set. Within tendering, different applied AI techniques, such as fuzzy set, knowledge-based expert system, and case-based reasoning, can provide the basis of selecting suppliers.

Additionally, different AI models can be deployed to evaluate and classify tenders. For example, k-means clustering can be used to identify the bidding trends within tendering contracts. Moreover, the applied neural network (NN) and support vector machine (SVM) can be used to classify text documents and provide insights about features, characteristics, and buyer's overall purchasing patterns.

We have identified four steps in the building of an ML model for bidding in tendering. These include: identify data on tenders, including award and bid level data; prepare data; select the ML algorithm, e.g. deep learning; train the algorithm (using created data set); evaluate different models; deploy the model to cloud as part of a software system, e.g. web-based procurement system or an e-procurement system; use deployed model to predict with new data, and finally assess the legitimacy of model's prediction.

The framework for developing a bidding ML model can be grouped into four stages:

1. Identifying the descriptive attributes (or Features) within the historical bidding data.
2. Identifying the target attributes (or Labels) across each of the product/feature space.
3. Training the machine learning models (using train/test data).
4. Evaluating the models (on test live and validation data) and selecting the most suitable one.

Conclusion

Vamstar's procurement data reveals two key points regarding purchasing decisions in Europe during the pandemic.

The first point is that demand (tenders) for medical devices jumped by more than 30% in the latter half of 2020 compared to 2019, due in part to the UK stockpiling devices leading up to Brexit. And the second point being that award fulfillment fell from 70% in 2019 to 65% in 2020 due to supply chain issues, coupled with the trend of buyers opening contracts but not procuring as those budgets have been directed toward pandemic-related medical device spend.

Now this demand will begin to undergo fulfillment during Q1 and Q2 of this year, which has been anticipated in our medical devices forecast.

Vamstar also notes that SMEs played a larger role in procurement as healthcare providers shifted toward buying on a more transactional basis with regional vendors.

There are some demand indicators signaling that long-term budgeting with the global players is trending back, but it is likely that providers will want to keep a certain amount of nimbleness in their supply chain which will allow some of the SMEs to maintain a larger share of the market than they had pre-COVID.

Tenders are increasing in magnitude, and both buyers and suppliers are feeling its impact. This is true for both the pharma and med tech sectors but made more complex for med tech due to a combination of factors including purchasing entity consolidation and the start of value-based procurement (VBP) in the decision-making process. And while the last decade has seen many e-procurement tools and web platforms organise the source-to-pay (S2P) process, they remain relatively limited in solving the overall bottleneck. And they still do not reduce the overall administrative burden, nor do they automate the tasks across the process lifecycle for both buyers and suppliers.

To move beyond this traditional approach, artificial intelligence (AI) and machine learning (ML) are needed to apply algorithms in finding concealed trends that humans cannot recognise to make decisions using existing data. AI can also significantly improve process efficiency and automation.

Further, to enable comprehensive strategic insight that identifies opportunities and drives results, Vamstar suggests that it is necessary to pair AI-based procurement data with continually updated primary and secondary market research, creating a feedback loop that informs both sources of information. This combination becomes much more valuable than the sum of parts as it enables critical analysis of assumptions and more nuanced understanding of underlying trends, which is not possible when the data is siloed.

Vamstar's healthcare market research portfolio provides a unique perspective on the healthcare ecosystem by incorporating traditional business analysis with the latest data collection techniques and Vamstar's novel, AI-based, procurement insight. While Vamstar's AI is scanning millions of sources every day to enrich buyer and supplier data, the medical device analysis is pairing this data with market estimates built using a bottom-up approach utilizing data obtained from manufacturers, distributors, and other sources. These estimates are then compared with estimates using top-down analyses to identify and rationalize any variances.

Following is a list of report areas covered in Vamstar's medical technology market research portfolio.

Vamstar's MedTech Market Research Portfolio

- Anesthesia & Respiratory Therapy
- Cardiac Rhythm Management
- Clinical Laboratory
- Consumer Medical Wellness
- Diabetes Care
- Durable Medical Equipment
- Healthcare Informatics and IT
- Hearing Care
- Incontinence, Ostomy, and Urology
- Infusion and Renal Therapy
- Medical Imaging Equipment
- Medical Lasers and Aesthetic Devices
- Neuromodulation
- Oral Care
- Patient Monitoring
- Personal Protective Equipment
- Radiation Therapy
- Surgery
- Vision Care
- WoundCare

About the Writers

Praful Mehta

CEO at VAMSTAR

Praful Mehta is the co-founder and CEO of Vamstar. He has more than 17 years of experience in helping pharmaceutical and medical device companies create effective commercialisation strategies across different therapeutic areas. Mr. Mehta has been a longtime advisor to senior teams on the issues of market access strategies, sourcing and procurement, launch planning, landscape assessments, market competitiveness, and lifecycle planning. He has significant project experience in working with the BRIC-MT and EU-5 nations, as well as the United States and Japan. Mr. Mehta has been interviewed and quoted in various journals, print media, blogs and leadership forums within the industry. Prior to working at Vamstar, Mr. Mehta was a Senior Principal at IHS Markit, where he developed the company's core market access, pricing and reimbursement, and forecasting capability for different healthcare markets. Mr. Mehta also led various project teams at GlaxoSmithKline Pharmaceuticals and Johnson & Johnson.

Shane Walker

Research Director at VAMSTAR

Shane Walker serves as director for Vamstar's healthcare market research portfolio, which provides a unique perspective on the healthcare ecosystem by incorporating traditional business analysis with the latest data collection techniques and Vamstar's novel, AI-based, procurement insight. Mr. Walker has more than fifteen years of experience conducting industry research, business analysis, and strategy development. He has worked closely with a wide range of clients, including large end-equipment and semiconductor manufacturers, software developers, and start-ups, and continues to be actively engaged in the investigation of technology being developed to improve care outcomes. Prior to joining Vamstar, he served as research director and principal analyst for healthcare technology at IHS Markit, operated his own consultancy, and spent several years in the computer software sector as a sales director for a leading CAD developer. Mr. Walker received his Bachelor of Arts from the University of West Florida, and an MBA in Corporate Finance from St. Edward's University, Austin, Texas. He is based in Los Angeles, California.

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