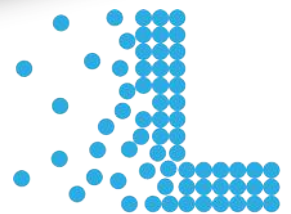# FROST & SULLIVAN
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2020 NORTH AMERICAN AUTONOMOUS MOBILE ROBOTS FOR ECOMMERCE RETAIL FULFILLMENT TECHNOLOGY INNOVATION AWARD

Contents

Background and Company Performance

Industry Challenges

Frost & Sullivan ongoing analysis of the retail fulfillment industry shows that warehouses are undergoing a transformation, with the adoption of autonomous mobile robots. Typically, warehouses are posed with challenges based on picking errors and worker fatigue, such as high travel times from workers walking up and down aisles to fulfill orders. Such challenges associated with human labor results in low throughput, low worker productivity, and the warehouse's low efficiency to fulfill orders on time, especially with same-day or next-day delivery.

Warehouses of eCommerce retailers and third-party logistics companies often face the challenge of adding more labor during holidays and festivals, resulting in a large additional cost. Moreover, hiring labor for a short period can be difficult and can become a capital expenditure for the company. Another challenge associated with labor is the shortage of available resources, and the inefficiency of conventional solutions, such as forklifts and carts, to ease operations has resulted in low efficiency in warehouses.

Such challenges have created the need for automation, such as autonomous mobile robots, into warehouses, which can improve warehouse productivity, throughput, and efficiency while eliminating the need for additional labor and cost.

Technology Attributes and Future Business Value

Visionary Innovation

US-based Locus Robotics spun out of Quiet Logistics, a third-party logistics company, in 2014. Quiet Logistics had been using robots from Kiva Systems to support warehouse operations. In 2012, Amazon acquired Kiva Systems, creating a void in the large-scale robotic logistics arena. Recognizing the significant potential for warehouse fulfillment robots, the founders of Locus Robotics, Bruce Welty and Mike Johnson, decided to build the robotic technology in-house instead of acquiring robots from another company.

Because Locus Robotics had its roots as a logistics company, it was more aware of the challenges faced on a daily basis in warehouses. This knowledge helped the company equip its robot with the required technologies, tools, and accessories to address the industry's challenges, rather than acquiring a readily available solution from a robot company with only certain available technologies that may or may not address all the problems faced in different situations within a warehouse.

The company's robot, LocusBots™, addresses the problem of labor shortage and reduces workers' time, effort, and energy, in terms of eliminating the need to walk long distances to fulfill each order because a significant amount of time is spent walking and searching racks to find products.

Frost & Sullivan research indicates that such an accurate knowledge of the industry's challenges helped Locus Robotics develop an optimal robotic solution that appeals to diverse eCommerce fulfillment companies.

Product Impact

LocusBots is an autonomous mobile robot that has the following three elements to enable autonomy: light detection and ranging (LiDAR), 3D vision, and telemetry, all of which provide information on how far the robot is moving relative to the map, based on the number of revolutions made by the robot's wheels. The robot consists of a single forward-facing LiDAR system that provides a 270-degree view so the robot can see everything except what is directly behind it, propelling the robot in a forward motion. The robot has three cameras that form its 3D vision system. The computer system is sophisticated enough so that the robot can travel at a speed of 2 meters per second, which is not faster than a human can typically walk. Essentially, the robot can identify when objects hinder its path of movement, and one robot can alert the rest of the robot fleet about a blockage in a particular lane.

Locus Robotics's robot has a tablet display with a scanner placed beneath it as well, which is used to scan products as they are picked by human workers and placed into the robot's bins during order fulfillment. Moreover, the robot has an adjustable tray on which bins/totes can be placed, a charging port, a 3D time-of-flight camera, and light indicators that come in the following four colors: blue to indicate robot travel, green for position, orange for priority order, and red for concern.

Most of the robot's operation is in the software system, developed by Locus Robotics, that seamlessly connects with the existing warehouse management system (WMS). Locus Robotics's partnerships with JDA (now BlueYonder), Manhattan, and HighJump are key to enabling the LocusBots to have a direct one-to-one connection with customers' warehouse management server, develop integration tools, and seamlessly interface with existing WMSs.

The robot's operation occurs when information from the WMS is sent to the LocusServer™, which alerts the robot of priority orders and any other orders in the queue. Workers place the required number of bins as suggested by the LocusServer, based on the order requirement, and the server then clusters groups of orders that occur in the same aisle. The robot, when sent to the worker, waits until the worker has picked all the right orders, which is ensured when the worker scans the barcode of each product and places it into the bin. The robot then moves the orders to delivery. Grouping orders within an aisle saves a significant amount of time that is wasted on having the worker move from one end of the location to the other, which delays delivery as well. The robot separates the worker from the cart and improves the worker's number of picks.

Furthermore, unlike competing solutions that do not offer a multi-language option, Locus Robotics's robot has a multi-language display that is currently integrated with about 26 languages to assist workers in their native language. Locus Robotics's confirms that with any new language requirement, it can translate and integrate the new language into the robot system. Frost & Sullivan research shows that this multi-language feature allows Locus Robotics to expand easily into newer global markets by overcoming the communication barrier.

The multi-language feature is typically activated when the robot senses the worker's unique Bluetooth badge identity. Workers' profiles are initially created on the robot server, which identifies the language chosen by the worker. The Bluetooth-enabled linkage between the robot and the worker eventually helps warehouses track the worker's location, productivity, pick rate, and number of items picked.

Scalability

Locus Robotics has been scaling the features on its LocusBots. For example, the company has recently added a put-away functionality to help customers add new items to warehouses, apart from order fulfillment. The suggestion to add this capability came from an automotive supplier, which is a customer of Locus Robotics, that needed to pick items, put labels on them, and then parcel the items into poly bags before shipment. This process requires a large amount of time that includes the worker walking up and down aisles to carry out each step of the process. To meet the demand for the put-away functionality, Locus Robotics partnered with Zebra Technologies (whose strategic investment arm, Zebra Ventures, along with Scale Venture Partners, invested $26 million in Series C funding that Locus Robotics garnered in April 2019) to integrate additional technologies to improve worker efficiency while reducing the time involved during the pick-and-place process. For this purpose, Locus Robotics integrated the printer from Zebra Technologies into the LocusBots, which comes preloaded with poly bags. The worker can effectively pick the item when the robot comes to him/her, print the label on the spot using the printer on the robot's arm, and immediately use the poly bag from the robot bin to pack the item and place it back onto the robot to be carried to delivery.

Frost & Sullivan research shows that integrating these additional technologies to perform more applications with the robot eliminates the time, energy, effort, and personnel required for the task while improving the efficiency of both the worker and the robot. Furthermore, Locus Robotics is looking to add other functionalities in the near term, such as integrating a radio frequency (RF) scanner into the robot to allow it to perform inventory counting when passing through the warehouse.

However, making the robot completely autonomous to perform pick-and-place robotic applications would be a long-term goal that still requires several technical challenges to be addressed before being realized. Competing solutions have stationary robotic arms that perform pick-and-place or sorting operations; however, when placing the robotic arm on an autonomous mobile solution, several issues prove to be challenging, such as the distance the robot's arm can reach into shelves and the robot's ability to distinguish different products accurately.

Industry Impact

The impact that the robotic technology has on warehouses of eCommerce fulfillment companies and third-party logistics providers is largely economic.

As labor becomes a premium service and more unaffordable, robots provide companies with the ability to scale and deliver based on business opportunities while, at the same

time, not incurring significant costs associated with robot adoption. The easy adoption of robots by warehouses is largely based on the robot's ability to adapt seamlessly to existing infrastructure and not require any changes to be made to warehouses, which is not the case with competing solutions. For example, several competing solutions in the market require major infrastructure changes, such as replacing stationary shelves with mobile shelves to allow robots to carry entire shelves of items. Locus Robotics's LocusBots can be up and running in a matter of four weeks and do not require the entire warehouse to be revamped and do not need to start from a greenfield environment to install the robots.

The company's LocusBots solution has been adopted by France-based GEODIS, a key transport, logistics, and supply chain management company, in collaboration with a women's apparel client, to overcome the labor shortage problem at its warehouse, especially during peak seasons. The LocusBots solution was adopted as a pilot program and witnessed significant positive results, such as reducing employee training time and doubling employee productivity.

The robot is user friendly, and training a worker to use the robot requires only about five to ten minutes, and the fleet can be up and running quickly and can seamlessly collaborate with humans. Locus Robotics has cut the training time of workers by almost 80%, which expands the pool of labor that can be deployed with minimal knowledge or experience required to use the robots, thereby addressing the already existing labor shortage challenge in the industry. Locus Robotics's robot allows complete flexibility for customers, making it the most cost-effective way to drive long-term growth for the company.

Based on Frost & Sullivan analysis, robot adoption achieves a two-fold improvement in productivity, thus minimizing the number of workers needed because the number of robots can be increased and put into service when surge seasons occur.

Customer Acquisition

Two of Locus Robotics's largest customers are DHL International, a major courier, parcel, and express mail service, and GEODIS. Locus Robotics has many deployments, with approximately 42 worldwide, of which most are in the United States and about five in Europe (two in the United Kingdom and the remaining three across other parts of Europe). Some of the company's other customers include Radial, a multinational eCommerce company; Marleylilly, an online boutique; and Port Logistics, a gateway logistics company. Frost & Sullivan research shows that according to customer success stories, Locus Robotics has consistently achieved a two-fold increase in performance and higher worker efficiencies. The boost in performance is largely attributed to faster pick-and-place operations by humans in collaboration with the LocusBots as well as the continual monitoring of worker productivity by the LocusServer, which provides other statistics as well, such as robot productivity and status.Locus Robotics provides robots-as-a-service to its customers, which has been instrumental in gaining a large customer base because this service reduces the capital expense of the customer, which only has to lease robot fleets

when needed and only take care of operating expenses. During peak seasons, such as holidays and festivals, which experience a surge in sales, companies tend to hire robot fleets for that particular period to handle workloads, without increasing the labor at their warehouses and thus improving worker efficiency. Typically, the number of LocusBots in a leased fleet range from 10 to 200 a month, depending on the intensity of the workload.

Locus Robotics's robots-as-a-service business model is targeted at larger operations, such as million-square-foot warehouses. Before carrying out installation at a customer's site, Locus Robotics initially evaluates the site to understand whether it is operationally suitable for the solution because the company only deploys robots if they will add value to the customer. During each deployment, Locus Robotics works closely with the customer by setting up functionalities from top to bottom, right from the server that operates the robots for security reasons and to ensure there is no latency in communication in case the customer depends on Wi-Fi or other infrastructure, thereby facilitating complete support service as part of the overall package.

Human Capital

While Locus Robotics manufacturers the entire robot in-house at its headquarters in Boston, Massachusetts, it has employees dispersed across several countries/regions worldwide, such as Scotland, Ireland, and South America, who help with developmental process. This team of employees includes roboticists, software engineers, and hardware engineers who are responsible for putting together the LocusBots technology solution and further scaling it for advanced applications.

The company's robotic solution, developed by such an expert team, is a profitable tool for customers' business and has attracted key logistics companies, such as DHL and GEODIS.

Conclusion

Warehouses of eCommerce retail giants often face the problems of critical labor shortage, low worker efficiency, delivery delays, and incorrect orders. Third-party logistics providers and retail warehouses require workers to walk long distances, which can be difficult and exhausting. Conventional solutions, such as carts and forklifts, do not solve this problem, thus creating the compelling need for warehouse and logistics automation.

Locus Robotics's LocusBots solution is an autonomous mobile robot equipped with software that can integrate seamlessly with existing WMS and enable each robot to fulfill orders and perform put-away functionality by collaborating with human workers. The company's robot can travel lengthy distances to carry items back and forth, thus improving delivery times and throughput. In addition, the robot improves productivity in terms of measuring workers' pick rates, thus effectively reducing workers' idle time.

For its strong overall performance, Locus Robotics has earned Frost & Sullivan's 2020 Technology Innovation Award for autonomous mobile robots in the North American eCommerce retail fulfillment industry.

Significance of Technology Innovation

Ultimately, growth in any organization depends on finding new ways to excite the market and maintaining a long-term commitment to innovation. At its core, technology innovation, or any other type of innovation, can only be sustained with leadership in 3 key areas: understanding demand, nurturing the brand, and differentiating from the competition.

Understanding Technology Innovation

Technology innovation begins with a spark of creativity that is systematically pursued, developed, and commercialized. That spark can result from a successful partnership, a productive in-house innovation group, or a bright-minded individual. Regardless of the source, the success of any new technology is ultimately determined by its innovativeness and its impact on the business as a whole.

Key Benchmarking Criteria

For the Technology Innovation Award, Frost & Sullivan analysts independently evaluated 2 key factors—Technology Attributes and Future Business Value—according to the criteria identified below.

Technology Attributes

Criterion 1: Industry Impact
Criterion 2: Product Impact
Criterion 3: Scalability
Criterion 4: Visionary Innovation
Criterion 5: Application Diversity

Future Business Value

Criterion 1: Financial Performance
Criterion 2: Customer Acquisition
Criterion 3: Technology Licensing
Criterion 4: Brand Loyalty
Criterion 5: Human Capital

Best Practices Award Analysis for Locus Robotics

Decision Support Scorecard

To support its evaluation of best practices across multiple business performance categories, Frost & Sullivan employs a customized Decision Support Scorecard. This tool allows research and consulting teams to objectively analyze performance according to the key benchmarking criteria listed in the previous section, and to assign ratings on that basis. The tool follows a 10-point scale that allows for nuances in performance evaluation. Ratings guidelines are illustrated below.

RATINGS GUIDELINES

9–10 Excellent
7–8 Good
4–6 Fair
1–3 Poor
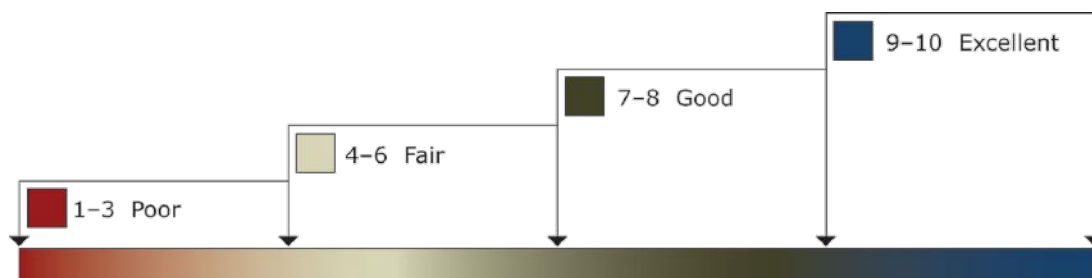
The Decision Support Scorecard considers Technology Attributes and Future Business Value (i.e., the overarching categories for all 10 benchmarking criteria; the definitions for each criterion are provided beneath the scorecard). The research team confirms the veracity of this weighted scorecard through sensitivity analysis, which confirms that small changes to the ratings for a specific criterion do not lead to a significant change in the overall relative rankings of the companies.

The results of this analysis are shown below. To remain unbiased and to protect the interests of all organizations reviewed, Frost & Sullivan has chosen to refer to the other key participants as Competitor 1 and Competitor 2.

Measurement of 1–10 (1 = poor; 10 = excellent)			
Technology Innovation	Technology Attributes	Future Business Value	**Average Rating**
Locus Robotics	**9**	**9**	**9**
Competitor 1	8	8	8
Competitor 2	8	7	7.5

Technology Attributes

Criterion 1: Industry Impact
Requirement: Technology enables the pursuit of groundbreaking ideas, contributing to the betterment of the entire industry.

Criterion 2: Product Impact
Requirement: Specific technology helps enhance features and functionalities of the entire product line for the company.

Criterion 3: Scalability
Requirement: Technology is scalable, enabling new generations of products over time, with increasing levels of quality and functionality.

Criterion 4: Visionary Innovation
Requirement: Specific new technology represents true innovation based on a deep understanding of future needs and applications.

Criterion 5: Application Diversity
Requirement: New technology serves multiple products, multiple applications, and multiple user environments.

Future Business Value

Criterion 1: Financial Performance
Requirement: Potential is high for strong financial performance in terms of revenue, operating margins, and other relevant financial metrics.

Criterion 2: Customer Acquisition
Requirement: Specific technology enables acquisition of new customers, even as it enhances value to current customers.

Criterion 3: Technology Licensing
Requirement: New technology displays great potential to be licensed across many verticals and applications, thereby driving incremental revenue streams.

Criterion 4: Brand Loyalty

Requirement: New technology enhances the company's brand, creating and/or nurturing brand loyalty.

Criterion 5: Human Capital

Requirement: Customer impact is enhanced through the leverage of specific technology, translating into positive impact on employee morale and retention.

Decision Support Matrix

Once all companies have been evaluated according to the Decision Support Scorecard, analysts then position the candidates on the matrix shown below, enabling them to visualize which companies are truly breakthrough and which ones are not yet operating at best-in-class levels.
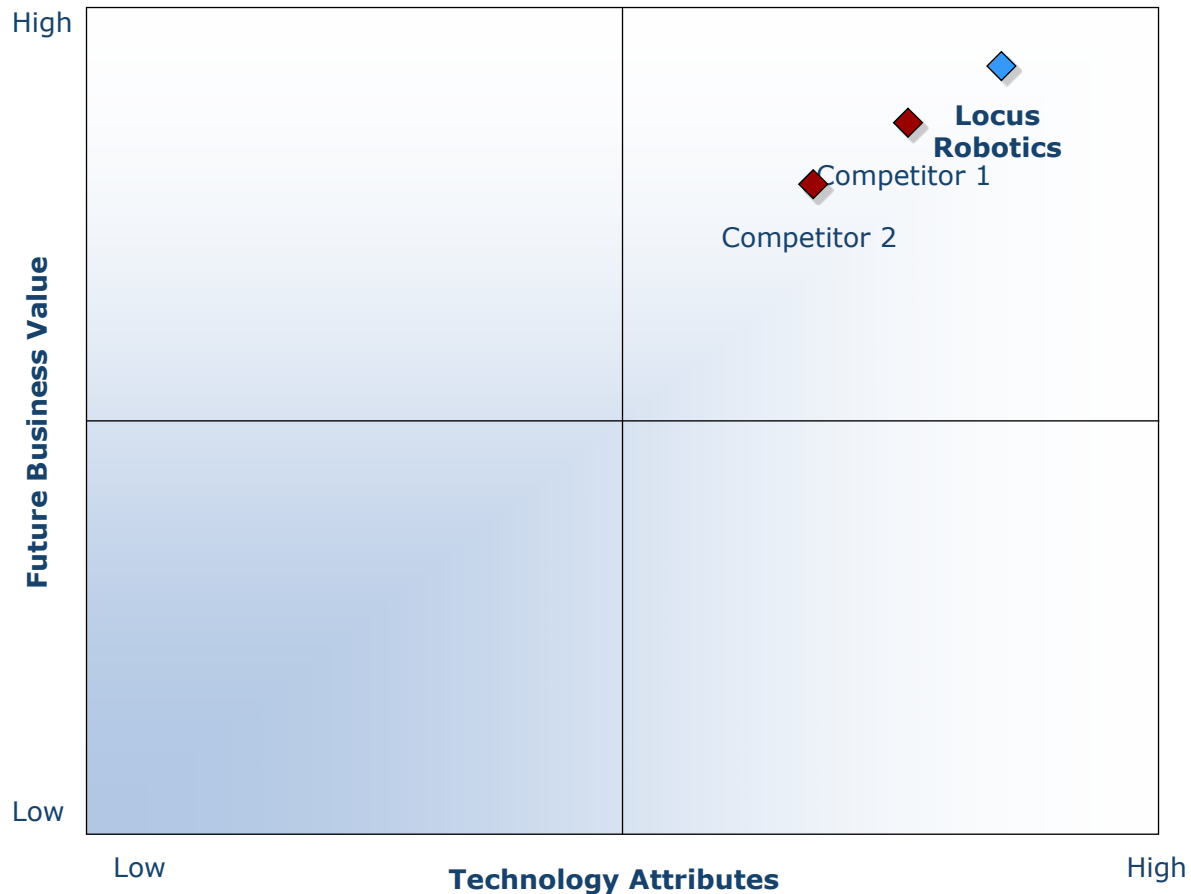
Best Practices Recognition: 10 Steps to Researching, Identifying, and Recognizing Best Practices

Frost & Sullivan analysts follow a 10-step process to evaluate award candidates and assess their fit with select best practices criteria. The reputation and integrity of the awards are based on close adherence to this process.

STEP		OBJECTIVE	KEY ACTIVITIES	OUTPUT
1	**Monitor, target, and screen**	Identify award recipient candidates from around the world	• Conduct in-depth industry research • Identify emerging industries • Scan multiple regions	Pipeline of candidates that potentially meet all best practices criteria
2	**Perform 360-degree research**	Perform comprehensive, 360-degree research on all candidates in the pipeline	• Interview thought leaders and industry practitioners • Assess candidates' fit with best practices criteria • Rank all candidates	Matrix positioning of all candidates' performance relative to one another
3	**Invite thought leadership in best practices**	Perform in-depth examination of all candidates	• Confirm best practices criteria • Examine eligibility of all candidates • Identify any information gaps	Detailed profiles of all ranked candidates
4	**Initiate research director review**	Conduct an unbiased evaluation of all candidate profiles	• Brainstorm ranking options • Invite multiple perspectives on candidates' performance • Update candidate profiles	Final prioritization of all eligible candidates and companion best practices positioning paper
5	**Assemble panel of industry experts**	Present findings to an expert panel of industry thought leaders	• Share findings • Strengthen cases for candidate eligibility • Prioritize candidates	Refined list of prioritized award candidates
6	**Conduct global industry review**	Build consensus on award candidates' eligibility	• Hold global team meeting to review all candidates • Pressure-test fit with criteria • Confirm inclusion of all eligible candidates	Final list of eligible award candidates, representing success stories worldwide
7	**Perform quality check**	Develop official award consideration materials	• Perform final performance benchmarking activities • Write nominations • Perform quality review	High-quality, accurate, and creative presentation of nominees' successes
8	**Reconnect with panel of industry experts**	Finalize the selection of the best practices award recipient	• Review analysis with panel • Build consensus • Select recipient	Decision on which company performs best against all best practices criteria
9	**Communicate recognition**	Inform award recipient of recognition	• Inspire the organization for continued success • Celebrate the recipient's performance	Announcement of award and plan for how recipient can use the award to enhance the brand
10	**Take strategic action**	Upon licensing, company is able to share award news with stakeholders and customers	• Coordinate media outreach • Design a marketing plan • Assess award's role in strategic planning	Widespread awareness of recipient's award status among investors, media personnel, and employees

The Intersection between 360-Degree Research and Best Practices Awards

Research Methodology

Frost & Sullivan's 360-degree research methodology represents the analytical rigor of the research process. It offers a 360-degree view of industry challenges, trends, and issues by integrating all 7 of Frost & Sullivan's research methodologies. Too often companies make important growth decisions based on a narrow understanding of their environment, resulting in errors of both omission and commission. Successful growth strategies are founded on a thorough understanding of market, technical, economic, financial, customer, best practices, and demographic analyses. The integration of these research disciplines into the 360-degree research methodology provides an evaluation platform for benchmarking industry participants and for identifying those performing at best-in-class levels.

360-DEGREE RESEARCH: SEEING ORDER IN THE CHAOS

About Frost & Sullivan

Frost & Sullivan, the Growth Partnership Company, helps clients accelerate growth and achieve best-in-class positions in growth, innovation, and leadership. The company's Growth Partnership Service provides the CEO and the CEO's growth team with disciplined research and best-practices models to drive the generation, evaluation, and implementation of powerful growth strategies. Frost & Sullivan leverages nearly 60 years of experience in partnering with Global 1000 companies, emerging businesses, and the investment community from 45 offices on 6 continents. To join Frost & Sullivan's Growth Partnership, visit http://www.frost.com.