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START-UP NATION CENTRAL

Unlocking Industry 4.0 Potential

Transforming through startup-manufacturer collaborations and the unique role of the Israeli startup ecosystem

Contents

Preface

This report was prepared in a joint effort by Deloitte and Start-Up Nation Central, an Israeli non-profit organization focused on connecting Israel's innovation ecosystem with global business leaders, governments, NGOs and academic institutions, to explore Industry 4.0 from the perspective of manufacturers and to understand the unique value proposition Israeli startups bring to this field. We have examined the needs and pain points of manufacturers as well as current Industry 4.0 solutions used to address them. Given the ever-growing number of technological breakthroughs produced by startups alongside rising corporate interest in accessing them, startups play a vital role in Industry 4.0. This report will therefore focus on the areas in which startups are utilized to effectively compete in the modern industrial age.

We further explored how innovations being developed by startups meet the needs of manufacturers to formulate ways in which collaborations can create mutual value. In particular, we closely analyzed the Israeli ecosystem, given its international recognition as an innovation hubz and the unique capabilities its startups bring to Industry 4.0. We hope you find this report insightful and resourceful in fulfilling your Industry 4.0 aspirations.

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Executive Summary

We are on the cusp of a fourth industrial revolution, referred to as Industry 4.0. Enabled by the concurrent development of disruptive technologies and the digital era, Industry 4.0 promises to radically transform the manufacturing ecosystem. As these waves of change reshape the competitive landscape, manufacturers must think strategically when determining where to focus and invest. To gain a better understanding of the pressing needs of manufacturers and the ways in which startups can add value to them, we conducted interviews with industry leaders, experts, and organizations across the globe, gathered and analyzed hundreds of use cases, and created an exhaustive mapping of startups engaged in Industry 4.0. The purpose of this report is to enable corporate leadership to make informed decisions by exploring various Industry 4.0 technologies and applications, providing an overview of different players within the Industry 4.0 ecosystem, and suggesting strategies for how to maximize shared value through collaboration with startups.

The Three Horizons of Industry 4.0

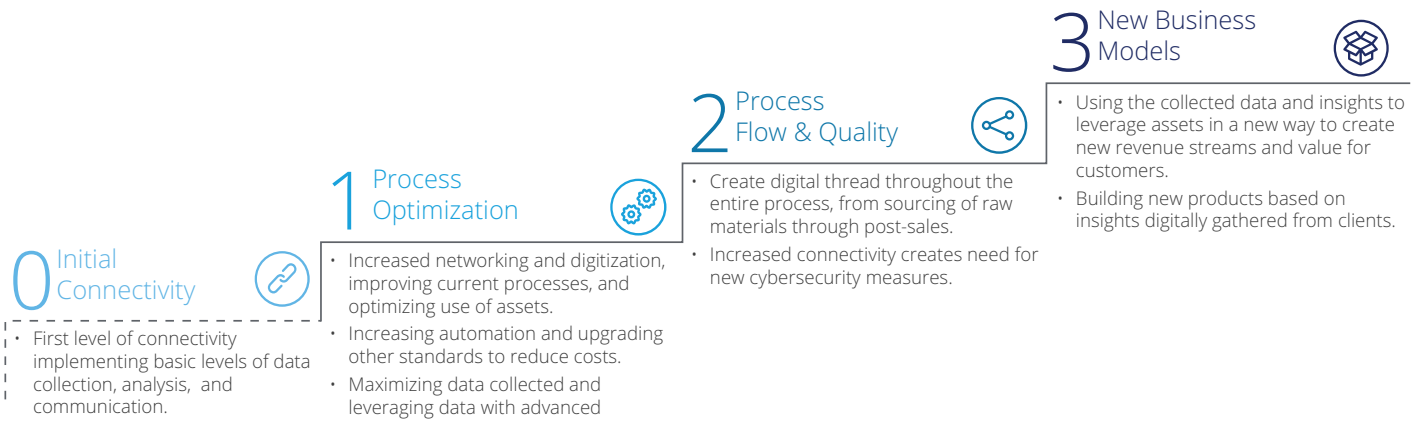
Development of Industry 4.0 capabilities occurs gradually, beginning with the establishment of a fundamental level of connectivity. Once that foundation is laid a company can then begin to integrate Industry 4.0 processes, which typically occurs in three successive horizons, each one drawing closer to realizing more and more of the benefits Industry 4.0 can offer:

1. **Process Optimization:** Companies look inward to optimize asset utilization, increase automation, and reduce costs. Initiatives in this horizon generally have easily quantifiable benefits with a clear ROI.
2. **Process Flow and Quality:** Companies look to collect and integrate data in order to improve process flow and upgrade quality by increasing connectivity levels throughout a fully connected supply network.
3. **New Business Models:** Companies look to create new revenue streams through new or improved products, increased product personalization, or new models entirely.

Current Focus of Implementation

Deloitte conducted research and surveyed global corporations as well as Industry 4.0 experts to gain a better understanding of the level of attention different types of Industry 4.0 initiatives are receiving. Manufacturers specifically identified types of initiatives currently being implemented as well as those that will be of future focus. Most manufacturers are still in the early stages of this transition, so far having focused on four main areas of implementations primarily in the first horizon:

- **IoT platforms and connectivity** is a foundational element of Industry 4.0. These technologies enable the transmission of data from hundreds of separate machines and sensors for analysis.
- **Operations optimization** provides new ways to increase productivity and reduce operating costs by analyzing collected data to derive insights for improving processes.
- **Supply chains** demand new connectivity solutions due to increased globalization and growing process-related complexities. Additional visibility into the supply chain and improved predictability both produce significant cost savings.
- **Predictive maintenance** solutions decrease unplanned downtime, one of the greatest costs to manufacturers, which improves asset utilization and boosts the bottom line.



Future Focus of Implementation

As companies continue to move from the first horizon of process optimization into the second horizon of process flow and quality, they face issues of data collection and protection. Manufacturers have therefore identified two areas which they will need to focus on in the near future:

- **Cybersecurity:** As connectivity becomes more advanced and ubiquitous, the threat from cyber-attacks will grow. Because of this reality, companies are limited in developing greater connectivity until more protective systems are in place.
- **Sensing and imaging:** As Industry 4.0 progresses, the need for technologies capable of collecting more actionable data will be required, both in terms of quality and scale.

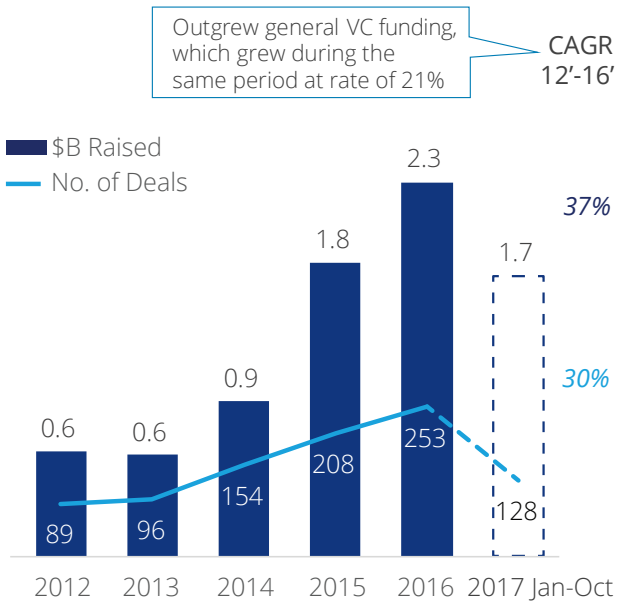
Startups – an Integral Role in the Transformation

Transforming traditional manufacturing plants into Industry 4.0 equipped facilities requires a set of capabilities that is typically foreign to manufacturers. To overcome these barriers, manufacturers are partnering with innovative players such as startups, who bring a new set of capabilities to the table. The mounting belief that startups will indeed provide critical technological breakthroughs in Industry 4.0 is evidenced by the approximate 40% yearly growth rate of Venture Capital (VC) funding in this arena (see Figure A). Forward-thinking companies have also identified the value created by startups, and are increasing the scale and scope of both acquisitions and corporate partnerships with them accordingly. Four out of every five corporate manufacturers interviewed for this report view startups as an integral part of their continuous innovation efforts. While a number of leading corporate players in various industries and verticals have established scouting avenues, including corporate venture arms, accelerator programs, and innovation hubs, in general, manufacturers are not yet accustomed to these kinds of collaborations.

Israel's Role in this Revolution

Given its unique innovative ecosystem and startup culture, Israel has developed a reputation for entrepreneurship. This is no different within the context of Industry 4.0, where Israeli startups are playing a leading role in introducing transformative products and processes. Israeli entrepreneurs have identified Industry 4.0 as a space for exponential growth and are rushing to create new solutions. This can be demonstrated by Israel receiving 10% of global VC investment in Industry 4.0 in 2016 despite a populace accounting for

Figure A: Industry 4.0 VC Funding



Source: CB Insights, Start-up Nation Finder, Deloitte Databases, TechCrunch, Pitchbook, Crunchbase. Traxcn, Venture Pulse, Deloitte Analysis

only 0.1% of the global population. In the first ten months of 2017, Israeli Industry 4.0 startups received $193 million in VC funding, with over 10% expected growth from 2016. Additionally, Israeli startups are attracting attention from corporate VC's, especially from companies leading development in Industry 4.0 such as, GE, Siemens, ABB, and many others.

Israeli Advantages

Israel has achieved a unique preeminence within the context of Industry 4.0 by leveraging national strengths in the areas of analytics software and security technologies. These strengths are demonstrated by the advanced cybersecurity and Unmanned Aerial Vehicle (UAV) industries, of which Israel is a global leader.

Our research indicates that Israeli startups have superior, unique capabilities in four of ten Industry 4.0 subsectors. Of these, two subsectors were defined by manufacturers as key focus areas currently and two subsectors were defined as key focus areas of future interest.

Israeli Advantages in Current Focus Areas of Implementation

Both manufacturers and startups alike start by directing their energy toward projects focused on cost reduction with a clear return on investment (ROI) and obvious benefits. In this respect, Israeli entrepreneurs have identified two areas

within Industry 4.0 in which their relative advantages can be leveraged to reduce costs for manufacturers:

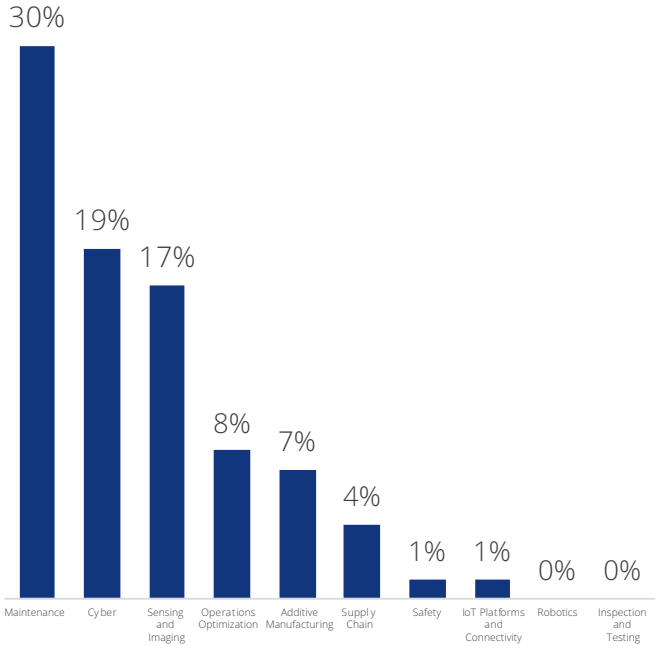
- **Predictive Maintenance:** These solutions combine Israeli strengths in analytics and sensor technology. From 2014 to 2016, over 30% of global VC funding in predictive maintenance companies went to Israeli startups (See Figure B).
- **Operations Optimization:** These technologies, which focus on increasing product yield, decreasing input consumption, and decreasing time to market, among other KPI's, largely rely on advanced analytics software; an area in which Israel excels. Approximately 25% of innovative Industry 4.0 companies in Israel are active in this field, many of which are in advanced stages of development.

Israeli Advantages in Future Areas of Implementation

As manufacturers move to integrate second horizon technologies and solutions, they have identified the growing need for cybersecurity and sensing and imaging solutions. Given Israel's leading position in developing these technologies, Israeli startups can serve as valuable partners in addressing these future areas of interest:

- **Cybersecurity:** Israel is known for its strength in this area – 15% of global research and development spending on cybersecurity technologies occurs in Israel. Additionally, close to 20% of global VC funding in Industry 4.0 cybersecurity startups occur in Israel (see Figure B).
- **Sensing and Imaging:** From 2014 to 2016, approximately 17% of global VC funding in startups developing sensing and imaging technologies went to Israeli companies (see Figure B).

Figure B: Israel share of Global Funding by Segment 2014-2016



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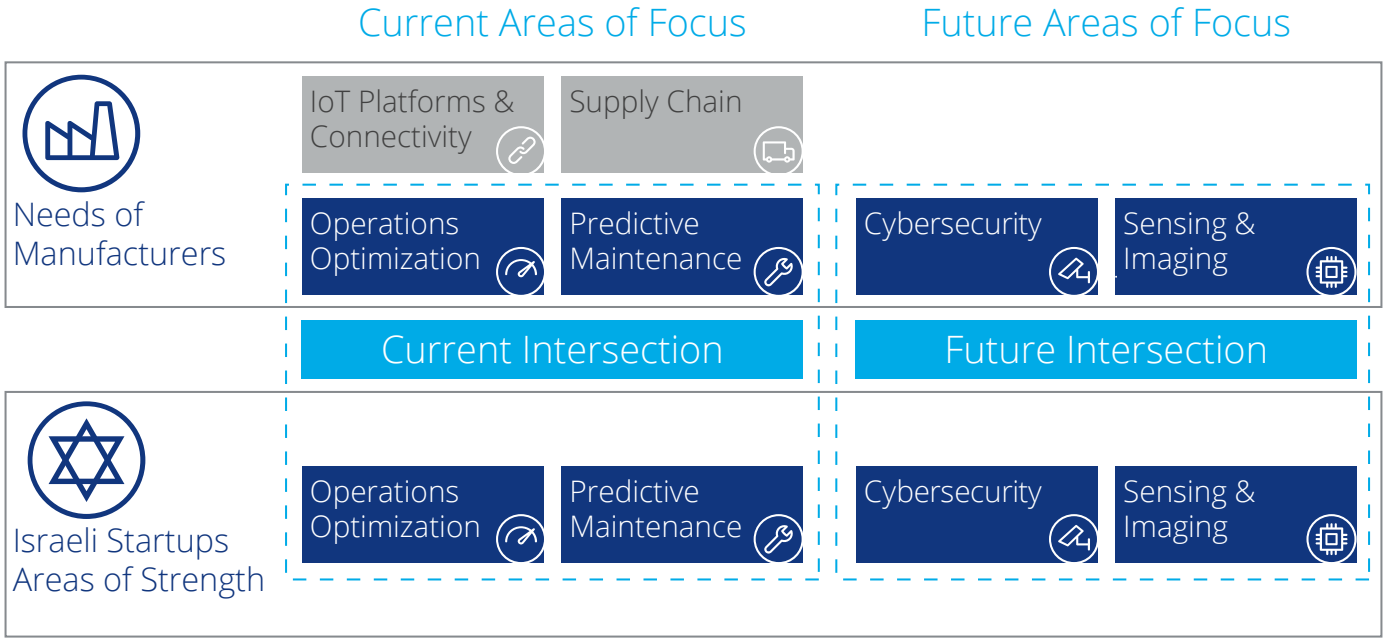


1. Introduction to Industry 4.0

Over the last two centuries, the world has witnessed three industrial revolutions, each one dramatically reshaping the way goods and services have been developed, produced, and sold. Now it appears we are on the cusp of a new and far-reaching industrial revolution – Industry 4.0. Manufacturers are facing an increasing number of challenges on multiple fronts while the concurrent introduction of disruptive technologies is radically transforming the interaction between the digital and physical worlds. While Industry 4.0 applies to a variety of capital intensive industries (such as oil & gas, construction, infrastructure, energy, etc.), this report will focus on the manufacturing sector.

Industry 4.0 technologies are ushering in a new era of design, production, and after-market service. Increased connectivity and ever more sophisticated data-gathering and analytic capabilities enabled by the Internet of Things (IoT) have led to a shift toward an information-based value chain. The IoT conjoins physical objects with data, making it possible to build smarter manufacturing processes, supply chains, and brand new business ecosystems.

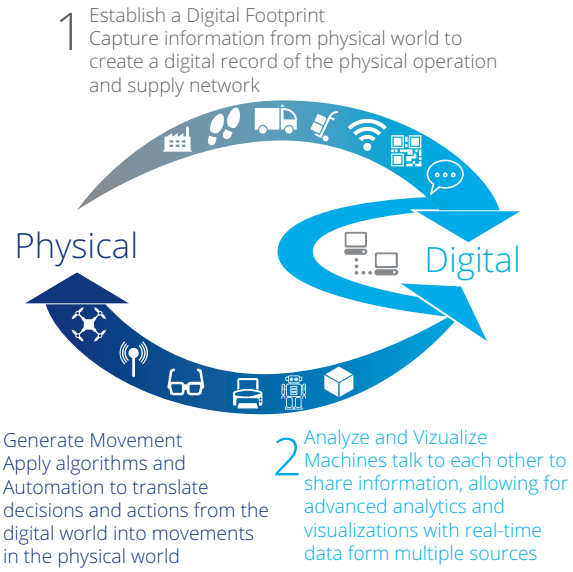
Corporate leadership can discover new ways to push their organizations forward by exploring the various Industry 4.0 technologies and applications and developing an understanding of the value that startups bring to this space. Furthermore, innovative ecosystems like the one in Israel can play a crucial role in enabling and supporting the digitization of large businesses, offering the unique and diverse solutions that define this revolution.

What is Industry 4.0?

Industry 4.0 (alternatively known as smart manufacturing or Industrial IoT) encompasses the promise of a new industrial revolution. This revolution consists of advanced manufacturing techniques combined with the Internet of Things to create a digital manufacturing enterprise that is not only interconnected, but also communicates, analyzes, and uses information to drive further intelligent action back into the physical world. It has thus shifted the entire paradigm of manufacturing in regards to how the physical and digital worlds interact.

An Industry 4.0 solution captures a constant stream of data across system-wide assets, thus creating a digital record of the entire operation and supply network. This data is analyzed and integrated to allow connected operations and production systems to learn and adapt. These continuous physical-to-digital-to-physical cycles enable a leap forward

Figure 1.1: Industry 4.0 Closes the Loop Between the Physical and Digital



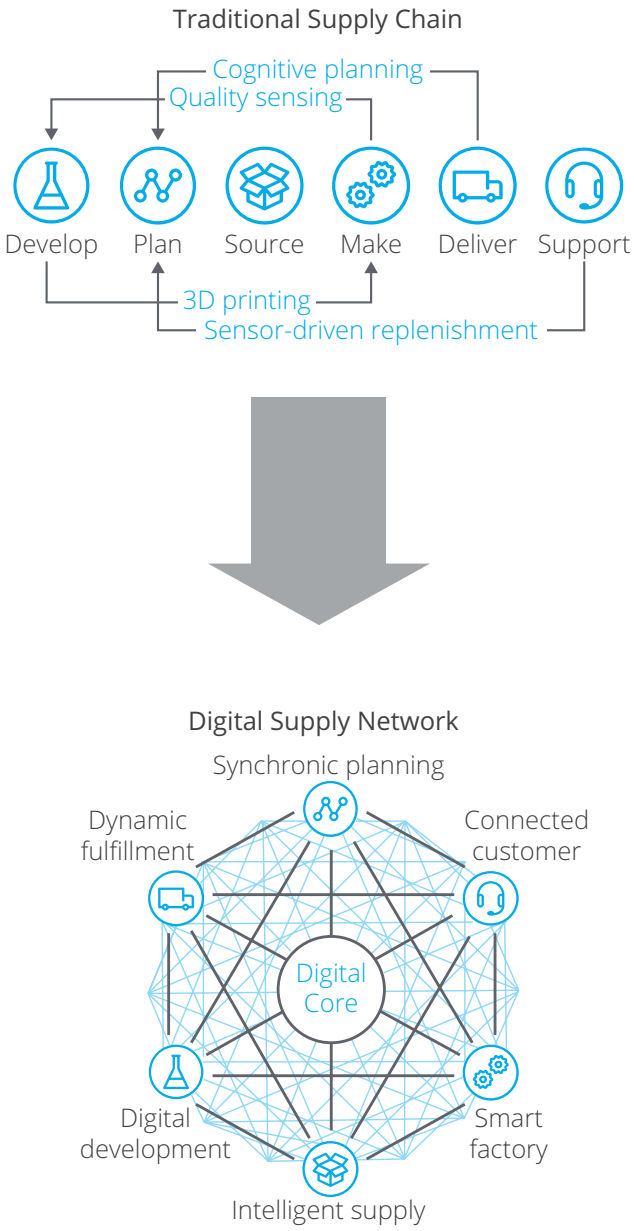
from more traditional automation to a fully connected and flexible supply chain known as a Digital Supply Network (DSN).

The concept of adopting Industry 4.0 systems can feel complicated, even insurmountable; however, rapidly changing technological trends have made the shift toward a more flexible, adaptive production system inescapable for businesses striving to effectively compete. Implementing changes will not be easy, however, and as manufacturers strive to adopt these systems, they will need to overcome various obstacles. Those challenges can be organizational, such as overcoming cultural barriers, bridging business functions, and altering organizational structures in order to accommodate new business models. They can also be technical, involving the retrofitting of old systems to Industry 4.0 applications and mitigating the increased cybersecurity risks that come with higher levels of connectivity.

A Revolution in the Making

While execution is certainly a challenge, successful implementation can simultaneously result in improvements to both the bottom and top lines. By 2025, Industry 4.0 is expected to generate close to $1 trillion in economic value,[1] much of which will come from the technological advancements of startups. Given its strong innovative ecosystem, Israel is playing a leading role in Industry 4.0 and is developing new breakthroughs that are changing the manufacturing landscape.

Figure 1.2: Traditional Supply Chain to Digital Supply Networks



2. Israel's Growing Role in Industry 4.0

Often referred to as the "Silicon Wadi" or the "Startup Nation," Israel is a country well known for its innovative abilities and has the highest number of active startups per capita, globally.[2] Israel has developed competencies in the areas of advanced analytics, sensing and imaging technologies, and cybersecurity, and Israeli companies have a storied history of identifying issues and leveraging these strengths to develop creative solutions. Their value is clearly significant and recognized as can be seen from the $45 billion spent on acquisitions of Israeli startups in the past five years alone.[2]

Israel is leading the way in automotive innovation

Despite the lack of local auto manufacturing, Israel has become a recognized hub of disruptive technologies in this industry. Major automobile players such as Hyundai, Skoda, Daimler, Renault-Nissan, and GM have all established R&D centers in Israel to harness unique local capabilities. Israeli entrepreneurs have noticed the challenges and opportunities faced by auto manufacturers and found ways to apply their expertise in sensing and imaging, cybersecurity, and analytics technology. Ford, Volkswagen, BMW, and Daimler have all made strategic investments in Israeli startups, while Porsche, Honda, Volvo, and Hyundai have invested heavily in Israeli accelerators and VC funds. In 2017 alone, two massive acquisitions of Israeli companies were made in this segment: Mobileye, a company that develops sensors enabling Advanced Driver Assist Systems that support autonomous driving, was acquired by Intel in 2017 for $15.3 billion.

Argus, which has developed cybersecurity solutions to protect connected vehicles from cyber-attacks, was acquired by Germany's Continental AG in November 2017 for $400 million.

Otonomo, another Israeli startup that has contributed significant breakthroughs to the automobile industry, raised $25 million in an investment round led by Delphi Automotive. This partnership allowed Delphi to utilize Otonomo's analytics capabilities, a particular Israeli strength, in order to develop a central marketplace where car-generated data can be packed and sold between mobility service providers.

Israel's Focus on Industry 4.0

Parallels can be drawn between the auto industry and the burgeoning Industry 4.0 ecosystem. Although Israel's manufacturing sector is relatively small, local innovators have taken notice of the need for new tech-based solutions and have begun to develop products based around the same Israeli competencies of cybersecurity, analytics, and sensing and imaging. As such, Israel is quickly becoming a hub of innovation for Industry 4.0, having received 10% of global VC funding in 2016.[3] Israeli startups are also attracting attention from corporate VC's especially from leading Industry 4.0 companies such as GE, Siemens, ABB, and many others.

ABB, among other industry leaders, has specifically identified Israel as an ecosystem where key Industry 4.0 technological advancements are being made. As such, they have focused on identifying potential strategic investments in the region – ABB's venture arm has participated in over $20 million of funding rounds for Israeli startups that provide Industry 4.0 solutions.

"We have made a few strategic investments in Israeli startups. Tel Aviv is a well-developed hub for Industry 4.0"

Industry 4.0 Manager, ABB

The Israeli government has also identified Industry 4.0 as an opportunity to both strengthen the nation's innovation ecosystem and improve productivity of the local manufacturing industry. To help achieve this goal, the Ministry of Economy established a dedicated Center for Advanced Manufacturing. Additionally, the Israel Innovation Authority (IIA) has several programs aimed at creating a conducive environment for investing in startups as well as adapting to Industry 4.0 standards. They provide special tax deductions for angel investors (up to 5 million NIS per company invested), a range of benefits for the establishment of R&D centers, government supported incubator and accelerator programs (to the tune of over $40 million), and grants for foreign companies establishing partnerships with local startups.

The Technological Innovation Lab (TIL), a government program promoting collaboration between foreign manufacturers and Israeli startups, provides access and funding towards engaging with the Israeli ecosystem. Merck, a leading science and technology company, is establishing a technology innovation laboratory through the TIL to serve as an incubator for startup companies in Israel. The endeavor, named PMatX, will focus on startup companies dealing with next-generation electronics that integrate advanced materials with novel manufacturing methods. Others, such as HP and US-based investment firm, Battery Ventures, have seen the potential this initiative holds and joined Merck to collectively invest €20 million toward this initiative.[4]

3. Industry 4.0 in Action

Manufacturers have been facing an increasing amount of pressure from a variety of sources. Some of these challenges arise from competition and require improvements on performance metrics such as quality, efficiency, and productivity. Additional problems, such as the changing business landscape, increased compliance issues, and customer demand for improved services are also affecting the ways in which manufacturers operate. Whatever the impetus for improvement is, Industry 4.0 is already being implemented to address issues along the entirety of the supply chain.

Design Process and Product Optimization

Local Motors is a low-volume, open-source motor vehicle manufacturing company that operates through multiple microfactories. These microfactories employ a series of technologies, such as additive manufacturing, which enable rapid prototyping and on-the-fly iterative design. As a result, production can occur five times faster and with 100 times less capital.

Planningw & Inventory Efficiency

Michelin embedded its tires with sensors that tracked key metrics such as wear and air pressure, and installed telematics systems in tires to relay this sensory data back to a mobile network. The company then used the data to produce cognitive analytics that recommend tactics for reducing fuel costs and increasing a tire's useful life. Michelin also built apps compatible across mobile platforms which display analytics in an intuitive dashboard and offer users paid subscriptions to the data. These applications have greatly impacted inventory management, customer experience and responsiveness, and flexibility.

Risk Prevention and Mitigation

Biopharma companies use Process Analytical Technology (PAT) to monitor and review product quality throughout the manufacturing process as opposed to an evaluation at the end. The PAT system designs, analyzes, and controls manufacturing processes based on timely measurements of critical quality and performance attributes (e.g., biological, chemical, and physical).

Supplier Collaboration

Walmart has created a system to enable their suppliers to work more efficiently and cut their own costs, in turn, forcing the retail giant's own supply costs down. Their system provides access to Walmart's sales and inventory data, allowing suppliers to time production runs more accurately. Suppliers are then able to specialize and compete against each other in a fully transparent marketplace. This unique, multi-entity supply chain planning system has contributed to Walmart's revenue growth rate of 13% versus a flat growth rate for competitors.

Operations Efficiency

EasyJet uses augmented reality smart glasses to enable two-way communication between its network of remote maintenance technicians and the central engineering team. The streamed information provides an accurate view of the situation: enhancements like QR-code part scanning allow the software to automatically push relevant information and step-by-step walkthroughs enable technicians to perform complex maintenance operations. By reducing downtime, creating a more efficient operating environment, and eliminating travel for its central engineering team, EasyJet has been able to save an estimated $500,000 per year from fuel costs alone.

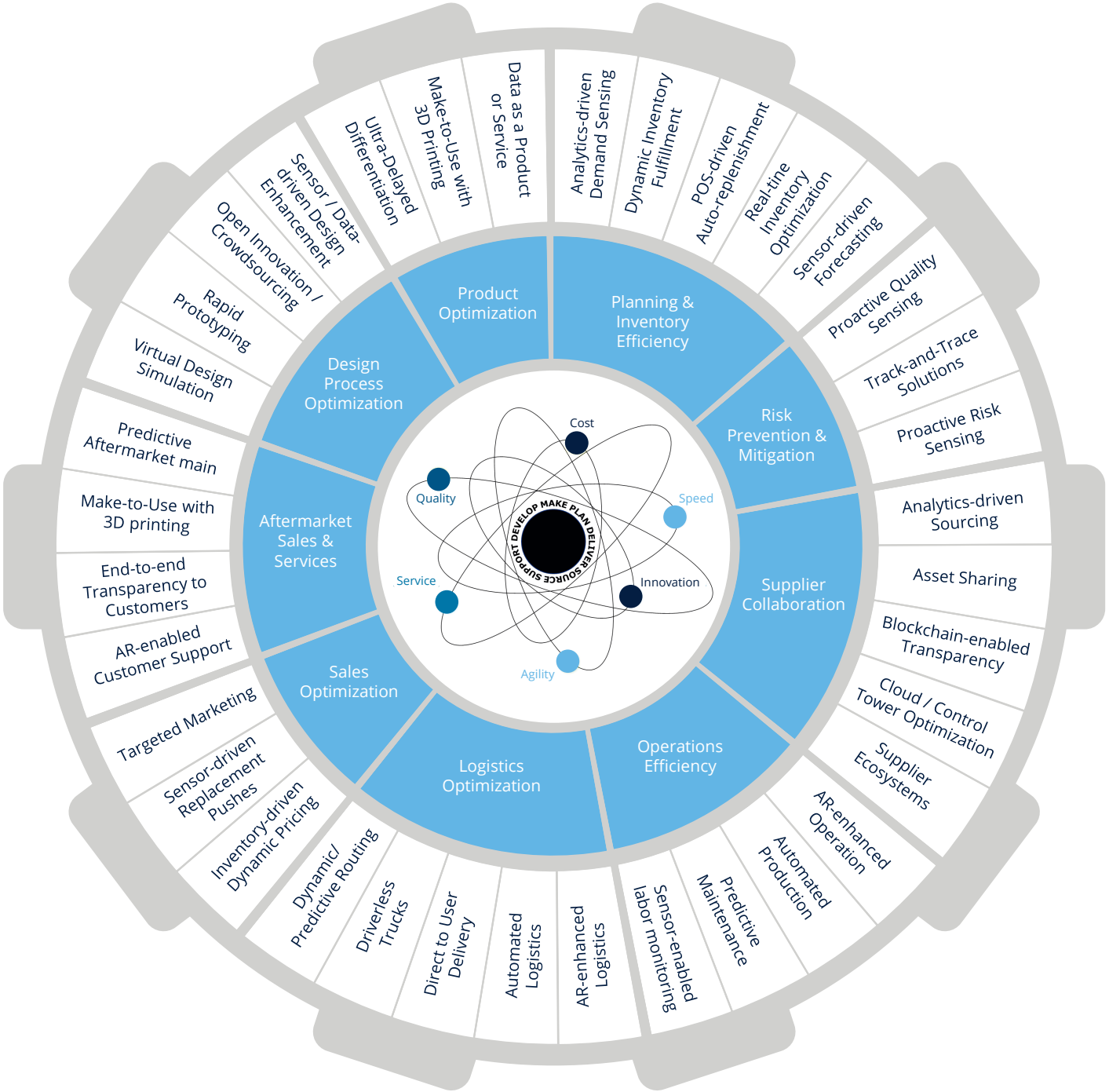
Logistics Optimization

The Port of Los Angeles employs over two dozen "straddle carrier" robots to pick up containers that come right off the ship, transport them for later organization, and retrieve them when truckers arrive to pick up the cargo. This automation boosts terminal reliability and productivity by an estimated 30% while cutting labor costs – robots can reduce the need for longshore labor up to 50%.

Sales Optimization and Aftermarket Services

McDonald's in Australia created a digital app to provide customers the ability to scan a QR code on a burger container in order to see where the ingredients originated from and how they were processed along the way. This end-to-end supply chain visibility enabled McDonald's to convey the freshness of their product and provide the customer with full transparency.

Figure 3.1: Industry 4.0 Across the Value Chain



4. Value Creation and Impact

Application Modes

Industry 4.0 technologies have the ability to add value to both the top and bottom line, simultaneously; however, most manufacturers typically focus on either one or the other. Today, the majority of manufacturers are implementing Industry 4.0 technologies to improve a specific process or solve a specific pain point, but as these technologies become increasingly advanced, we will see a transition toward more holistic solutions with less directly calculable benefits.

The Three Horizons of Industry 4.0

Before beginning the transformation to an integrated system, a basic level of connectivity is required. Once this connectivity is established, a company can begin its journey integrating digitalization processes. This typically occurs in three different horizons: process optimization, process flow and quality, and new business models (see Figure 4.1).

1. **Process Optimization:** In this phase, companies look inward to improve current processes. Initiatives in this phase typically are targeted at a specific issue and have a clearly visible ROI. For example, solutions in this horizon include predictive maintenance of machinery and utilization of data for production process improvements. This requires a basic level of connectivity to enable data collection and analysis; however, it is usually limited in scope. Thus, these solutions are easier to implement as they represent a limited number of technologies targeting a specific issue. Further, they do not face many of the organizational challenges nor the technological barriers required to link multiple different legacy systems in larger, cross-functional initiatives.

"Cost savings is the easiest sell, as it has a clear cut ROI"

Former Senior Product Manager, Schneider Electric

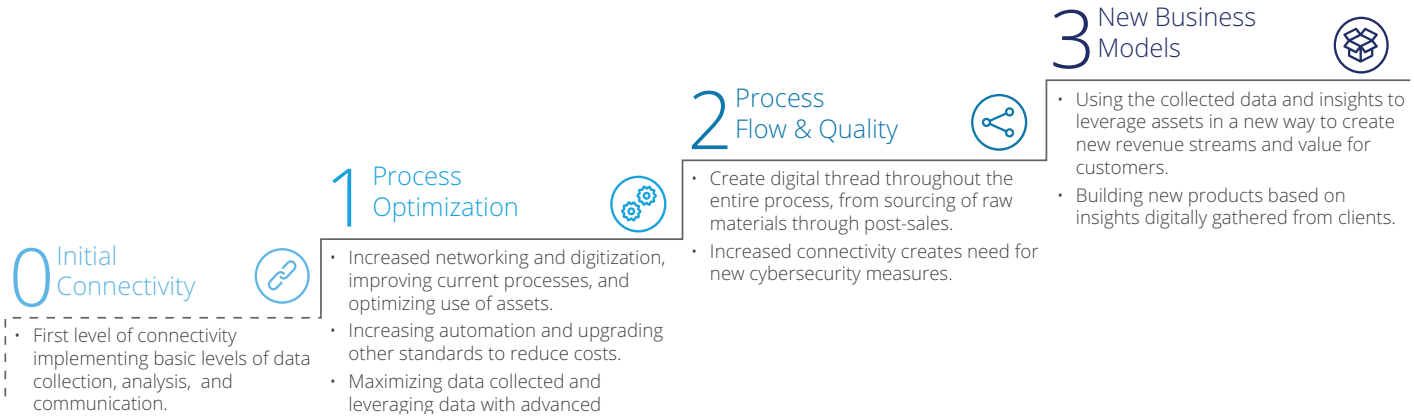
2. **Process Flow and Quality:** Companies working on the second horizon increase their level of connectivity to improve process flow and upgrade quality. In this phase, the supply chain transforms into a Digital Supply Network in which production stages dynamically interact with one another. Sales data is collected and analyzed, then automatically transferred to sourcing and manufacturing systems. Unlike the first horizon, there are more technological and organizational obstacles to overcome in order to achieve system-wide connectivity, and the benefits are not always easily quantifiable.

3. **New Business Models:** The third and final horizon is one in which new business models are created. This can consist of new products, increased product personalization, or new models entirely. For example, many Original Equipment Manufacturers (OEMs, who produce manufacturing equipment) are adding smart equipment into their portfolio and some are even attempting to use these products to pivot from being a supplier to a service provider. While a great deal of companies can agree that the greatest value lies in this horizon, most are still struggling to formulate how to successfully integrate the idea into an effective model.

"OEM customers are going intelligent so they are demanding smart products. OEM's are being pushed into Industry 4.0 solutions from the demand, even if it's not in their strategy"

Product Portfolio Manager, Kirloskar Brothers

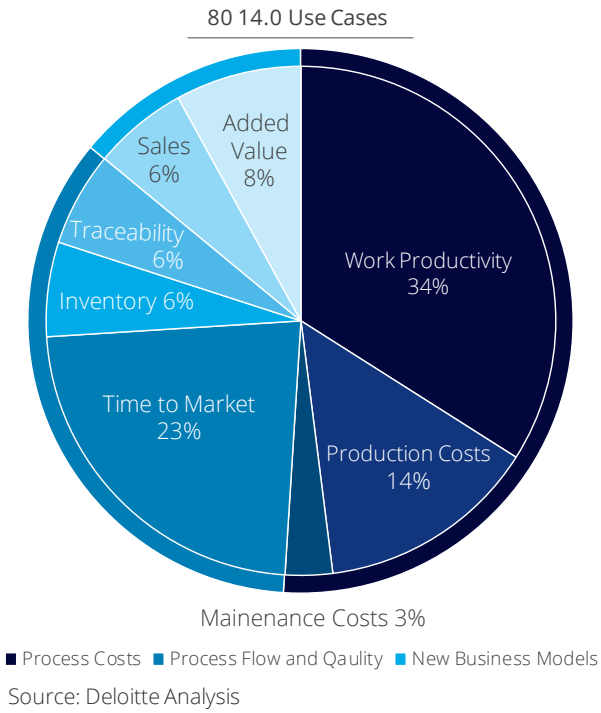
Figure 4.1: Three Horizons of Industry 4.0



Implementation of the Three Horizons

Well before the fourth industrial revolution, manufacturers have and continue to implement new, innovative technologies to operate more efficiently. Focused initiatives with a tangible ROI have therefore been easier to adopt by those on the shop floor. Based on Deloitte analysis of over 80 different Industry 4.0 use cases, approximately 50% of the time Industry 4.0 was implemented to optimize processes and reduce costs. Roughly 35% of the cases were targeted to improve the process quality and efficiency, and around 15% of cases directly improved the top line (see Figure 4.2).

Figure 4.2: Implementation of Industry 4.0



Source: Deloitte Analysis

Current Focus of Implementation

Deloitte surveyed global corporations and Industry 4.0 experts to understand the level of attention different types of Industry 4.0 initiatives have been receiving. Manufacturers identified areas of their business that they are currently focusing on as well as those that will be of future focus (see Figure 4.3). The four main areas identified as currently most important are: IoT platforms and connectivity, operations optimization, supply chain, and predictive maintenance.

- **IoT platforms and connectivity** is a foundational element of Industry 4.0. These technologies enable the transmission of data from hundreds of separate machines and sensors for analysis, which is then leveraged throughout various processes.
- **Operations optimization** provides new ways to increase productivity and reduce operating costs by improving processes, a longtime focus of manufacturers.
- **Supply chains** demand new connectivity solutions due to increased globalization and growing process-related complexities. Increased visibility into the supply chain and improved predictability provide companies with significant cost savings.
- **Predictive maintenance** solutions decrease unplanned downtime, one of the greatest costs to manufacturers, which improves asset utilization and boosts the bottom line.

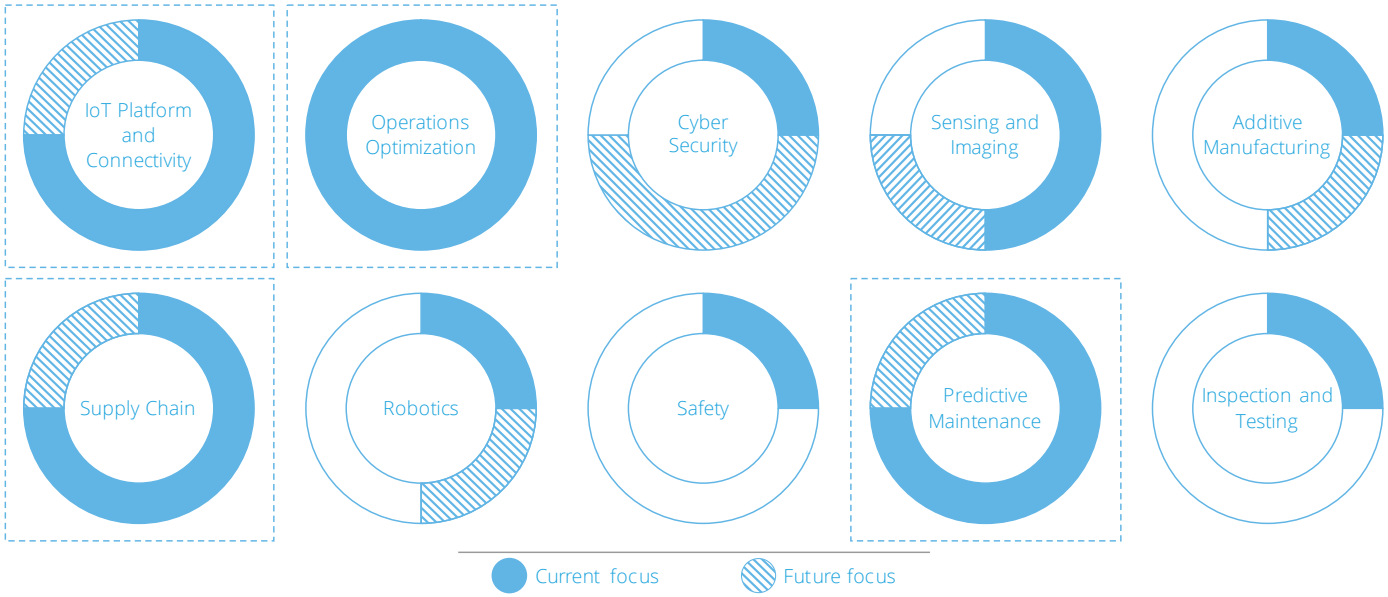
Future Focus of Implementation

As companies continue to move from the first horizon of process optimization into the second horizon of process flow and quality, they face issues of data collection and protection. Manufacturers have identified two key areas that will become more important throughout the transition to fully connected systems (see Figure 4.3):

- **Cybersecurity:** As connectivity becomes more advanced and ubiquitous, the threat from cyber-attacks will grow. Because of this reality, companies are limited in developing greater connectivity until more protective systems are in place.
- **Sensing and imaging:** As Industry 4.0 progresses, the need for technologies capable of collecting more actionable data will be required, both in terms of quality and scale.

Figure 4.3: Manufacturers' Areas of Interest

Question: What are the main areas of interest for manufacturers within Industry 4.0?



Industry 4.0 Value Creation

Across all three horizons the impact of Industry 4.0 is clear and proven. Based on Deloitte analysis, Industry 4.0 has the potential to boost several performance indicators:

Source: Deloitte Analysis

"By adopting sensors and adaptive control technology we were able to reduce cycle time by 30%"

Director of John Olsen Advanced Manufacturing Center

Despite the relatively recent adoption of Industry 4.0, some companies have already significantly improved their processes. However, given the challenges of implementing new technologies quickly and flexibly, many manufacturers continue to struggle in reaping these benefits. Those unsure of how to begin should remember that there is a significant amount of tangible ROI to be gained from limited initiatives which are, in fact, a necessary step in the development of capabilities to launch wider ranging programs. Companies searching for solutions to Industry 4.0 related challenges possess a range of options in a large ecosystem of players – particularly, startups serve as excellent long term, innovative partners.

5. Segmentation of Main Players

Oftentimes technological revolutions are made by a single player followed by other companies iterating and improving upon the foundation of certain products and technologies. The new era of Industry 4.0 quite strikingly contrasts. There are far too many actors, and too wide a spectrum of capabilities required for any single player to pull ahead independently. In order to understand how Industry 4.0 is developing and to identify the sources creating the most value for the ecosystem, it is important to examine the types of players involved and how they interact.

Five Types of Industry 4.0 Players

Five different types of players in the Industry 4.0 ecosystem can be identified:

1. **Technology providers** include startups as well as more advanced companies developing new enabling technologies, such as sensors, machine learning, AR, and others. Generally speaking, these are the most focused companies that address specific problems in order to create value-added solutions.

2. **Platform players** offer products that facilitate communication between digital and physical infrastructures. These platforms span the entire system to collect and analyze data from industrial machines. Developers can create applications for these platforms to analyze the collected data and provide users with actionable insights. Companies in this category include GE, Siemens, SAP etc.

3. **Original Equipment Manufacturers** (OEMs) sell production equipment to the manufacturer of the end product. These players can implement Industry 4.0 in their own manufacturing processes and can also use these technologies to create smart products for their customers. This presents OEMs with a unique opportunity to adopt new business models, giving them the ability to go from being an equipment supplier to an ongoing service provider. For example, SAMSON, a leading German valve provider, made a strategic decision to put a strong focus on Industry 4.0 opportunities and is offering its customers IoT integrated smart control valves. They now offer a full valve performance package which enables possible faults to be detected and removed at an early stage as well as through proactive maintenance management.

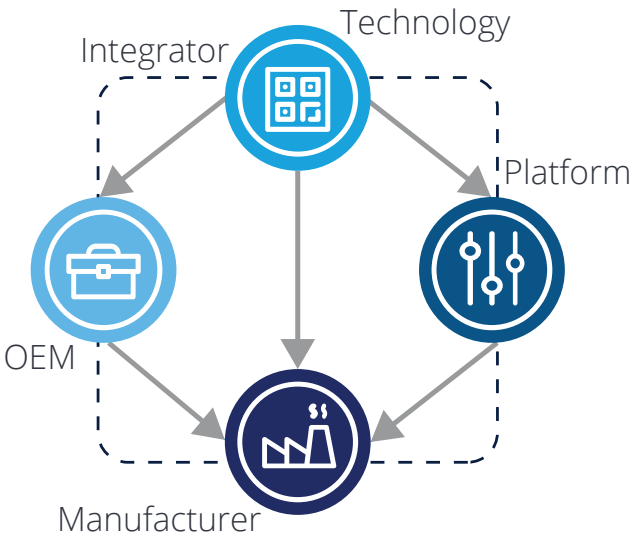
4. **Manufacturers** may have the most complex job. They not only need to anticipate changing consumer needs, but must also simultaneously optimize current production capabilities while seeking new technologies adaptable to future trends.

5. **Integrators** consult the aforementioned actors on how to design, implement and collaborate on development of smart solutions in order to bring the most value. These players are highly familiar with different solutions on the market and industry best practices. Thus, they can help manufacturers embrace, implement, and manage the transformation.

"Major changes are taking place at a high speed and corporations need startups with fresh blood and innovation to adapt. We need to work together to combine our industrial experience with their creativity"

CEO, Samson

Figure 5.1: Five Main Types of Industry 4.0 Players



Collaboration in Action

The need to adopt Industry 4.0 technologies has become ever more necessary to remain competitive in manufacturing. While many companies still have an incomplete understanding of the technologies involved and are unsure of where to begin, those who have recognized the unique opportunities and the advantages of scale have already greatly benefited.

One such example is the wide scale collaboration between BASF, SAP, Pepperl+Fuchs, SAMSON and Endress+Hauser. This partnership includes four of the five different types of players: a chemical manufacturer (BASF), equipment providers, (SAMSON and Edress+Hauser), a sensor technology provider (Pepperl+Fuchs), and a leading platform player (SAP). Together, these companies, each bringing their own unique capabilities, have developed a platform that gathers data on the condition of devices and components involved in the manufacturing process to define required maintenance activities.
While these large scale, multi-player collaborations can create value, other companies are choosing to make more straightforward partnerships with a single provider, whether to solve a specific problem or create long term value.

Enel, an Italian electric and gas provider, has partnered with an Israeli startup, 3DSignals, to predict and fix problems within their plants before they occur. 3DSignals developed a solution that uses sensors to monitor machines for changes in acoustic levels in order to predict anomalies. This collaboration has allowed Enel to fix problems without stopping the entire plant's production and has enabled their technicians to monitor situations remotely via a mobile application. Following a successful test run in its hydroelectric plants in Italy and Spain, Enel plans to roll out this technology to all of their plants.

Collaborations are becoming more and more common as companies are realizing the benefits of a shared pool of complementary knowledge and capabilities. While companies must look at various options for collaboration to successfully compete in today's manufacturing environment, startups in particular, can serve as eager and innovative partners. In order to take advantage of these opportunities, it is crucial for manufacturers to understand the startup landscape within Industry 4.0.

6. Areas of Opportunity for Startups

Startups can be excellent partners for manufacturers when it comes to Industry 4.0 initiatives. In fact, four out of every five corporations interviewed by Deloitte already work with startups in Industry 4.0 and view them as an integral piece to their continued innovation efforts. Aside from access to their unique skills and know-how, collaborating with startups creates value in other various ways. Firstly, the services offered by startups are often significantly cheaper than those offered by more established companies. Startups also offer increased flexibility and customization to manufacturers. Typically, they are much more dedicated and willing to go the extra mile to please their customers. Additionally, startups are often comprised of a multidisciplinary team of entrepreneurs who have both worked on developing the technology and implementing it, making them excellent partners who are able to provide end-to-end solutions. Finally, startups tend to view their customers as long-term partners. Due to this, startups work more closely with them and maintain a long-term commitment to gaining deeper insight and expertise as their technologies develop.

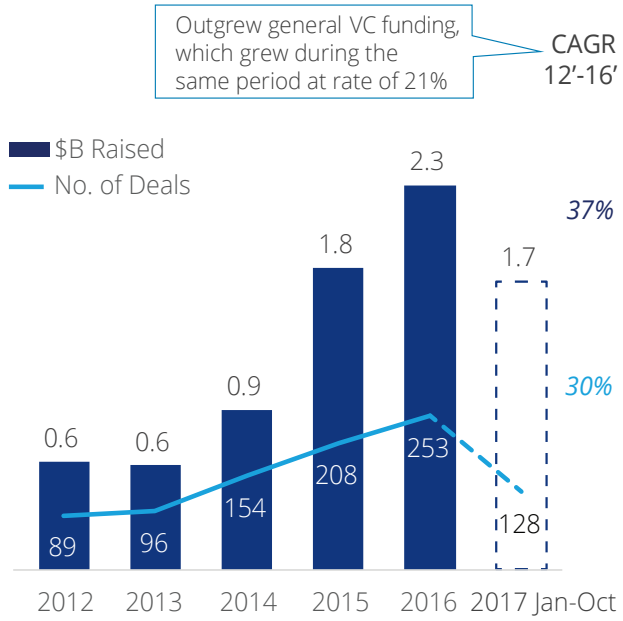
"A platform is built by many small projects. Even with GE's Predix, we still need to turn to 3rd party solutions. Startups are agile, flexible, and will modify customer solutions for free"

Strategic Business Developer, HAM-LET

Global Venture Capital Investments in Industry 4.0 Startups

Recent years have seen tremendous growth in the number of startups active in the Industry 4.0 arena. Innovative technologies are becoming more prevalent and venture capitalists are making even greater investments in them. Venture capital investments in Industry 4.0 focused startups have steadily increased, both in terms of size and number of deals. Globally, venture capital investments in this arena grew from approximately $600 million in 2014 to $2.3 billion in 2016, representing a 40% CAGR.[3] The 40% growth rate was significantly higher than that of the overall venture landscape, which saw a 21% CAGR over the same period.[5] Based on data available through October 2017, $1.7 billion was raised in the first ten months of the year.[3] The fact that leading smart money investors see more potential here signifies the exponential growth opportunity that startups in Industry 4.0 possess and the transformative potential their technologies offer (see Figure 6.1).

Figure 6.1: Industry 4.0 VC Funding



Source: CB Insights, Start-up Nation Finder, Deloitte Databases, TechCrunch, Pitchbook, Crunchbase. Traxcn, Venture Pulse, Deloitte Analysis

Corporate Investments in Industry 4.0

Corporations too are seeking to fully leverage the value created by startups and are investing in them through their corporate venture capital (CVC) arms. In fact, three of the five most active investors in Industry 4.0 startups (in terms of number of deals) from 2012 through 2017 were CVC's – GE Ventures, Intel Capital and Cisco Investments.[6] Between 2014 and 2016, CVCs invested in over 30% of Industry 4.0 startup deals, in contrast to the typical 15% participation rate.[3] Considering that GE is a leader in Industry 4.0 technologies with a multitude of R&D employees and chooses to heavily invest in Industry 4.0 startups, speaks volumes about the value startups bring to the equation (see Figure 6.2).

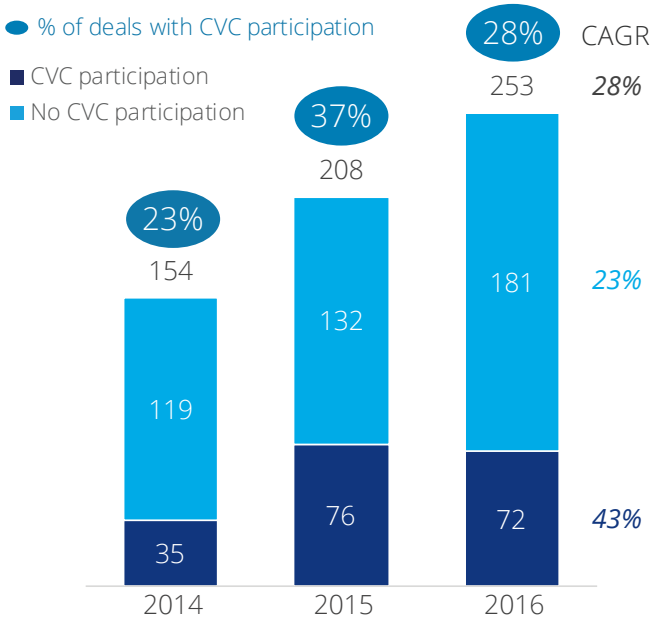
Many corporate players are establishing a presence in advanced startup ecosystems, such as Israel, to more easily identify emerging technologies that can impact their businesses. In early 2017, the Israeli startup Iguazio caught the attention of international giants – Verizon, Bosch, and Dell – who have established a local presence in Israel. These corporations invested in a $33 million round to help Iguazio develop their edge data analytics platform, which they are now integrating into their own systems.

Schneider Electric and Rockwell Automation reacted to an issue they were facing and sought out a startup to improve the security for their portfolio of offerings. Rather than attempting to develop the solution in-house, these companies partnered with Claroty, an Israeli startup

I. The databases these figures are based on often update only several months after funding deals occur. As such, 2017 data is not exhaustive and actual figures are likely higher.

providing cybersecurity solutions for industrial control systems.

Figure 6.2: Private Funding Deals by Type of Fund



Source: CB Insights, Start-up Nation Finder, Deloitte Databases, TechCrunch, Pitchbook, Crunchbase. Traxcn, Venture Pulse, Deloitte Analysis

Main Areas of Investment

Industry 4.0 solutions can be categorized into ten different segments:

Maintenance – Maintenance of production machinery to reduce downtime

Operations Optimization – Utilization of data for improvement of processes

Supply Chain – Improvement of supply chain efficiency or visibility

IoT Platforms and Connectivity – Communication and integration of data

Sensing and Imaging – Devices involved in data collection

Cyber Security – Protection of collected data and connected systems

Robotics – Advanced machinery for complex task automation

Additive Manufacturing – 3D printers and surrounding ecosystem

Safety – Improvement of worker safety

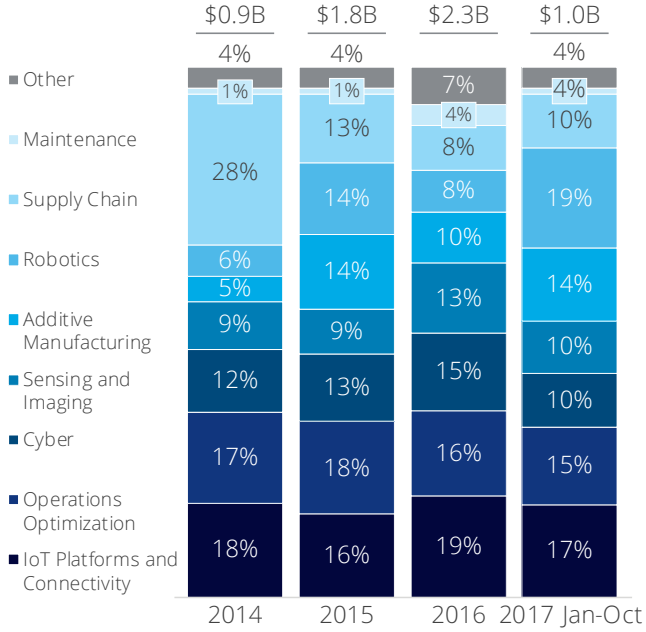
Inspection and Testing – Plant inspection or testing of materials and products

The segments that have most consistently raised the largest amount of VC funding from multiple deals since 2014 are: IoT platforms and connectivity, cybersecurity, sensing and imaging, and operations optimization. These four segments received approximately 60% of the total $6.6 billion raised from VCs, globally in this period[3] (see Figure 6.3).

In the first ten months of 2017, the robotics segment received the highest amount of VC funding globally as two companies, Brain Corp and CloudMind, raised over $100 million dollars each. The additive manufacturing segment also saw a surge due to $160 million raised by Desktop Metal. While the additive manufacturing segment accounted for 10%-14% of VC investments in Industry 4.0 from 2015-2017, two-thirds of these investments were made in only two companies, Carbon 3D and Desktop Metals.

In summary, Industry 4.0 startups represent a growing opportunity, as does Industry 4.0 itself. Private investors, both VCs and corporations, are taking notice and betting heavily on startups, providing good cause for manufacturers to pay close attention to them as well for their own advancement of Industry 4.0.

Figure 6.3: Industry 4.0 VC Funding by Segment



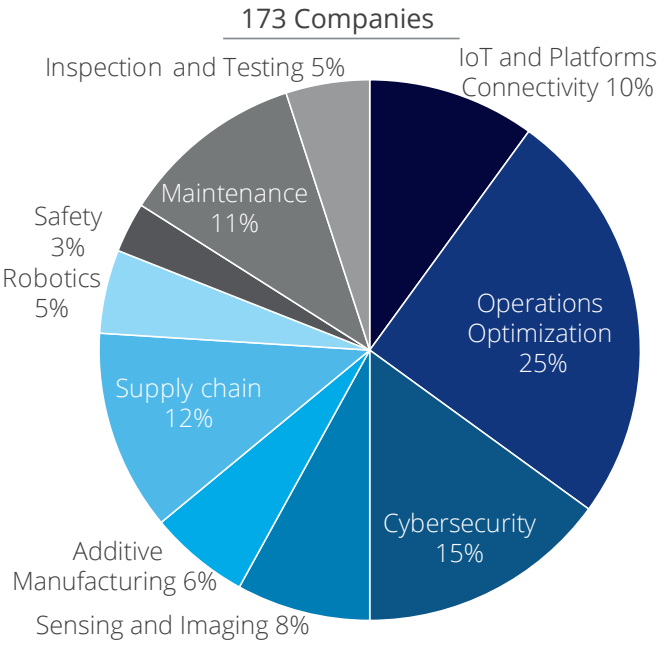
Source: CB Insights, Start-up Nation Finder, Deloitte Databases, TechCrunch, Pitchbook, Crunchbase. Traxcn, Venture Pulse, Deloitte Analysis

7. Mapping the Startup Ecosystem in Israel

Outside of the US, Israel is the largest hub for Industry 4.0 innovation, home to almost 200 companies specifically focused on developing disruptive technologies in the industrial sector.

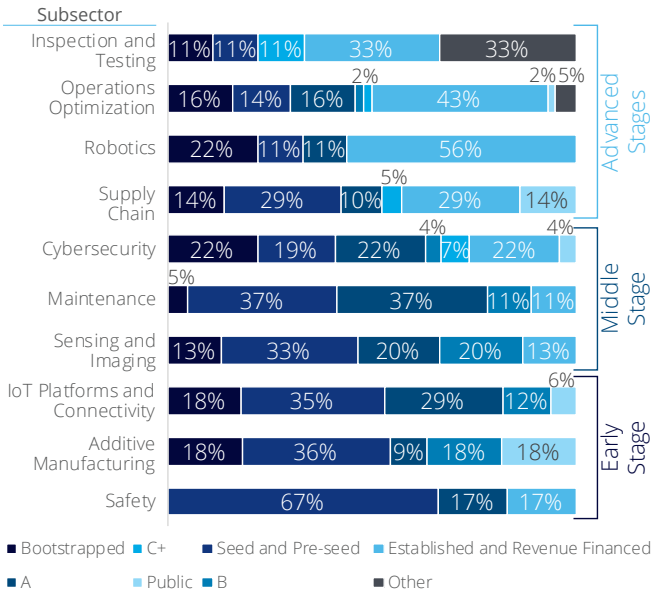
These companies are active across all Industry 4.0 subsegments. Operations optimization is the largest segment, with over 40 companies, followed by cybersecurity and then supply chain. Together, these three segments account for over 50% of all companies in the country producing innovative technologies in Industry 4.0 (See Figure 7.1). These segments are among the most developed in Israel, with many companies in later stages, some of which are already revenue funded (see Figure 7.2).

Figure 7.1: Israel Industry 4.0 Companies by Subsector



Source: Start-Up Nation Finder

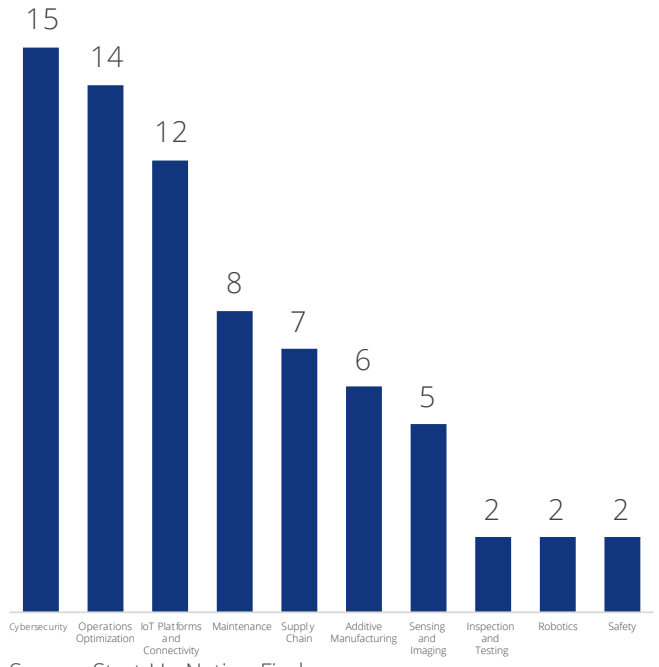
Figure 7.2: Industry 4.0 Segment by Funding Stage



Source: Start-Up Nation Finder

Between 2014 and 2017, 41 out of 73 companies developing Industry 4.0 technologies were established in the fields of cybersecurity, operations optimization, and IoT platforms, accounting for over 50% of total growth (see Figure 7.3). Israeli entrepreneurs are continuing to develop new solutions in the already established cybersecurity and operations optimization segments, and are starting to participate in the large global IoT platforms segment.

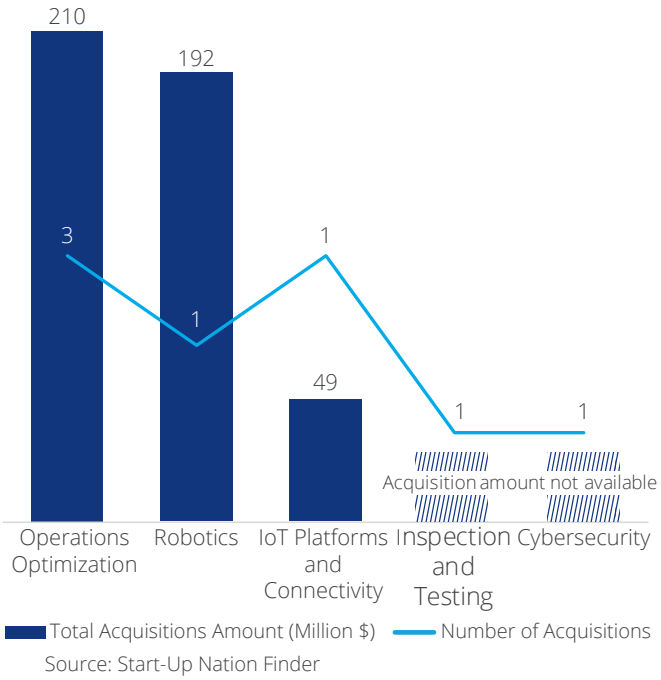
Figure 7.3: Number of Comapnies Founded in Israel, 2014-2017



Source: Start-Up Nation Finder

The Israeli ecosystem has also been a very hot target for acquisitions, with ten M&A's amounting to over $450 million in this time period. Operations optimization, with $210 million in acquisitions, has led the segments in terms of funding, followed by robotics and IoT platforms with $192 million and $49 million in acquisitions, respectively (see Figure 7.4).

Figure 7.4: M&A's of Israeli Industry 4.0 Companies 2014-2017



Source: Start-Up Nation Finder

GE has developed a strong presence in Israel, with several programs in place to interact with the innovation ecosystem. GE Digital, launched a partnership program in Israel focused on software solutions for the industrial space. The program acts to identify promising startups that can be integrated into the company's data platform, Predix, and support them in the onboarding process. In addition, GE Digital's center in Israel is focused on cyber security, software development, and data sciences. Ultimately, this strong presence in Israel has allowed GE to build a unique familiarity with local players as well as identify exciting opportunities ahead of the competition. In 2017 alone, GE made two significant acquisitions of Israeli startups amounting to approximately $65 million.
Siemens also has a wide-ranging presence in Israel, with local operations, an R&D center, as well as local venture funds and direct investments in startups. In 2015, Siemens established a liaison office in Tel-Aviv that specifically focuses on the company's collaboration with startups.

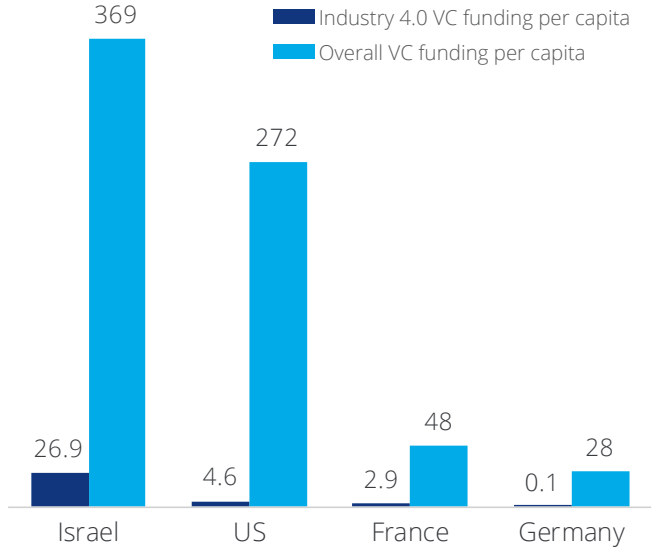
VC Funding in Israeli Industry 4.0 Startups

Israeli startups are world leaders in VC funding in general, and in Industry 4.0 in particular.

- Israel is known to have the highest ratio of VC funding per capita in the world (2% of global VC funding with only 0.1% of the world population (see Figure 7.5).
- During the time period between 2014 and October 2017:[I]
  - Israeli Industry 4.0 startups received a particularly high proportion of VC funding – 8% of the total $7 billion raised globally in this timeframe (see Figure 7.6).
  - Israeli Industry 4.0 startups received the second largest amount of Industry 4.0 VC funding of any country in the world (see Figure 7.7).
  - Ten Industry 4.0 startups in Israel were acquired for over $450 million (see Figure 7.4).
- The proportion of Industry 4.0 investments raised by Israeli startups has grown over the past few years– from 6% of global funds raised in 2014 to 10% in 2016. This trend is expected to continue in 2017.
- In the first ten months of 2017, Israeli Industry 4.0 startups have already received $193 million in VC funding, with over 10% expected growth from 2016.

Figure 7.5: VC Funding Per Capita 2016

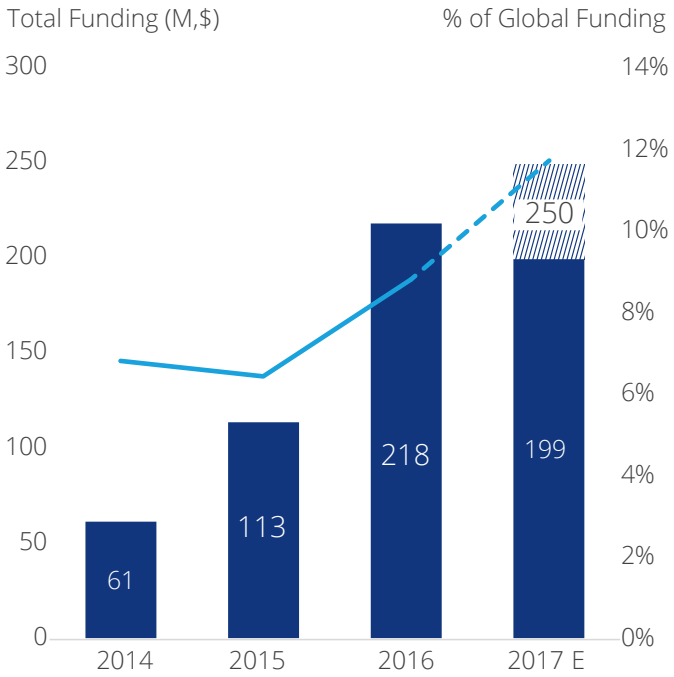
($, per capita)



Source: CB Insights, Start-up Nation Finder, Deloitte Databases, TechCrunch, Pitchbook, Crunchbase. Traxcn, Venture Pulse, Deloitte Analysis

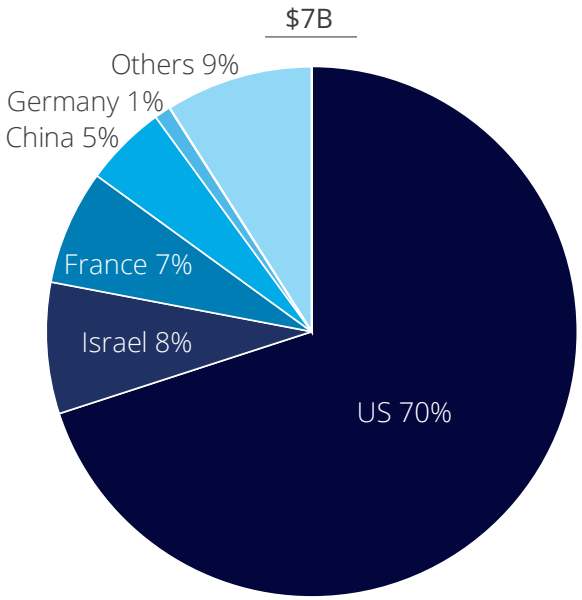
I. The databases these figures are based on often update only several months after funding deals occur. As such, 2017 data is not exhaustive and actual figures are likely higher.

Figue 7.6: VC funding in Israeli Industry 4.0 Startups



Source: CB Insights, Start-up Nation Finder, Deloitte Databases, TechCrunch, Pitchbook, Crunchbase. Traxcn, Venture Pulse, Deloitte Analysis

FIgure 7.7: Industry 4.0 VC Funding Per Country, 2014-2017 YTD[1]



(1) Based on available data as of November 2017, from January through October. May not be completely exhausive

Source: CB Insights, Start-up Nation Finder, Deloitte Databases, TechCrunch, Pitchbook, Crunchbase. Traxcn, Venture Pulse, Deloitte Analysis

Areas of Activity

Industry 4.0 investment activity is concentrated in companies that utilize Israel's traditional strengths — security, sensors, and analytics. Based on Start-Up Nation Finder, an online discovery platform that maps Israel's innovation ecosystem, the three segments that received the largest amount of funding between 2014 and October 2017 were cybersecurity, sensing and imaging, and operations optimization (see Figure 7.8).

Cybersecurity, a known Israeli proficiency, is unsurprisingly an area where Israeli companies are actively developing solutions targeting Industry 4.0. This segment received approximately $140 million of VC funding between 2014 and 2017. Israel's strong positioning in this segment arises from two main factors that work in conjunction.

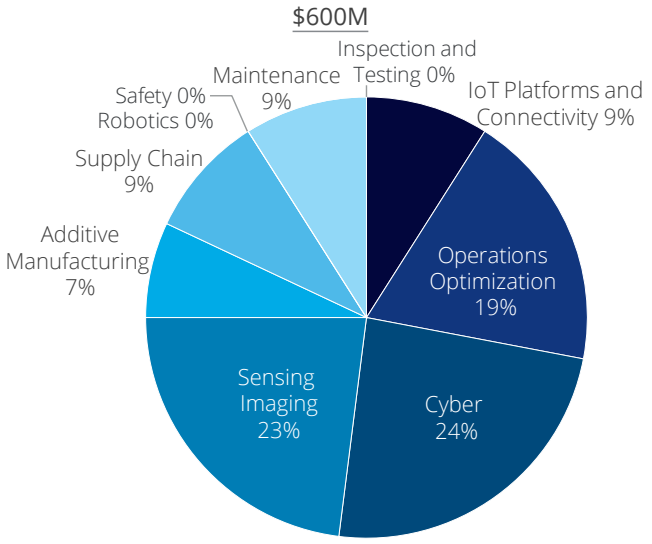
- Military training: In most countries, cybersecurity is handled by a distinct government branch with civilian employees; however, in Israel, the country's cybersecurity operations are housed under the military. Soldiers in cybersecurity units leave the military to enter the workforce at a very young age after receiving several years of training and experience with the most advanced cyber technologies. This provides the Israeli innovation ecosystem with a continuous source of young men and women with unique, applicable, and easily leveraged expertise.
- Well established cybersecurity private sector: Approximately 15% of global research and development spending on cybersecurity technologies is in Israel[8] – a large amount for any country, but especially impressive when considering Israel's small size.

Sensing and imaging is another area where unique Israeli strengths create favorable conditions for startups. Because of Israel's leadership in developing Unmanned Aerial Vehicles (UAVs), which use computer vision and advanced analytics, Israel's startup ecosystem possesses a wealth of talent related to sensing and imaging technologies.

Operations optimization, the third largest segment in terms of Industry 4.0 VC funding, received 19% of Industry 4.0 investments in Israel from 2014 to October 2017. High levels of technical talent and capabilities in sensing and imaging devices converge with analytics to create solutions that increase productivity.

Israeli startups have already begun to provide actionable value in these areas, some of which have resulted in significant acquisitions. For example, in 2017 Midea acquired Servotronix, a company which develops automation solutions focused on motion control, for $170 million. Around the same time, GE acquired Nurego, a cloud based analytics company, to incorporate into their Predix platform.

Figure 7.8: Israel VC Funding 2014-2017 YTD[1]



(1) Based on available data as of November 2017, from January through October. May not be completely exhausive

Source: Start-up Nation Finder

8. The Israeli Value Proposition

Despite Israel's small manufacturing industry, its startups have nonetheless identified a multitude of ways in which they can add value to manufacturers through the application of Industry 4.0 technologies. Our research indicates that Israeli startups have superior, unique capabilities in four of ten Industry 4.0 subsectors. Of these, two subsectors were defined by manufacturers as key areas of current interest and two subsectors were defined as key areas of future interest.

Value of Israeli Startups in the Current Focus Areas of Manufacturers

Both manufacturers and startups alike start by directing their energy towards projects focused on cost reduction with a clear ROI and obvious benefits. These solutions exist within the first horizon of Industry 4.0 implementation. Israel's entrepreneurs have identified two areas within Industry 4.0 in which they can leverage these abilities to reduce costs for manufacturers:

- **Predictive Maintenance** is founded on advanced algorithmic machine learning to produce recommendations for process improvements, often through the use of sensing technologies that collect data in real-time on the condition of machines. As previously discussed, Israel has developed unique capabilities in advanced analytics and cybersecurity, providing the relevant expertise in anomaly detection to develop necessary solutions. These companies sift through enormous data sets to derive insights and their success can be seen by the numbers – from 2014 to 2016, over 30% of global VC funding in predictive maintenance companies went to Israeli startups (see Figure 8.1).

"One of the greatest costs to manufacturers is downtime. With the new capabilities brought by Industry 4.0, reducing downtime is one of the biggest trends"

Director Advanced Technology, Rockwell Automation

- **Operations Optimization:** Over 40 innovative companies in Israel are active in operations optimization, making it the largest Industry 4.0 segment in terms of number of companies. Approximately half are well established and in revenue funded stages, offering proven products to the market.

Mueller Industries, a global manufacturer and distributor of copper, brass, aluminum, and plastic products partnered with Israeli predictive maintenance startup Augury to improve its repair processes. Using Augury's technology, Mueller was able to extend the operational life of machine components, eliminate catastrophic machine failures, and reduce overall labor costs. For example, only a few months after integration, an otherwise unknown, hidden problem was discovered in their high-speed motion operations and repaired with minimal downtime – saving significant costs and resources.
Panoramic Power, an Israeli startup that offers self-powered circuit-level technology with cloud-based analytics, was recently acquired for $60 million by Centrica, a multinational energy and utility provider. Panoramic Power improves operational efficiency by providing real-time visibility to business operations along with actionable insights. They have already been able to decrease energy consumption, reduce operational costs, and increase overall efficiency. Direct Energy president and CEO Badar Khan noted that the partnership has "supported [their] brand promise to help customers buy less of what [they sell]" through more innovative and effective energy solutions.

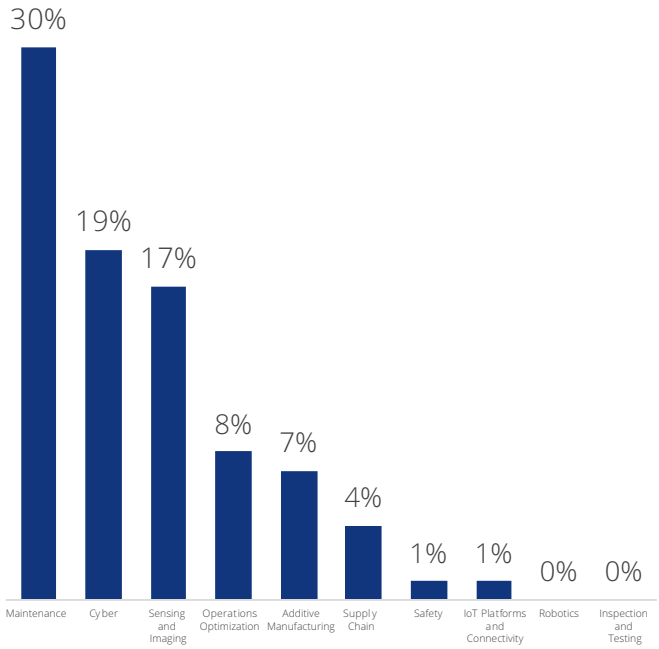
Value of Israeli Startups in the Future Focus Areas of Manufacturers

As manufacturers move into the second horizon of implementation and work to increase connectivity throughout their networks, they have identified the need for more advanced IoT platforms, sensing and imaging, and cybersecurity technologies. Israeli entrepreneurs are anticipating these opportunities and given their inherent capabilities in these areas, have already begun to develop solutions. Investors have recognized this promise as can be seen by the 20% of total global funding directed just to Israeli startups in these segments from 2014 to 2016.

- **Cybersecurity:** Israeli companies have already brought solutions to the market, and there is a wide range of innovative players at all stages of development. From 2014 to 2016, 19% of global VC funding in cybersecurity startups targeting the industrial sector went to Israeli companies.
- **Sensing and Imaging:** From 2014 to 2016, 17% of global VC funding in sensing and imaging went to Israeli startups. Israeli strength in this area is resulting in the development of solutions that will be much needed looking forwards (see Figure 8.1).

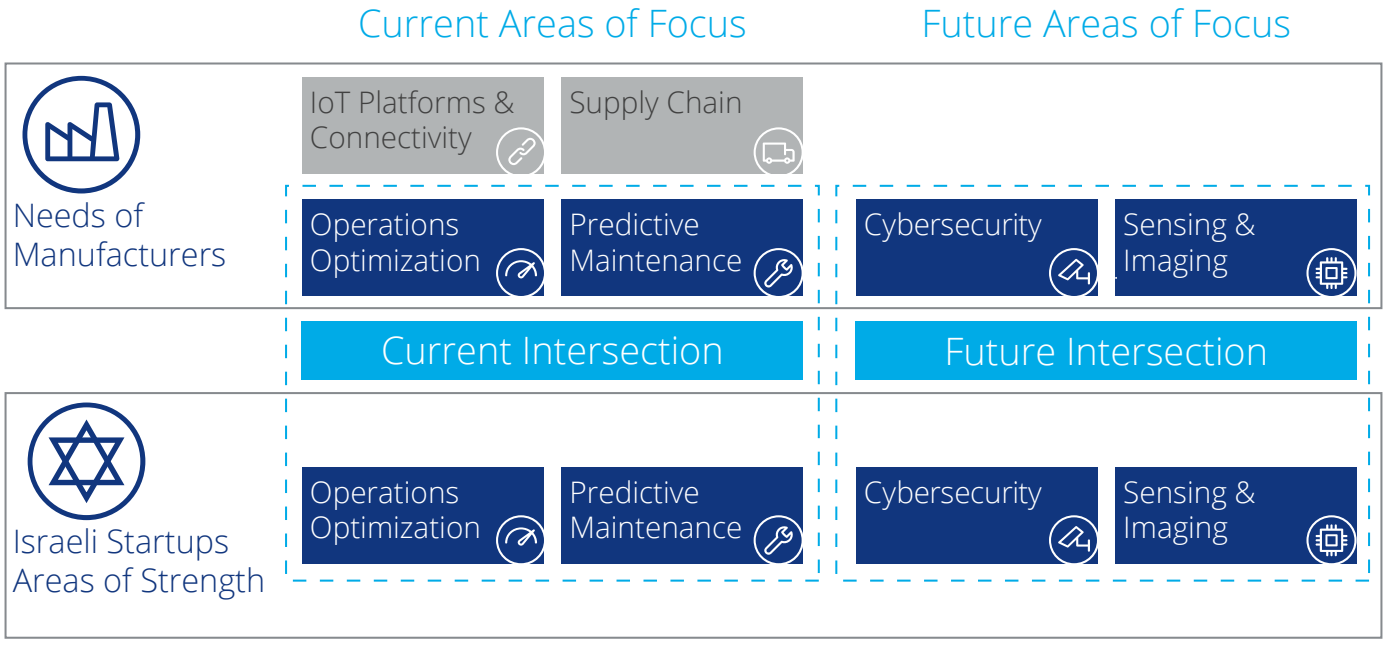
Nextnine, an Israeli startup specializing in cybersecurity solutions, was recently acquired by Honeywell, a company that protects the availability, safety, and reliability of industrial information. Honeywell integrated Nextnine's technology to expand their offerings and make their products even more meaningful for customers. Such benefits from the deal include new features to deploy and operate a single control system as well as simplify and better secure an entire network of manufacturing sites. Consumer Physics, the makers of the SCiO, which is the smallest handheld Near-Infrared (NIR) spectrometer, has partnered with Cargill Animal Nutrition to ensure livestock receive the most consistent diets. The Israeli company has input its sensing and imaging technology to create the Reveal, which will allow farmers to conduct real-time forage analysis to adjust feed programs and better maximize production capabilities. Once in place, the product will cost approximately one penny per cow a day (for most operations), making it the most affordable NIR spectrometer on the market.

Figure 8.1: Israel Share of Global Funding by Segment 2014-2016



Source: CB Insights, Start-up Nation Finder, Deloitte Databases, TechCrunch, Pitchbook, Crunchbase. Traxcn, Venture Pulse, Deloitte Analysis

Figure 8.2: Needs of Manufacturers Meet Israeli Strengths



Summary

The technological advancements brought on by Industry 4.0 have disrupted the ways in which business is conducted like never before. It is therefore imperative that companies, especially manufacturers, actively seek to enhance their systems and products in order to remain competitive. No longer will problems be solved simply by looking inward, but rather by forming partnerships to create new and innovative solutions. In particular, collaborations with startups have excellent potential to add value by implementing their cutting-edge innovations throughout a multitude of points along the value chain.

Throughout this transformative period for industry, close attention must be paid to areas where growth, opportunity, and potential are abundant. In particular, Israel has become a beacon of ingenuity, having fostered a dynamic startup ecosystem over many years. Not only developing new and exciting solutions for current areas of focus in manufacturing, such as predictive maintenance and operations optimization, Israeli startups are also ardently searching for the answers in future areas of concern, such as cybersecurity and sensing and imaging. This has enticed companies from all over the world to create hubs in Israel, as well as to work with Israeli companies in order to leverage the unparalleled innovation occurring here.

While the future of technology brings a great deal of change and uncertainty, it is ultimately in the hands of business leaders to challenge their companies, and in the process move them forward by building new alliances, implementing creative solutions, and harnessing the potential of Industry 4.0.

Endnotes

[1]Deloitte Analysis

[2]Deloitte, The Israeli Technological Eco-system

[3]Deloitte Analysis, Start-up Nation Finder, Deloitte databases, CB Insights, TechCrunch, Pitchbook, Crunchbase, Traxcn, Venture Pulse

[4]Merck Website “Pmatx incubator in Israel.” 2017

[5]KPMG Venture Pulse Q4 2016

[6]CB Insights

[7]Start-up Nation Finder

[8]Bloomberg, Israeli Cybersecurity Industry Grows as Global Threats Multiply

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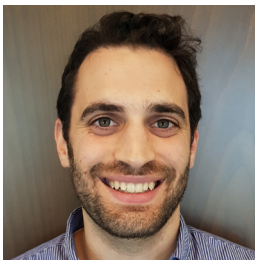

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