



The Disruption of the Infrastructure Industry

5

Coming Changes in Investment Decisions and How to Prepare for Them

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5.1 Small Disruptions, Big Impact

Firms in all industries operate in an increasingly complex ecosystem. As opposed to well delineated and relatively stable sectors, these business environments are more diverse, dynamic and interconnected, and as a result are less predictable than in the past. But many companies still approach strategy with the same methods that they used decades ago, often reacting instead of observing the changing environment of their industry and planning for these changes. An ecosystem may be defined as a complex of living organisms, together with their physical environment, and all their interrelationships in a unit of space. How does this relate to business, or any industry for that matter? Anyone who has worked in a firm, especially in a large multinational corporation, knows that a business environment can feel as complex and interconnected as a natural ecosystem. Industries can also be viewed as complex systems, the behavior of which is intrinsically difficult to model due to the dependencies and competition between different players within them. A major factor in the difficulty of predicting business ecosystems is that they can be described as nonlinear—meaning that they respond in different ways to the same input, depending on the context. Another feature of complex systems is that they have emergent behaviors which result from the relationships that develop over time within a system. Take for example a colony of ants, who each react to a series of stimuli (e.g. chemical scent from larvae, food, other ants, waste, etc.) and act as autonomous units. These properties result in a complex system, an adaptive one as well, where individual and collective behavior eventually self-organize in response to any tiny

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change in events (Holland 2006). An industry as a complex system is already intricate and responsive to internal changes, but imagine the disruptive individual firms that enter from the periphery of an ecosystem, and what a huge effect that they can have. Just think of Uber—a firm that entered the transportation sector with a completely unconventional approach and challenged the current business models, resulting in total disruption and the firm's own great success.

A Harvard Business Review study examined the longevity of more than 30,000 firms in the US over a 50-year span, and found something surprising: public companies have a one in three chance of being delisted in the next 5 years. This is six times the delisting rate of companies 40 years ago. And it seems there is no correlation between size, age, or sector and this shortening lifespan (Reeves et al. 2016).

To survive, firms need to be able to improve their understanding of how their environment is changing. The title of the book written by the Chairman of Nokia, Risto Siilasmaa, indicates that success can be toxic: “Transforming Nokia: The power of paranoid optimism to lead thorough colossal change.” Managers need to hold on to the optimistic belief that things will turn out fine, but at the same time they need to be paranoid enough to avoid being overoptimistic. Tali Sharot suggests that most humans show a bias towards overestimating the likelihood of positive events while underestimating the likelihood of negative ones (Sharot 2011). In other words, we expect changes in the ecosystem to be positive for the performance of our firm—but often, they are not.

5.2 Creating Industry Adaptability

Complex systems do not allow precise predictions of future states, but it is possible to detect patterns and make educated predictions by observing the entire industry ecosystem and tracking the changes. One way to do this is by actively monitoring industry trends, activities, and the success of new or innovative companies that have the potential to disrupt an ecosystem. When firms focus on tracking these alterations, they gain valuable knowledge about how their own business models could be impacted or disrupted. They create industry foresight, or the ability and acceptance of the fact that their industry is not static. They learn to adapt to their complex environment.

The goals of this process are distinct from mere prediction or forecasting. Prediction is a confident statement about the future state of affairs, best confined to systems that can be fully measured or understood. Forecasts, instead, extrapolate from the past into the future by applying “if . . . then” relations (Slaughter, Futures concepts 1993, p. 293). Organizations are therefore likely to predict mechanisms that can be fully measured or understood, such as the production process or the system-breakdown point caused by data overload in a computer network. But what if the system under observation is perceived as complex, non-linear, dynamic and unpredictable? What if no patterns of the observed system can be extrapolated from past to future? What is the goal, if not fairly accurately predicting or forecasting the future?

5.2.1 Experiencing the Future

Firms need to improve their ability to experience emergent futures. The ultimate way to adapt is to create awareness and clarity with regard to the dynamics of an emergent situation (Slaughter 1993, p. 801). Inherent to this view is an open attitude towards the future that we perceive as increasingly important in the light of highly dynamic industry ecosystems as described by Weick:

In a fluid world, wise people know that they don't fully understand what is happening at a given moment, because what is happening is unique to that time. They avoid extreme confidence and extreme caution, knowing that either can destroy what organizations need most in changing times, namely curiosity, openness, and the ability to sense complex problems. . . In this sense, wisdom, understood as simultaneous belief and doubt, improves adaptability (1996, p. 148).

Consequently, the first goal of this adaptability is to increase one's ability to "experience" the future, and to acknowledge one's inability to collect 100% of the relevant information necessary to completely understand an (emergent) situation. If every situation is perceived as emergent, and if any situation can only be filled with meaning after it has occurred, the importance of prediction or forecasting will be much reduced. Prediction and forecasting undervalue the dynamics and the ambiguity inherent in these situations. Some authors in the field of strategic management or organizational behavior argue that it might be problematic to think about the future before it has occurred. Karl Weick (1995) uses the term "Future Perfect Thinking" to describe a different attitude needed to talk about the future. One of the main goals of our process is to develop an awareness of the future by thinking in the "Future Tense" (James 1996; Morrison 1994) and by challenging prevailing mindsets. Firms need to develop the capability to think about the future as history. To what extent is the future inherent and rooted in the present? What experiences do we undergo now that will be intensified and become more relevant in the future? To find important experiences which may seem negligible at the moment, and to live through them or at least seriously consider these scenarios as if they were of utmost importance: the priority goals of becoming an adaptive firm.

5.2.2 Reducing Uncertainty and Ambiguity to Create a Preferred Future

In order for adaptability to provide results, a critical element is the desire to reduce uncertainty and ambiguity. Uncertainty arises from the perceived inaccuracy in "estimates of future consequences conditional on present actions" (March 1994, p. 174). While predicting and forecasting the future are essential to long-term survival, these activities might not be sufficient in themselves, because the future is highly uncertain. In order to cope with uncertainty, a complementary approach to strategy must be adopted. Firms need to develop the capability to shape their

ecosystems and develop processes that make them responsive to unpredictable events.

Ambiguity makes the task of shaping the environment even more difficult. Even if managers can predict with a decent level of certainty that certain events will happen, they still might not be able to understand clearly what these events mean for their business. Ambiguity refers to the confusion created by different interpretations of the same concept at the same time (Weick 1995, p. 91). Hence management teams need to engage in the social construction of what they think is going to happen. In addition, ambiguity may include the ignorance arising from insufficient information, which would call for more careful scanning and discovery.

The point we want to make here is that management teams can collect all possible data about the future development of their business ecosystem, but they still risk getting it all wrong. To increase the probability of survival in today's ecosystems, firms need to create rich experience about future events. The true purpose of developing industry adaptability is to have a role in shaping the futures one prefers, rather than having to simply be ready to accept likely futures created by others. This process emphasizes the possibility of influencing/creating one's own system. Hamel and Prahalad (1994, p. 105) state that: "Although potentially useful, technology forecasting, market research, scenario planning, and competitor analysis won't necessarily yield industry foresight. None of these tools compels senior management to reconcile the corporation and the industries in which it competes."

The objectives of Hamel and Prahalad's concept of industry foresight approximate most closely our perception of the nature of adaptability: to develop a new strategy framework that creates a seemingly unbridgeable gap between ambition and resources, to go beyond imitation, and to draw the future back into the present to generate a sense of urgency. Foresight processes ensue from an attempt to be guided by our own preferences rather than external forces: the idea is to motivate people by promoting a sense of shared expectations. The foresight process involves the entire organization and attempts to create awareness of changes in the system. If there is no consensus about the future role and activities of the company, it may be hard to commit the staff to daily work. Foresight processes may therefore create such a consensus and combine individual and organizational goals. "Experience is not merely a product of past events, or simply a passive record of elapsed time. Experience is the interaction of memory and foresight, of identity and purpose" (Slaughter 1996, p. 156). If the purpose of the company interferes with the individual or organizational identity created in the past, organizational members may have a low motivation to work in this company. This in turn mar the attractiveness of the company as an employer. Hence, to make a company fit for the future, managers need to get the opportunity to experience the future before it arrives.

5.3 Where Is Disruption Coming from, and Why Is it So Difficult for Incumbents to React?

Industry innovation in many sectors has been considered an oxymoron for many years. The infrastructure sector is not generally noted for its willingness or ability to embrace innovation. Francesco Starace, CEO of ENEL, explained this stereotype honestly, “A utility is not the most fertile ground for innovation. For decades the industry has selected people that had a certain mind set for skills of obedience, order, compliance, rather than to change or innovate. Those are the people owning the system—in an environment with a low stress for change.” (Chesbrough 2016, p. 1). But suddenly things have changed, and the environment is no longer low stress, now there is a very high demand for change, and it is clear that more and more often, large and previously stable companies are failing to do so.

As discussed in other chapters of this book, the infrastructure sector is being disrupted by several megatrends. Understanding these trends is the first step in focusing on the changes, challenges, and disruptions that the infrastructure ecosystem will face.

- *Convergence* refers to the merging of distinct technologies or industries into a unified whole as depicted in Fig. 5.1. Michael Porter and James Heppelmann (2014) outlined how the first wave of industry transformation revolutionized the order process and resource planning, resulting in standardized processes across companies. The second wave was triggered by the rise of the internet, which reshaped how firms coordinate and integrate globally. These two points increased

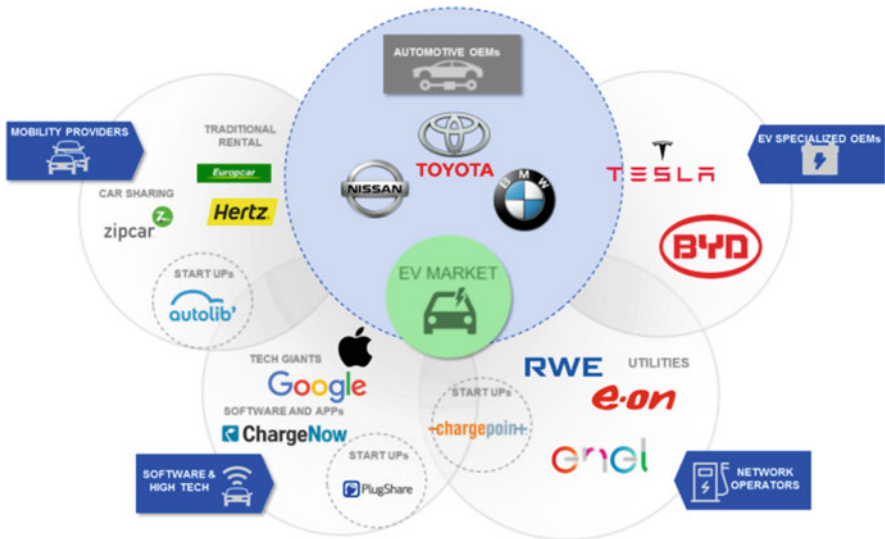


Fig. 5.1 Example of an industry ecosystem—illustrated with the electric vehicle industry

productivity and spurred growth in the economy, but products remained unaffected. The third wave saw the rise of smart products with IT as their integral components. The technological landscape has made the invention of smart products feasible: miniaturization, energy efficiency, low cost processors and data storage, low cost wireless connectivity, rapid software development, big data analytics. All these new technologies are now able to converge to become the product. The impact of all this has already reshaped industry landscapes by making separate industries overlap and enabling players to operate in multiple segments. Consider energy, telecom, and mobility, for example. Traditionally these segments were separate and no one dared to tackle them all at once. Now ENEL has become an industry leader competing in all three, something that would have been impossible even a decade ago.

- *Digitalization and servitization* are the natural consequences of equipping objects with sensors that provide data. The availability of data has increased exponentially, and as a result this has the ability to change the infrastructure landscape. Knowing exactly how, when, and why assets are used can guide intelligent infrastructure planning. Once the right data are compiled, important and potentially cost-saving decisions can be made to manage the overall network. As seen in many industries, business models have begun to shift quickly to adding services to their products. This allows companies to create an additional competitive edge and greater value in an increasingly competitive market. Looking at the market capitalization of these firms, it seems that value has shifted from owning assets to owning transactions. In fact, the top five most valuable firms in the world are all firms that deal in data, not in assets.
- Enhancing the *sustainability* of business operations is increasingly important. Particularly for energy infrastructure, drastic environmental changes (natural resource shortages, such as oil, water, etc.) and political commitments (e.g. EU 2030 targets) will accelerate major changes in the energy system. As discussed already, the lines between infrastructure industries are blurring and these new regulations will begin affecting all facets of the infrastructure world, as discussed by Gatti and Chiarella (2020) in Chap. 6.

These and other megatrends shape the evolution of the business ecosystems. Most firms are aware of these changes, but still are not able to act upon them. The financial services sector may serve as an example. Like large infrastructure companies, banks are not generally noted for their willingness to embrace innovation. The rather conservative financial industry lacks innovative power. Indeed, many of the financial innovations which have characterized the past 40 years were called into a serious question during the 2007–2009 financial crisis. Currently, many banks still offer only online banking, which does not completely fulfill the expectations of customers who want innovative solutions for their personal financial management. There are many reasons for the lack of entrepreneurship:

- Data protection makes Big-Data approaches very difficult to implement for financial services: data protection levels and processes are so high and complex that it becomes difficult to share large amounts of data. Other industries (i.e. internet, telco) are characterized by less constraints.
- Financial services are not customer-centric: a proliferation of requirements and domestic and international regulations call for expert managerial competencies, which have led to a decreased focus on customers. The implementation of these requirements and regulations takes up important resources, both human and monetary, since large investments in IT infrastructure are needed.
- Financial services are risk-averse: The decision-making structure generally avoids risk and does not encourage innovation. Due to a strong risk-averse decision-making structure, banks act very passively with regard to change. Innovations are seen as a risk here, since banks need predictable income and returns on any investment, partially due to the fact that banks have to satisfy their shareholders.
- Financial services are highly regulated: Compliance requirements in the banking sector significantly exceed those in other industries. Hence, understanding the role of regulation is crucial, first because it limits the strategic decisions of the managers and thus their opportunities to innovate. Second, because the strict regulation of the sector has left financial services with a legacy of a conservative culture hostile to change.
- Financial services lack internal technological competencies: Costs and lack of know-how and competencies hinder in-house development. Financial services have not developed technological competencies as a part of their core business, so now other industries have a competitive advantage. Acquiring or internally developing these kinds of competencies could be expensive in terms of time and money.

Infrastructure companies can learn from the financial services sector as there are many similarities between the two industry ecosystems. Who would have thought 10 years ago that banks might be replaced by Facebook or Apple? Many banks attempt to cope with the challenges posed by digital start-ups by adopting what Chesbrough (2003) labeled an “open innovation approach,” i.e. openly collaborating with external partners to favor speed of innovation, instead of trying to retain full ownership of ideas and intellectual property.

Infrastructure firms need to boost their capability to innovate and investors in infrastructure must be able to understand which companies in the infrastructure universe are the most disruptive. Generally speaking, the rather conservative infrastructure industry lacks innovation power. Firms like ENEL have shown how former state-controlled utility firms can become innovation powerhouses. ENEL’s key to success was open innovation.

There are potentially numerous answers to the question of how innovation processes can be organized in infrastructure firms. Only a few companies are able to realize the potential of each new finding internally. Projects may therefore sit on a shelf for years unless an internal champion of the project leaves the company to

develop the idea elsewhere (Chesbrough 2003). Collaborative R&D may be particularly well-suited to the current globalized and interconnected innovation environment. Scholars have identified several advantages for businesses that engage in open innovation (i.e., shorter time to market with fewer costs and risk, more innovations over the long term, increased quality of products and services, exploitation of new market opportunities, greater flexibility). The need for open innovation came about through the failure of financial services firms to successfully bring innovations developed by their in-house R&D facilities to the market. With open innovation, the boundaries between the business and the environment in which it operates have become more permeable; innovations can easily be transferred inwards and outwards.

In particular, we believe investing in start-ups is the most effective way for firms to deal with digitalization and other megatrends. A start-up investment (or the creation of a start-up accelerator) can move faster and more flexibly, and is more cost effective than traditional R&D to help firms respond to changes in technologies and business models. However, the main goal of the investment is not to increase market value but to utilize early strategic investments to expand the infrastructure firm's business model and to secure its long-term competitiveness.

Hence, infrastructure investment firms could and should do more than just monitor start-ups and analyze how they could impact the business model of firms they have invested in. In our view, these investment firms should investigate the opportunity of setting up an investment accelerator to identify, track, and potentially invest in disruptive companies. This would allow infrastructure investment firms to: (1) protect their core investments; (2) use their core investments to accelerate the business of start-ups; and (3) increase the profitability of their investments within an acceptable risk level. The development of an investment accelerator will be discussed in our closing section. Next, we focus on the potential benefits of investing in disruptive start-ups.

5.4 Benefits of Investing in Disruption

5.4.1 Protecting Core Investments

The market segments where many infrastructure firms invest are admittedly more stable than many other industries. However, as we have discussed those segments are still subject to substantial change. Firms do keep this in mind and carefully develop their investment criteria to select the safest harbors in the infrastructure industry. Yet they still have a lot to lose if there is no action or evolution to confront these trends, especially because the investment horizon of most infrastructure investment firms is 5 years. This means we need to look at an investment horizon of 10 years, as assets are usually sold to other investors with a 5-year investment

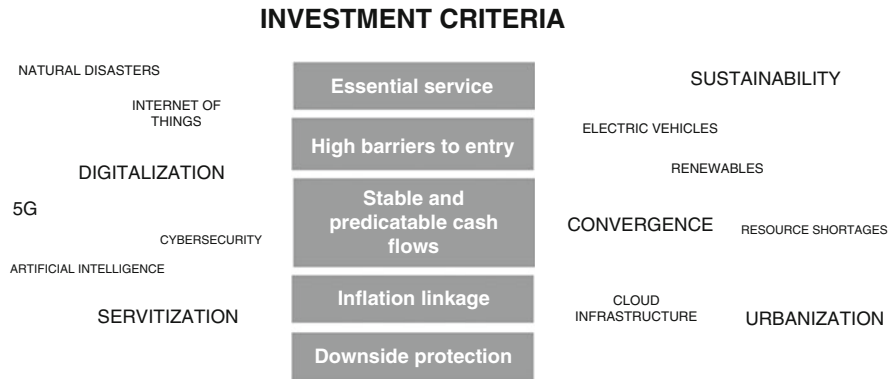


Fig. 5.2 Examples of investment criteria and potential trends that could challenge them

horizon. And with the evolution of the infrastructure ecosystem rapidly changing, firms need to be more prepared to make quick decisions (Fig. 5.2).

Consider solar farms. Renewable energy is becoming increasingly vital, as discussed by Di Castelnuovo and Biancardi (2020) in Chap. 2, and infrastructure firms are wisely investing. It is well known that the cost of solar panel installation has decreased exponentially, and at the same time, technological milestones are being achieved more and more rapidly. Harvesting solar energy doesn't have to mean using huge solar panels anymore, thanks to innovations in solar thin film technology. These solar films can be 'printed' in rolls, which greatly reduces both the cost and the installation, as well as opening up more opportunities for placement of these solar power producers. This new technology allows for the integration of solar panels directly into roofing material, at nearly the same power generation capability of standard solar panels.

How will this impact the future of solar farms? Is it feasible for individual homes to gradually begin switching to solar roofs to supply their own energy? Research shows an incredible trend where this is entirely possible. It is not so distant a possibility that entire buildings could become their own power generators, utilizing solar roofs, solar windows, and other renewable energy sources. These disruptive technologies have the capability not just to disrupt the solar farm industry, but the entire energy industry.

In the United States the total nationwide technical potential of photovoltaic energy across all buildings is 1118 GW of installed capacity and 1432 TWh of annual energy generation, which equates to 39% of total national electric sales. This is significantly greater than previous estimations of 664 GW of installed capacity and 800 TWh of annual energy generation. The state of California has the greatest potential to implement solar power for use on rooftops, and in total potential could generate 74% of the state's total electricity sold by utilities in 2013. A cluster of New England states could generate more than 45% of their needed electricity, despite these states' below-average solar resource. Washington, with the lowest population-

weighted solar resources in the continental United States, could still generate 27%. (Gagnon 2016). All these numbers assume full acceptance and implementation of rooftop solar panels but regardless it is clear that household energy generation is a huge market that cannot be ignored.

The first big player in the rooftop solar world was Tesla with the unveiling of their Solar Roof tile prototypes in 2016. Two years later, Tesla is struggling to meet demand in California. Meanwhile, Tesla, who itself is a disruptor in the industry, has already been disrupted in less than a year. Lost in the information tsunami surrounding Tesla's solar roof announcement was a competing solar roof technology launched by the Palo Alto, California based startup, Forward Labs. Its solar roof offering costs about one-third less than Tesla's and the company claims it can be installed in half the time, with a more minimal appearance that mimics a metal roof. And already there are players disrupting the (already disrupted) solar roofing industry, such as Polysolar and Solar Window, who have developed solar windows offering increasing efficiency every year. In university labs, research has produced solar panels that have doubled in efficiency from 20% to over 40% in just 2 years.

All these technological developments are happening at a completely different pace than the traditional energy industry- and have the power to affect how renewable energy develops in the coming years. By tracking these innovations and identifying firms who are commercializing disruptive technologies and business models, infrastructure firms will be able to adjust their understanding of segments that until now have all been relatively stable.

5.4.2 Use Core Investments to Accelerate the Business of Start-Ups

The accelerator can not only serve to protect core investment, but also to help those investments to thrive and grow in value. As discussed, the value system of the infrastructure (and most industries) has begun to shift, and most high-value activities generally involve a great deal of digitalization. Infrastructure investment firms have considerable market power in many areas, and by identifying and investing in relevant disruptors, they could greatly complement their investments with high value players. Furthermore, the scale of infrastructure investment firms can help start-ups commercialize their offer more quickly and create market champions.

For example, the transportation sector will see great changes in the coming years, as discussed by Baccelli in Chap. 3. Electric vehicles and autonomous vehicles will significantly shape the traffic of roads and cities. Certain elements of our current transportation world will always remain, such as roadside rest stops, but they will certainly be impacted by the new realities of transportation. For example, service stations along highways, like Roadchef in the UK and Autogrill in Italy, will see their business transformed by many technologies. Increasingly, cars will rely less on traditional fuel and begin switching over to electric batteries. Charging systems or battery swapping stations will have to be installed in order to serve this new market.

Service stations could substantially boost the business of companies such as Ubitricity, an electric vehicle charging company that develops low-cost mobile electric charging systems by integrating them into existing energy infrastructure such as lamp posts.

Another example is virtual reality, a key technology that will transform many sectors, for example social infrastructure. Special needs homes, assisted living homes [see Gatti and Chiarella (2020) in Chap. 6], and various educational segments can benefit greatly and boost their competitive advantage through adopting new technologies. In addition, virtual reality has proven to have great potential in the education sector, especially to complement special needs learning. (Jefferies 2009) Though not a critical infrastructure segment, digital services such as virtual reality or augmented reality could become essential in the offer of many infrastructure investments, and infrastructure firms can selectively find disruptors in these fields that complement their current investments.

5.4.3 Increase the Profitability of Investments with an Acceptable Risk

The above examples show that there can be strong ties between infrastructure disruptors and the core investments of infrastructure investment firms. So the clear question now is how to engage with those disruptors. Simply monitoring them and developing contractual agreements where it makes sense is clearly an option. Another strategy is to create a low risk infrastructure technology fund of less than 20 million. Based on their infrastructure radar, infrastructure investment firms could acquire minority stakes in companies that have the potential to either enhance or disrupt their core investments. In a period of 6 to 9 months, these investments have the chance to prove their value in relation to the core investments, either by demonstrating they can help protect the core business, or they can accelerate those start-ups to complement the core businesses of the investment firm. If the links between the core business and the start-up in question are not strong enough, the investment firm has the possibility to divest. Such a fund clearly has a higher risk profile, but also a better chance to yield higher returns.

Many infrastructure investment firms have the industry expertise which is necessary to adapt to shifting ecosystems. But clearly this cannot be done at the expense of the success of their current business. Adapting does not mean a drastic change, but instead being able to embrace trends without necessarily changing core investment strategies. Creating a separate investment unit like an investment accelerator would allow a firm to develop expertise in the industry, form partnerships with disruptors and other key players, externalize uncertainty, and to gain the flexibility to react quickly to disruption.

5.5 The Infrastructure Radar: How to Create a Disruption Map

An innovation radar is a theoretical framework that firms may use to (a) scan the market, and (b) select relevant start-ups in which to invest.

Screening

Screening involves scanning and coming up with a pre-selection of promising start-ups to support and in which to potentially invest. It can be organized as follows:

- Analysis of relevant markets. This is the first step, and includes both domestic and international markets. It implies active monitoring of relevant areas (universities, crowd-investment platforms, start-up centers).
- Platform creation. A passive search could be implemented by creating a development platform for capital-seeking companies. Start-ups could apply for investments or grants through an online platform.
- Identification and selection of different fields of innovation. Firms can scan and identify which field of innovation is most suitable for their purposes.
- Identification and selection of assessment criteria. These may include soft factors such as the degree of innovation as well as the magnitude of the potential threats posed by the innovation (Fig. 5.3).

To structure their screening efforts, firms have many analytical tools at their disposal:

Ecosystem analysis: To understand how disruptions will take place it is necessary to establish an ecosystem perspective in order to recognize how technologies and business models combine, and how the profit pools are distributed within the ecosystem. This approach will pinpoint those players who have the potential to influence the dynamics of the industry, directly or indirectly, or even coming from different sectors. The result: identification of the disruptors.

Once the disruptors are identified, they can be more thoroughly investigated and mapped in relation to each other and the respective business ecosystems they could impact (Fig. 5.4).

Competitor intelligence: Promising start-ups can be evaluated and selected according to some specified criteria (see an example in [Appendix 1](#)). The result of this step is an investment decision. Firms should consider hard factors such as

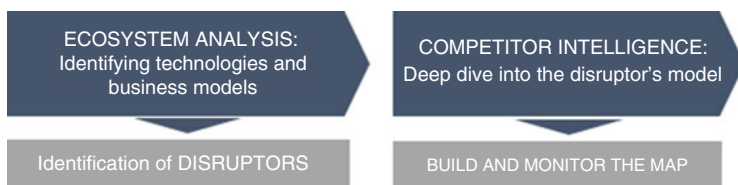


Fig. 5.3 Methodology for mapping disruption

Step 2: Competitor Intelligence

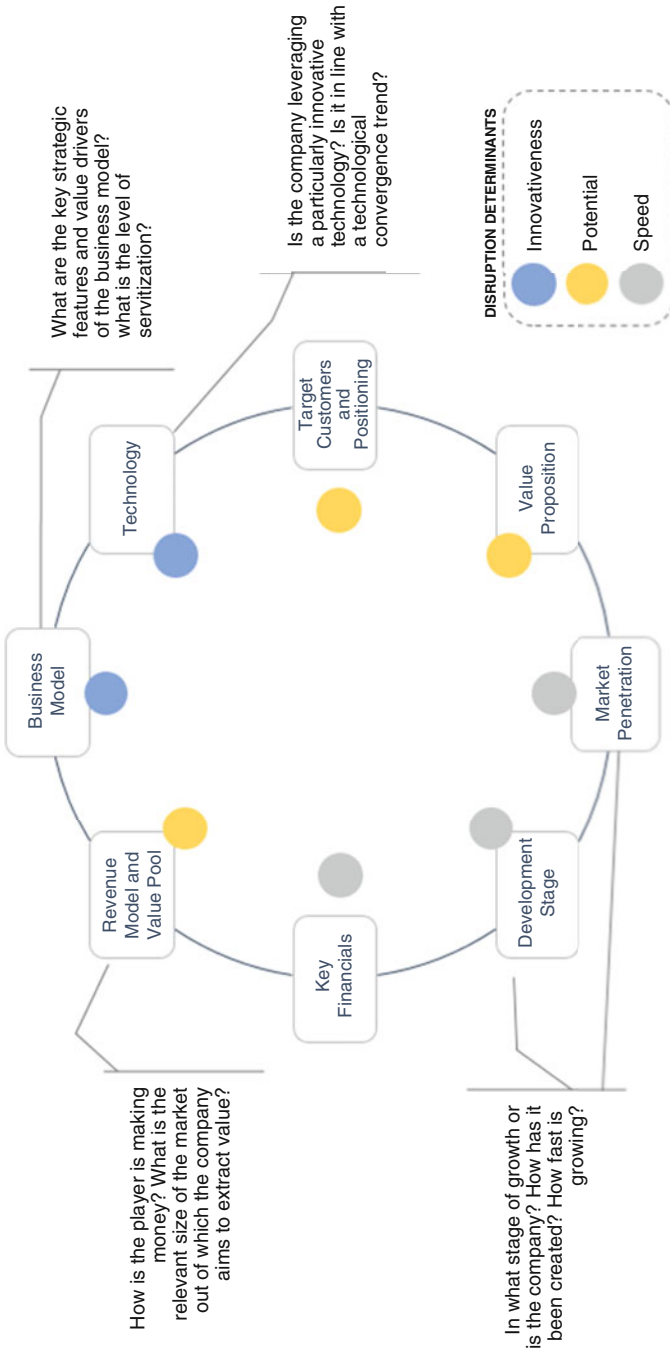


Fig. 5.4 Qualities of a firm to evaluate during competitor intelligence

plausibility checks of the business plan or the adherence to key performance indicators, along with strategic criteria such as potential threats, as well as market and development predictions for the start-up. The following questions may be used to guide the evaluation process:

- Will the firm generate competitive advantages through the investment?
- Is an integration into existing investments possible?
- How will the investment affect long-term revenues?
- What influence does the innovation have on existing business fields within the firm?

5.6 Learning from Disruptors: Alternative Investment Strategies

We have described the tools required to learn about industry ecosystems and to discover new opportunities by identifying infrastructure trends and developments in this industry, by active monitoring relevant markets, and by recognizing potential industry disruptors. We argue that infrastructure investment funds should invest in creating an infrastructure radar to understand where the next disruption is likely to come from. By discussing these insights with the management teams in charge of running infrastructure firms, investment funds can substantially contribute to preparing contingency plans and protecting investments. But are contingency plans enough?

5.6.1 Creating Industry Adaptability Through an Innovation Accelerator

As discussed, an innovation accelerator is a practical tool that firms can use to assist and finance start-ups, obtaining the biggest returns and moving faster to embrace megatrends such as digitalization. There are different options for financing the selected start-ups. The investment can be made by establishing a traditional venture capital firm, or by creating an incubator or an accelerator. However, since the goal of the investment is to secure and develop the firm's own business, the creation of a classic venture capital firm is unsuitable for this purpose. (From now we will refer to this type of venture capital firm as an 'incubator'.) We propose the creation of an investment 'accelerator' as the most suitable solution for infrastructure investment firms to follow through with data collected on disruptors and to implement some degree of adaptability into their investments. The substantial difference between an incubator and an accelerator is the business stage of the company. Incubators focus on the so-called seed-phase, which involves coming up with an idea for a product or a service. The business plan is not yet in place, and the company still does not exist.

Consequently, this means that the duration of the project is significantly longer and more extensive compared to an accelerator. Additionally, external competencies, especially in the area of IT, have to be brought in to evaluate the feasibility of the project.

In contrast, the investment focus of the accelerator is on the start-up or the expansion phase, which means that market maturity has already been reached. The accelerator supports companies only for a few months during the realization of their business ideas. In this case, the type of support can be versatile and would depend on the focus of the accelerator. To get an overview of the diversity of accelerator models, we briefly describe three of them in [Appendix 2](#).

5.7 Implications for Infrastructure Investment Firms

An accelerator is a practical tool that infrastructure investment firms can use to assist and finance start-ups, to obtain the biggest returns and to move faster towards digitalization and other industry trends. Accelerators help ventures define and build their initial products, identify promising customer segments and secure capital and human resources. More specifically, accelerator programs are limited in duration (lasting approximately 3 months), and assist cohorts of ventures with the new venture process.

Now is the time for infrastructure investment firms to use and adapt their investment and management capabilities to finance smaller industry disrupters. It is not too late for traditional infrastructure firms to escape the innovation trap and to face their digital competitors. It is crucial, however, that they take a systematic approach to innovation. In this chapter, we highlighted the need for infrastructure firms to address barriers to innovation in the face of the major trends that are shaping the industry ecosystem. To do so, we suggested that these firms create an innovation radar to be used by an investment accelerator. By doing so, infrastructure firms will be able to protect their core investments, use these investments to accelerate the business of start-ups, and increase the profitability of their investments within an acceptable level of risk.

Appendix 1. Sample of Basic Screening of a Selection of Potential Disruptors Within the Port, Road, Solar, and Rail Ecosystems

Example disruptor identification and intelligence

Company	Brief Description	Problem to be solved	Key people	Investors	Funding Notes
VesselBot	Vessel owners and cargo charterers rely on brokers to match goods with ships. VesselBot uses algorithms to match particular less than half of the 2.5% fee charged by brokers.	The world's 24000 cargo ships often travel empty in one direction.	<ul style="list-style-type: none"> Constantine Komodros (Co-founder/CEO) Anastasia Panagiotopoulou (co-founder/CMO) 	<ul style="list-style-type: none"> PortXL (accelerator) Egg-THI Excellence Award Pitching Competition 	<p>Similar start-up Shipmax raised \$2.5M. Planned full N/A launch by the end of 2016 and to reach breakeven by 2018.</p>
StaffAI	UCIS: Universal twist-lock mechanism that is compatible with current mechanism and can still be used during integration period.	Container industry needs a standard, safe and automated system for securing containers to one another. UCIS can provide estimated savings of USD 2k per upgraded well.	<ul style="list-style-type: none"> Norman Kaiser (co-founder) Peter Walker (co-founder) 	<ul style="list-style-type: none"> Poul Jansen Mare Straelmanns PortXL (accelerator) 	N/A N/A
NYSHEX	Ocean shipping through digital contracting. SaaS created to increase reliability in the shipping industry.	Currently, process of contracting includes face-to-face negotiations between multiple parties and is resource-intensive.	<ul style="list-style-type: none"> Gordon Trouncer Downes (Founder and CEO) Math Bornstein (Board observer) 	<ul style="list-style-type: none"> Goldman Sachs GE Ventures 	\$13,000,000 N/A
Parlofon	Device for park-and-pay to be integrated in tolls, meters and gates)	Due to outdated paying system, Americans yearly overpay USD 20 billion for parking time they don't use.	<ul style="list-style-type: none"> Evgeny Kochikhin (Co-founder and CEO) Vladimir Kochikhin (Co-founder and chief engineer) 	<ul style="list-style-type: none"> Conscious Venture Lab (accelerator/incubator) 	Product is market ready and has been tested - N/A company interested in raising funds from accredited investors.
Alchera Technologies	Machine learning software that provides data for safer, cleaner and less congested cities	Cities have become congested, polluted and inefficient "beings" due to poor planning of infrastructure & mobility systems.	<ul style="list-style-type: none"> Emil Hewage (Founder and director) 	<ul style="list-style-type: none"> Cisco (incubator) Nitrous London (incubator/accelerator) 	N/A N/A
Arivo	High-speed super urban network	2D structure of traffic which leads to congestion, pollution and negative economic spillovers.	<ul style="list-style-type: none"> Brogan BranBrogan (Co-founder and CEO) 6 other co-founders 	<ul style="list-style-type: none"> Plug and Play Ventures Trucks VC 	<p>Comptelior Hyperloop Transportation technologies and Virgin Hyperloop One raised USD 69M and 300M, respectively.</p>



Example disruptor identification and intelligence

Company	Brief Description	Problem to be solved	Key people	Investors	Funding Notes	
Oxford PV	Perovskite-silicon solar cells	Breaking the theoretical efficiency limit of silicon solar cells using perovskite thin-film solar cells.	<ul style="list-style-type: none"> Frank P. Auerling (CEO) Prof. Henry Smith (co-founder and Chief Scientific Officer) Michael Rowley (CFO) 	<ul style="list-style-type: none"> Legal & General Capital Equinox Paradek Advisors Ltd. Nill Longtail Venture Partners 	Oxford PV announced in December it has been granted €15M from the European Investment Bank (EIB). \$39,700,000	
Aquion Energy	Safe and sustainable saltwater batteries	Batteries made from abundant, safe materials that remove the hazards of lithium batteries	<ul style="list-style-type: none"> Scott A. Peckson (CEO & Board of Directors) John Connolly (CFO) Prof. Jay Whitacre (co-founder & CTO) Ted Wiley (Co-founder & VP of product & Corporate Strategy) 	<ul style="list-style-type: none"> Foundation Capital (lead) DNS Capital (lead) Bill Gates Total Energy Ventures Shell Technology Ventures 12 others 	"Emergent" from Chapter 11 bankruptcy in July 2017. Company is now regrouping, rehiring and reshaping sales and supply chain. CEO's LinkedIn page says he is not the CEO anymore.	
1366 Technologies	New standard in water manufacturing	Silicon water is the most expensive part of the solar manufacturing process. 40% of the total price. 1366's technology cuts the cost of producing the water by more than half.	<ul style="list-style-type: none"> WACKER Chemie Helm Capital Rabot Partners North Bridge Venture Partners & Growth Equity US Department of Energy 	\$96,500,000	Japan's IHI Corporation has announced it will feature more than 120 thousand Direct Water® products in one of its 500kW solar installations.	
Hedgehog Applications	Regenerative braking systems for metros, trams and trolleys	Recharging batteries with energy that was previously wasted while still braking the train.	Ajan Heinen (Founder)	N/A	N/A	
Cy/us	Rail Cyber-security	Provide cybersecurity to a system of increasingly automated railways	<ul style="list-style-type: none"> Amir Levinthal (CEO) Boaz Zafir (President) 	<ul style="list-style-type: none"> Zohar Zisapel Magma Venture Partners Vertex Ventures Israel SBI Group 	€4,700,000	N/A
GreenRail	Energy generating ecological sleepers	Sleepers made out of recycled materials with integrated solar panels used to power analytics and sensors providing diagnosis of the railroad line.	<ul style="list-style-type: none"> Giovanni Maria De Lisi (CEO) Fras Bunni (COO) 	SME Instrument	€2,200,000	In January 2018 GreenRail signed its first contract with the Italian railway operator Ferrovie dello Stato Italiane for a €7.5 million contract with an American company.
Kinergator	Asset monitoring through sensors powered by motion energy harvesters	Reducing costs of maintaining power lines by using motion energy harvesters to power sensors used in the IoT. Company plans to achieve its goals by creating systems which are self-sufficient energetically.	<ul style="list-style-type: none"> Oleg Guzy (CEO) Nima Tabou (CTO) 	N/A	N/A	Recently attempted to raise €1.8M through Access to Capital in The Hague



Appendix 2. Benchmark Innovation Accelerator Models

ENEL

ENEL was organized as a collection of quasi-independent companies until 2014. Each country's operations were led by a country manager, who had full P&L responsibility for operations in that country, covering the whole value chain from generation to distribution to sales and services to customers. The company had different lines of business along geographies and products, with a culture that was very hierarchical and structured in organizational silos, each relying on their own individual knowledge. In fact, innovation activities of the company followed the organizational silos approach. To manage the transformation of the company's innovation process, new CEO Francesco Starace recruited Ernesto Ciorra, who worked on projects at ENEL previously as a consultant and knew the company from the outside. He soon realized, though, that transformation would need to reverberate throughout the organization and would require significant time and CEO support. Ciorra became the Head of the newly-created Innovation and Sustainability Department reporting directly to the CEO, to concentrate innovation efforts and strategy, and to overcome the issue of organizational silos. All innovation functions in the company's business lines and countries were now grouped together into a central innovation hub, which reported directly to the CEO of ENEL. This structure was supported by new tools that allowed innovations to be more widely known throughout the company and be more closely connected to the businesses. As each project was initially established, it would be evaluated for its innovative potential. Initially, funds to support the project would be kept small, to keep them agile. But as progress was made, if it was substantial more money would be provided.

Clearly, ENEL's current strategy is driven by an innovation perspective that aims at looking beyond the traditional electricity sector. The company has developed an approach based on a framework that spots innovative projects coming from the external environment that could be new for ENEL or for the entire industry, combining both technology and business model innovativeness. The final aim was to detect interesting opportunities in adjacent markets to build on leveraging the company's strategic assets and capabilities. The combination of technology innovativeness, business model innovativeness and asset fit made business intelligence possible that could overcome the industry myopia. What is more, a new unbiased lens gave a measurement of the risk and uncertainty and the potentially disrupting effects associated with each innovative initiative.

RWE

In 2014 RWE created a centralized task force called the "Innovation Hub" with the aim of developing new business models and scouting outside technologies to contribute to RWE turnover over the next 10 years. The main difference with standard RWE innovation is the unprecedented focus on the customer, the search

for new business models rather than simply technologies, and a conscious effort to look beyond the energy sector. The Hub is led by InkenBraunschmidt, in RWE since 2004, with extensive experience in reorganization, restructuring, mergers and acquisitions, and business transformation. The organization of the Hub centers on the collection of small teams emulating start-up environments. It does not have an organizational chart. Instead the hub is considered a network organization, with people from inside and outside the company, and from different countries, working on proof-of-concept in small start-up teams.

The Hub also makes an effort to scout ideas and set up partnerships. A “small, hand-picked” team had been dedicated to drive forward a change across European markets and to identify new partners, technologies and solutions so that RWE could come up with an initial business model for its markets in Europe. Teams also moved in Berlin and Israel. In Berlin, they demonstrated via the ‘Accelerator Programme’ that concepts can be brought to market quickly and successfully in such a dynamic market environment. In just 2 weeks, a team from the RWE Innovation Hub and several young entrepreneurs developed and tested a concept for a social network to help senior citizens to live independently. Recently, following the reorganization in 2016, RWE decided to move the Hub inside Innogy, a wholly-owned subsidiary with the core business of developing the digital energy market. In this contest, the Hub started to manage the Innogy’s venture capital fund, with 130 million in start-up funding, and continued in the development of a network of partnerships with start-ups to get promising ideas and projects onto the market as quickly as possible. To do so they created the “Innogy Generator Programme”, providing consulting and support to start-ups. The programme offers the partnership, coaching and infrastructure to help start-ups become high performance, high-growth businesses.

Fintech Europe

A new approach in the financial sector is to combine forces and use this combined expertise and market power to approach the need for innovation. For example, Aareal Bank, BNP Paribas, Deutsche Bank, DZ Bank and NETS Group have joined with Silicon Valley-based innovation platform “Plug and Play” to create a hub for financial tech, or fintech, in Frankfurt, Germany. The hub, called Fintech Europe, aims to provide the infrastructure and support for start-ups to work with and present their products to Europe’s leading banks. Naturally the selected start-ups will benefit greatly, but advantages for the banks will be significant as well. Funding and working closely with disruptive start-ups will strengthen the banks, allowing them to understand the rapid digital changes in the financial world, to develop expertise in evolving technologies, and to quickly adapt (and possibly even lead) the disruption in their industry.

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