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Circularity and business ecosystems

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Agile co-creation processes for digitalization

— How principles of joint engagement and a micro-service approach addresses the digitalization paradox

Pathway to digital process innovation

— How dynamic capabilities can help process industries

Innovation i elsystemet

— Fast i det gamla eller tid att tänka nytt?

FORSKNINGSINFORMATION FRÅN STIFTELSEN IMIT – INSTITUTE FOR MANAGEMENT OF INNOVATION AND TECHNOLOGY

Digitalisering & affärsmodeller

Av Martin Sköld

Under året har Stiftelsen IMIT initierat ett flertal forskningsprojekt bl a på digitalisering, AI, affärsmodeller och ecosystem. Ofta ihop med företag och i form av företagsfinansierade doktorander som intresserats för: (1) Nya affärsmodeller - i form av vad som krävs för att erbjuda varor och tjänster med nytt digitalt innehåll och hur verksamheten tjänar pengar på digitalisering. (2) Ledning och strategi - hur företag driver den mycket mångfacetterade förändringsprocess och kompetensutveckling som behövs för en digital omvandling. (3) Företagets förändrade relationer med omvärlden – t ex leverantörer, kunder och samarbetspartners om hur data får och kan användas och delas. Forskarskolan utvecklas kontinuerligt och nya antagningar planeras för det kommande året. Du är välkommen att ta kontakt med mig om detta låter intressant för dig och din verksamhet.

Årets sista nummer av tidskriften bjuder på fyra artiklar som på något sätt berör förändringar i affärsmodeller. Den första av Wiebke Reim, Daria Sas och Vinit Parida som intresserats för hur den cirkulära ekonomin håller löftet om ett systematiskt tillvägagångssätt för att ge ekonomiska, sociala och miljömässiga fördelar. Men att flytta till ett mer cirkulärt tankesätt kräver nära samarbete med befintliga och nya ekosystempartners. Den analysram som föreslås i artikeln identifierar fyra typer av cirkulära affärsmodellmöjligheter och beskriver för varje affärsmodell framtida aktiviteter som kan leda till större cirkularitet.

Den andra artikeln som är författad av David Sjödin och Vinit Parida handlar om hur tillverkande företag investerar kraftigt i digitalisering som en källa till innovation och nya intäktsströmmar. Trots detta konstateras att många företag har lägre intäkter från digitala tjänster än förväntat och oväntade kostnader som minskar vinsterna. För att hantera den här utmaningen kan företag anta en mer kundfokuserad process som baseras på mikrotjänster för att skapa en högre avkastning på investeringen.

Artikel nummer tre handlar om hur teknologier för digitalisering och industri 4.0 lovar att ge många nya möjligheter och fördelar för processindustrin. Ändå står många företag inför utmaningar när det gäller att anta och använda dem för processinnovationer. Koteshwar Chirumalla förklarar hur processindustriföretag kan utveckla en väg för digital processinnovation steg för steg genom att bygga dynamiska funktioner.

Den avslutande artikeln inriktas på hur andelen solceller och elbilar ökar kraftigt i Sverige. Petter Johansson menar att den här utvecklingen är bra för miljön men skapar utmaningar för etablerade aktörer. Innovationsprojekt som bedrivs av aktörer inom elsystemet resulterar ofta i inkrementella snarare än radikala förbättringar. I den här artikeln lyfts mikronät fram som ett alternativ för utveckling av systemövergripande lösningar på framväxande problem i elsystemet.

Trevlig läsning!

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Circularity and business ecosystems

— Ecosystem analysis for circular business models

By Wiebke Reim, Daria Sas and Vinit Parida

The circular economy holds the promise of a systematic approach to delivering economic, social, and environmental benefits. But moving to more circular operations requires close collaboration with existing and new ecosystem partners. Thus, the readiness of business ecosystems to accept circular business models is a deciding factor in commercial success and advancing towards greater circularity.

We are all aware of the need for greater sustainability and the need to prevent global-warming effects from becoming irreversible. Thinking, planning, doing, and acting in a sustainable and circular manner must become the prevailing philosophy for individuals and for companies from global corporations to small and medium enterprises (SMEs) in sparsely populated areas. Everyone must share responsibility and should be supported in order to contribute to a sustainable world now and in the future. In particular, the food industry can make substantial gains from effective resource utilization and optimization throughout its value-chain activities. Currently, however, we are witnessing too little happening beyond pilot projects and local initiatives.

Circular Economy

In July 2020, the Swedish government published a national strategy on moving towards a circular economy to increase resource efficiency and decrease climate and environmental impacts. According to the Ellen MacArthur Foundation, a circular economy is a systematic approach to economic development design that benefits business, society, and the environment. In comparison to the 'take-make-waste' linear economy, a circular economy is regenerative by design and aims to gradually decouple growth from the consumption of finite resources. The goal of the circular economy is to eliminate resource waste by providing various opportunities and solutions to keep materials and products in use for as long as possible.

To enhance sustainability, all steps towards greater circularity are important. Some companies have already shifted their entire business model towards circularity. Other companies are attempting to change some aspects of their business models or add new business models to their operations. For example, food companies could change their entire production process to circularity or add processes to make resources from side streams available for human consumption. In most cases, this shift requires close collaboration with interdependent partners in a business ecosystem (Reim et al., 2019). The evolution of these business ecosystems is crucial for circular success, but they are challenging to establish and to operate.

Business ecosystems for circularity

For the most part, research literature has studied large companies to exemplify circularity initiatives. However, to achieve major circular benefits, it is important to consider close cooperation between large, small, and medium-sized enterprises (SMEs) as well as other supporting actors in an ecosystem.

Ecosystems can be defined as the alignment structure of a multilateral set of partners that need to interact for a focal value proposition to materialize. In such ecosystems, partners may have different roles based principally on their aspirations. The roles can usually be divided into leaders and followers. No role is better than the other; both are equally indispensable. Leaders align partners and secure the competitiveness of the ecosystem. Naturally, followers act in accordance with a leader's plan but, crucially for future success, they complement the initiatives by supplying the products and services. The leader must facilitate conditions that strengthen the willingness of the follower to continue collaboration.

The literature on business ecosystems demonstrates the importance of supportive ecosystems for innovation and the development of new businesses (Parida et al., 2019). However, ecosystems evolve over time, and new business models require the simultaneous development of an ecosystem. During the emerging phase of an ecosystem, there is still much room for innovation, but success is rather tenuous. Established ecosystems are characterized by stability in terms of the established partnerships and the prevailing economic conditions. Moving to a circular economy requires, in most cases, the establishment of new ecosystems to better utilize resource streams.

Business ecosystem analysis framework – Exploiting circular business model opportunities in the food industry

The food industry has significant potential to improve its circularity through innovation and the establishment of new ecosystems. Greater circularity in this specific industry can accomplish several of the global sustainable goals, such as Goal 2 zero hunger, Goal 12 responsible consumption and production, and Goal 13 climate action. Nevertheless, strict regulations, perishable raw materials, and the small size of many actors are major impediments. The greatest potential lies in finding new solutions to handle waste streams in a profitable and sustainable way. Currently, waste is seen as a problem first and foremost, and not as a source of value. This misconception can be overcome by analysing and building ecosystems to facilitate valorisation of side/waste streams.

Our framework (see Figure 1) allows individual companies to assess their business ecosystems and, as a first step towards exploiting circular business model opportunities, undertake an ecosystem analysis. This ecosystem analysis includes an ecosys-

tem partner analysis (leader vs. follower) and an ecosystem maturity analysis (emerging vs. established ecosystem). From this analysis, conclusions can be drawn on the potential for exploiting circular business model opportunities. For each of the four business-model types, specific activities are identified that should be pursued in moving sequentially towards sustainability and successful commercialization. This framework is based on interviews with 30 small and medium-sized enterprises in the food processing industry located in sparsely populated areas of Finland, Sweden, Norway, and Ireland. Below, we illustrate one case from our data collection for each of the four circular business model opportunities identified in the business ecosystem framework and pinpoint activities that can usefully be pursued in each of the stages.

The "explorer" business model: A brewery provides spent grain – one of their side streams – to a bakery that uses it for making bread. Thus, the brewery explores opportunities to valorise the side stream in another industry even though it did not engage in any value-adding activities and is dependent on the bakery's demand for spent grain. To increase circularity, the brewery should further engage in business-model development to capture value from the waste in the future and to develop their ecosystem so that larger quantities of the side streams can be utilized.

The "adventurer" business model: A fishery company with well-established fish products on the market has invested in technology to utilize more of the edible fish parts for human consumption. This process works for atypical fish such as bream and the residuals from fish fileting. The company needs to work actively to align all necessary actors such as suppliers and distributors in the ecosystem and to develop the market for sustainable products.

The "sustainable enabler" business model: A potato processing company buys locally harvested potatoes with a certain percentage of soil. Potato processing results in the typical waste of soil, wastewater, and peeled potato skin. The company is not interested in processing this waste further, but it supports its established ecosystems in utilizing the waste in as circular a manner as possible. The future holds opportunities for the firm itself to add processes to valorise the waste. Or, at the very least, it could attempt to capture some value from the waste and not merely perceive it as a problem to be off-loaded.

The "circular hero" business model: A brewery company in collaboration with a data centre has a pilot project to harvest meal worm. These worms can be used as feed in local chicken farms instead of imported soy. The brewery's side stream, spent grain, has a wet texture and is used as feed for the meal worms. The heat generated from the data centre provides good conditions for harvesting the worms. During their growth phase, the meal worms consume most of the spent grain and the water. The residuals are a particularly good "dried" fertiliser that is much easier to handle than the wet spent grain. In an established ecosystem with collaborating and collocated actors, this process is scalable, and it is a prime example of how to facilitate greater circularity and sustainability in a high demand, growth industry.

Conclusion

It is important to enhance both current and future potential to shift towards a circular economy if more sustainable development goals are to be met. Consequently, large and small companies must rethink existing business models and rise to the challenge of building new circular business models. An analysis of roles in and across ecosystems as well as ecosystem maturity is seen as crucially important. Ecosystems are constantly evolving. Each of the readiness phases has its opportunities and challenges. Instinctively, every company should aim to become a "circular hero". However, it depends on the industry, the current position in the marketplace, and the existing network of actors. Commonly, companies that strive to valorise waste streams lack an existing ecosystem. This is in contrast to the established ecosystem of a company's core business product/unit. SMEs have a particular challenge because the development of an ecosystem is both time and resource consuming. These companies need to become fully conversant with how to navigate and orchestrate an ecosystem, and that means creating, capturing, and maintaining value in business models that incorporate greater circularity.

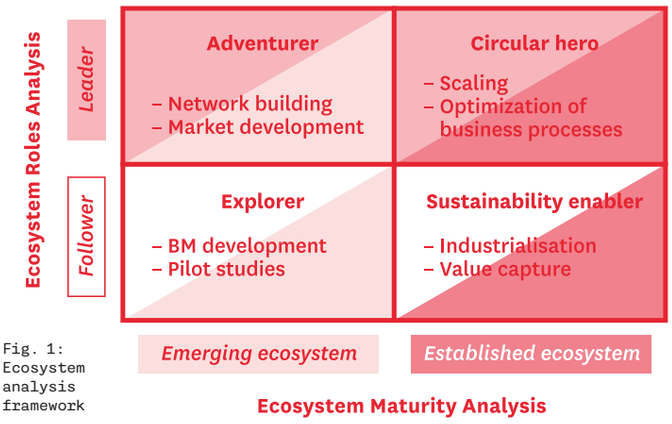

Fig. 1: Ecosystem analysis framework

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Agile co-creation processes for digitalization

— How principles of joint engagement and a micro-service approach addresses the digitalization paradox

By David Sjödin and Vinit Parida

Industrial manufacturers are investing heavily in digitalization as a source of innovation and new revenue streams. Yet, many face lower-than-expected revenues from digital services, and unexpected increases in delivery costs which risks undercutting the profit potential. To deal with this digitalization paradox, firms should adopt an agile customer focused co-creation process following a micro-service innovation approach creating a stable return on investment.

Digital servitization is a concept that captures the transformation in processes, capabilities, and offerings within industrial firms and their extended ecosystems of partners, in order to progressively create, deliver, and capture higher service value from enabling digital technologies such as the Internet of Things (IoT) and Artificial Intelligence (AI) (Sjödin et al., 2020). An example is Sandviks's remote Optimine solution which transforms data from mining operations into actionable predictive insights, helping customers optimize the full mining process, capitalizing on the efficiencies of IoT and AI.

Typically, providers adopt a digital servitization strategy to create a competitive advantage that differentiates them from competitors and open the door for new revenue streams. However, digital service innovation is highly challenging for a number of reasons. First, technology is rapidly evolving, and companies often struggle to keep pace with the demand for complex digital system developments because it may extend beyond their existing capability base. The results are often long development cycles of increasingly complicated digital systems that ends up being outdated before they are even commercialized. Second, in digital servitization, value creation does not happen in internal R&D labs; it occurs at the point of customer contact, where value is realized in the use of the service to improve customers operation. What is required is a co-creative approach to identify the relevant use cases and problems to solve for a specific customer. Yet, most firms are not set up for co-creative innovation. Thus, despite investing considerable effort in developing digital services, many companies struggle to create real customer value, and both providers and customers risk failing to make a financial return on investment This pervasive complexity and uncertainty can lead companies into a digitalization paradox, where increasing revenues from digital services fail to deliver greater profits because of spiraling cost increases.

To address these challenges and understand how providers and customers co-create digital service solutions, we conducted in-depth qualitative study of multiple industrial relationships in various industries in Sweden (Sjödin et al., 2020). We summarize our insights in this article and present an *agile co-creation framework for digital servitization (see figure 1)*. The framework describes the foundation of a micro-service innovation approach for agile co-creation as a means of coping with the digitalization paradox.

An agile co-creation approach for digital servitization

Our findings reveal a five-phase agile co-creation process for developing digital micro services. Phases include: 1) Need identification 2) Value prioritization, 3) Micro-service development 4) Implementation 5) Evaluation. An important characteristic is the iterative and agile way of working with micro-services to enable multiple short planning and execution cycles governed by customer and operational feedback.

As described by our informants a micro-service in the context of digital servitization is a focused digital service functionality which does one thing (i.e. solves a specific customer problem) and does it well. Accordingly, micro services lends itself to a continuous delivery of increasingly more sophisticated digital servitization solutions. For example, a construction equipment manufacturer described developing a weight loading micro-service which on its own had substantial effects in reducing fuel costs, and traffic congestion but coupled with other micro services over time such as positioning and traffic awareness enabled more a more effective site management. The full site management solution would thus emerge over several cycles of micro-service development, each adding a distinct value proposition to the overall solution. This approach means that providers and customers focus their attention on progressively addressing one customer need at a time rather than developing complex full-scale digital service solutions. Three overarching principles underpin the micro-service innovation approach: *Start small and make incremental digital investments, use iterative sprints to solve customers' problems, and prioritize operational testing and learning by doing* According to our respondents, these principles truly reflect the flexibility, pace, and customer focus required in digital servitization. Further elaboration on these principles is provided below.

Start small and make incremental digital investments

A key approach to cope with the uncertainty surrounding the creation of new digital offerings is by starting small and making incremental micro-service investments. Indeed, our informants reported that digital services cannot and should not be planned as one large initiative; it is an iterative process in which providers and customers must agree on and prioritize initial opportunities to exploit digitalization together. This process involves making a series of small bets with the potential for large gains, employing a jointly negotiated investment strategy with the customer, and following recurring investment loops. By setting small, realizable goals and making small investments, providers can develop trust and commitment from customers and legitimate their innovation processes while reducing risk. A technology manager from a industrial manufacturer succinctly described how this approach of making quick iterations through micro-services is an optimal way of dealing with digitalization investment opportunities: "With digital services, we need to eat the elephant in small bites."

After the first initial micro-service development cycle is completed, the process is repeated indefinitely to identify and prioritize new needs that should be targeted and met. There are several benefits to the micro-service approach. A focus on modularity means that the overall systems are easier to understand, develop, test, and make resilient to changing conditions. In addition,

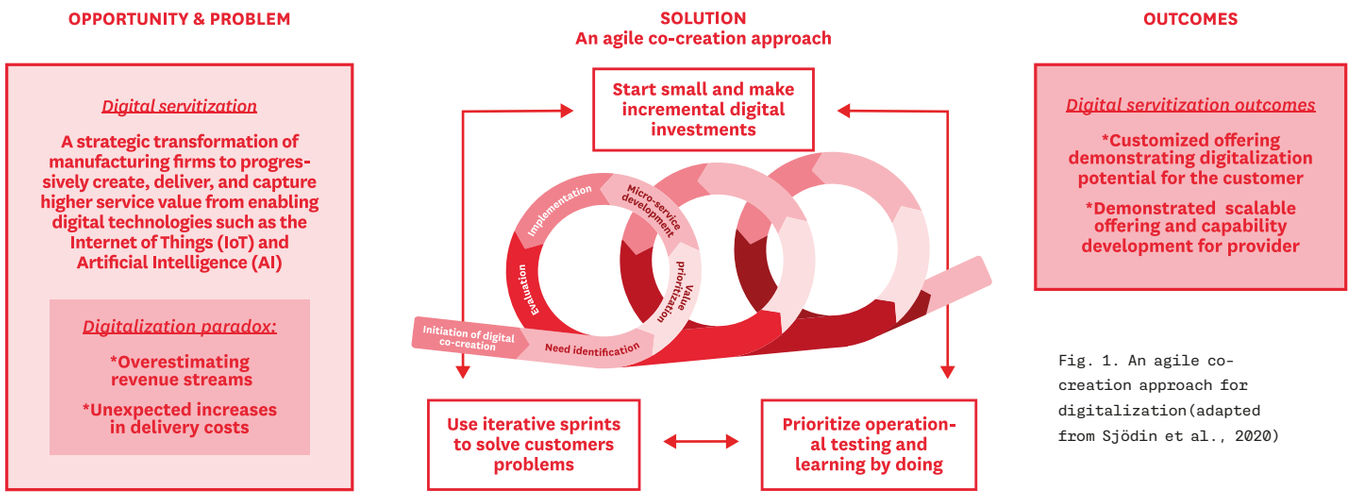

Fig. 1. An agile co-creation approach for digitalization (adapted from Sjödin et al., 2020)

scalability is increased. Because micro-services are developed and implemented independently of each other, they can be scaled independently, simplifying commercialization.

Use iterative sprints to solve customers problems

To prioritize speed and customer value the manufacturer and customer should employ an iterative sprint-based development approach with clear and useable outputs at the end of each cycle (i.e., proof of concept). A key account manager from a equipment manufacturer described: "You need really tight relationships with the customer to truly understand their dilemmas and not only think that you understand it. You need to have joint sprints to be able to deliver value in a very agile and quick manner from a business perspective and from a technology perspective." Each sprint follows an iterative process model of step-by-step development, implementation, and testing of improvements to advance quickly and then modify the details of the micro-service solution based on experience. Thus, the requirements and features of the micro-service are continuously evolving and being prioritized according to the value they bring. Informants underlined that quickly weeding out failing or low-value-adding micro-service concepts or features is important to avoid wasting scarce resources.

Prioritize operational testing and learning by doing

The agile co-creation process is firmly rooted in the benefits of continuously applying, testing, and refining solutions in an operational real-life environment. Micro-services must be tested in operational environments to allow companies not only to explore ways to refine routines for using the current service but also to identify new opportunities for the next iteration of micro-service development. Specifically, digitalization requires incremental improvement of the underlying routines for using the technology from the operational staff of both providers and customers. This approach enables stepwise digital capability development and increased trust in the solutions from the workforce. As a director of connected sites at an equipment manufacturer remarked, "It's not only about the services we deliver. For me, it is more about the capabilities we build when implementing and refining these systems over time."

Conclusion

The benefits of following the principles of the agile co-creation approach is the formation of customized, modular, and scalable offerings. By crafting such offerings, the potential of digitalization is realized by customers as their needs are progressively met through the development of an increasingly comprehensive digital solution consisting of multiple micro-services that build on each other. Focusing on quickly implementing customized micro-services that target specific needs demonstrates the value of digitalization for customers and creates trust for further co-creation. For providers, the micro-service approach enables progressive development, testing, and commercialization of modular and scalable micro-service offerings for paying customers. Over time, a more comprehensive portfolio of micro-services is developed, enabling the provider to configure more complex solutions. A final benefit is the ongoing focus on capability development as micro-services are quickly implemented and new routines for service delivery can evolve through learning by doing. That is the front end (i.e. customer service and support) and back end (e.g. technology implementation) capabilities for delivering value from digital services can be built in a stepwise fashion. We foresee this approach to have a high importance in speeding up the digital transformation of industry.

FOR MORE READING CONNECTED TO THIS TOPIC PLEASE SEE:

> Sjödin, D., Parida, V., Kohtamäki, M., & Wincent, J. (2020). An agile co-creation process for digital servitization: A micro-service innovation approach. Journal of Business Research, 112(5), 478-491. https://doi.org/10.1016/j.jbusres.2020.01.009

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Pathway to digital process innovation

— How dynamic capabilities can help process industries

By Koteshwar Chirumalla

Digitalization and industry 4.0 technologies promise to provide many novel opportunities and benefits to process industry firms. Yet many firms face challenges in adopting and utilizing such technologies for successful process innovations. This article explains how process industry firms can develop a pathway for digital process innovation in a step-by-step manner by building dynamic capabilities.

Process innovations—the development of new or improved production methods, techniques, or technologies—are critical for process industries. The process industries refer to a cluster of manufacturing sectors (mining, steel, pulp and paper, chemical, pharmaceuticals, mineral, and food and beverage). In Sweden, this cluster of sectors contributes approximately SEK 135 bn to the country's net export value. Production processes in process industries are often capital-intensive, leading to inflexibility when changing process settings. Any kind of poor management in the implementation of process innovation could lead to inappropriate product properties (e.g., durability, strength, colour, appearance), inadequate work processes, competence gaps, etc.

The adoption of digital technologies such as IoT, cloud computing, big data analytics, augmented reality, and AI could enable enormous new opportunities with their real-time connectivity, intelligence, and analytical capabilities. All of the significant production parameters can be recorded using hundreds of sensors, and the predictive models developed from the data could be used to anticipate optimum settings for improving manufacturing processes, material usage, predictive maintenance, and life cycle management of the product. The generation of such extensive data sets as well as historical performance also offers possibilities for proactively enhancing process design and drive innovation. However, firms have yet to explore the potential of many data sources, which creates challenges for seizing opportunities provided by digital technologies. Consequently, results and conclusions drawn from the data analysis may not be completely accurate as such analyses are often performed in a non-reflective way, making digitalization difficult to realize.

"We are going for digitalization and all that, and that's fine. But you need to know where you are and where you are going before you start running."

Digital process innovation requires dynamic capabilities

In our study of the digitalization of process innovation within two steel manufacturing firms, we found that process industries must extend the scope of traditional manufacturing and development-related activities to digitally/IT-driven-related activities, which requires building and integrating a whole range of novel capabilities and resources. These capabilities are not fundamentally limited to technology diffusion; they also relate to firms' strategic change and organizational management, including strategy, organizational structure and processes, resources, and cultural readiness. Dynamic capability, which is a firm's *"ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments"* (Teece, 2007), is a potentially interesting analytical framework for holistically studying such strategic organizational changes. Firms' lack of dynamic capabilities is one source of inertia for missing the required agility to respond to digital transformations.

Three-phase model moving towards digital process innovation

Our study defined digital process innovation as *"the use of a combination of new digital technologies to support the development and implementation process of completely or significantly new production methods, procedures, or techniques by acquiring, integrating, or reconfiguring organizational resources, structures, infrastructure and culture."* (Chirumalla, 2020). We found that process industry firms should complete three phases to become successful in the digitalization of process innovation: preparing the organization for digital process innovation, exploiting the digital opportunities within the organization, and innovating the organization for digital process innovation (see figure 1). In each phase, firms need to acquire and develop specific dynamic capabilities to achieve a mature digital process innovation readiness, which is also supported by specific key enablers. The following section briefly describes each phase and the specific dynamic capabilities that need to be built by process industry firms.

Phase 1 – Preparing the organization for digital process innovation

In the initial phase, firms need to develop a foundational basis to

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holistically prepare the organization for a smoother transition from "traditional process innovation" to "digital process innovation."

Dynamic capabilities: In this phase, firms need to develop four dynamic capabilities: management vision and a giraffe's view, integration of process and IT know-how, agile cross-functional teams, and data-driven sensing. To reconfigure and transform the traditional organizational setup to embrace a digital way of working, firms must prepare for change management and help employees realize that they need to change. Management can do a lot to prepare the organization internally for such change, such as clarifying the firm's vision, explaining why the change is necessary and what it hopes to achieve with the change, and showing what the future will look like with a few examples and possible scenarios. It is also important to establish a good technical understanding and a common way of working between process developers and IT developers in order to communicate both process know-how and IT know-how effectively. Formulating digitalization cross-functional teams focused on digital initiations across functions will help support the organization in the long term. Firms should also realize the need to be more agile when forming teams made up of various experts to achieve better seizing capability. After establishing these dynamic capabilities, firms can use the available data—OEE measurements, maintenance data, and shutdown times—to visualize various parts of the process on a daily basis.

Key enablers: Firms should establish proactive management practices and define infrastructure and methodologies to promote digitally-enabled process innovation. This radical shift takes time, costs money, and requires a lot of dedicated resources; therefore, management must be on board. Examples of management support include adding appropriate resources to visualize and analyze the processed data; defining the way of working, including collecting, handling, analyzing, and visualizing data; and translating top management's digital strategy to the local production site management. In addition, firms must build a foundation for technology and digitalization infrastructure as a starting point in order to establish the necessary methodology to connect all essential production equipment and process steps to realize a structured way of working with and managing data.

Phase 2 – Exploiting the digital opportunities in the organization

In the second phase, firms must invest in exploiting their digital opportunities by running, for example, pilot projects or demonstrators in order to analyze data sets, enhance collaboration around the data, and define necessary training mechanisms.

Dynamic capabilities: In this phase, firms need to develop four dynamic capabilities: ability to navigate visually abstract and detailed views with data, support for scenario-planning practices, ability to leverage collaborative engagement with data, and strategic training mechanisms. Digitalization provides firms with a greater opportunity to get an overview of and details on the situation and production plant quickly. Digitalization provides rational and interdependent process correlations for errors as well as for key performance indicators (KPI). For example, a product quality error is considered the tip of the iceberg; digitalized tools make it possible to identify the factors that might affect quality outcome. Firms can use digitalization to enable "what-if" scenarios to help them determine what to produce and how to introduce new processes. Firms can also compare stored historical data for different problems, incidents, and defects to live data in order to determine how to prevent future problems. Moreover, with digitalization, firms can involve more people—not only experts, but also operators—in identifying and solving problems. By visualizing the process data and making it available to every employee, firms can identify the possibilities of leveraging social interactions and discussing root causes. Finally, firms should consider educational training and ways to change people's mindsets as essential efforts and take steps to promote thinking outside the box. In this way, firms can recognize that digitalization is not a silver bullet; people need to come together to find opportunities in the new working setup.

Key enabler: Planning a digital matureness for each function and department plays a key role in this phase. Firms need to develop a matrix to understand and plan the digital maturity in each function and department. There are a lot of variations in the way several functions look at the strategy and drive their own initiatives. Process developers, process technicians, and IT technicians need to speak the same language to ensure that the right specifications are translated into the development of tools.

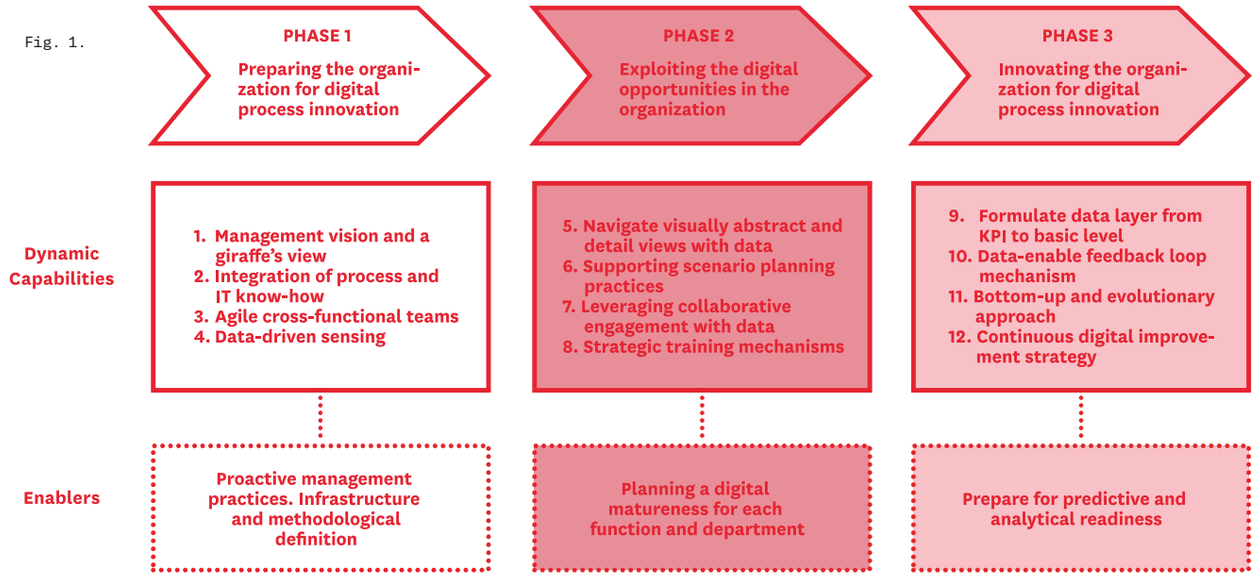
Phase 3 – Innovating the organization for digital process innovation

In the third phase, firms are able to innovate their organization by achieving a full-scale data-driven way of working for process innovations.

Dynamic capabilities: In this phase, firms need to develop four dynamic capabilities: ability to formulate data layers from KPI to the basic level, a data-enabled feedback loop mechanism, a bottom-up and evolutionary approach, and a continuous digital improvement strategy. Forming a good data layer is critical for handling data and investigating problems to improve production processes, product quality, and delivery performance.

"The digital solution could help you see things that you can't see with your naked eye or with a testing. If the system could predict and give you guidance in one way—"This is how you should try to do it"—it could be a great help."

Fig. 1.



Firms need to connect all the right data and ensure that they interact throughout the process to develop a broader overview and determine if causes correlate to each other. Digital support is a feedback loop that allows firms to predict problems and give early guidance (temperatures, vibrations, sounds, etc.) through warnings or alerts. Firms can also suggest a structured way of building data-driven operations and workstations, following a module-based approach. Such an approach allows for the categorization of products, machines, workstations, and operations in a structured way, making it possible to turn data back and forth in a standardized way. In addition, firms need to adopt a continuous digital improvement strategy to succeed with seizing opportunities.

Key enabler: Firms need to prepare to work with more predictive and analytical data as the data available will be enormous. Placing all available data from the factory in layers makes it possible to see the overview of the plant transparently on a screen (e.g., different colored lights indicating issues). Firms also need to develop the capability to acquire the big picture and dig deeper, as needed (e.g., navigation of abstract/detailed views).

How can industry benefit from the three-phase model?

Our findings offer several useful insights for production/plant managers, technical directors, and process development leaders in the process industries who are seeking to improve performance in process innovation with the support of digitalization. The proposed three-phase model and dynamic capability approach could help these leaders holistically understand their process innovation work and analyze their firms' distinct resources, processes, structures, and infrastructure. Accordingly, managers can either develop a clear vision for the digital process innovation work or build/modify their firms' digitalization maturity roadmap through the targeted modification of resources and capabilities. Our study findings can also support managers making strategic investment decisions on data gathering, analytics capabilities, and cloud-based platforms as well as when planning competence development and training programs for smart factories. Finally, the results from the study can be used as guidelines for managers seeking to initiate a dialogue on capability building with multiple stakeholders within the firm.

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Innovation i elsystemet

— Fast i det gamla eller tid att tänka nytt?

Av Petter Johansson

Andelen solceller och elbilar ökar kraftigt i Sverige. Utvecklingen är bra för miljön men skapar utmaningar för etablerade aktörer. Innovationsprojekt som bedrivs av aktörer inom elsystemet resulterar ofta i inkrementella snarare än radikala förbättringar. I den här artikeln lyfts mikronät fram som ett alternativ för utveckling av systemövergripande lösningar på framväxande problem i elsystemet.

Det var vid Lucia, 1894 som strömmen från Sörbylunds Kraftstation slogs på för första gången. Kraftstationen låg vid en damm längs det lilla vattendraget Ösan i hjärtat av Skaraborg. Härifrån matades ström via en luftledning till ett tröskverk över två kilometer bort. Idag skulle vi ha kallat denna anordning för ett mikronät. I början på 1900-talet fanns inget nationellt stamnät i Sverige. Istället fanns i Sverige en myriad av mikronät i olika storlek, ofta uppbyggda kring sådana här typer av små vattenkraftverk. Så småningom integrerades de många små mikronäten i det framväxande nationella elsystemet.

Sörbylunds mikronät hann växa till att omfatta över 500 abonnenter innan det införlivades i Vattenfalls elnät 1955. Sedan dess har ett ramverk av lagar och regler i Sverige utvecklats och anpassats för ett centraliserat elsystem baserat på storskalig kraftproduktion. Men nuvarande ramverk har visat sig vara illa anpassat för den tillväxt av solceller och elbilar som skett under de senaste åren.

Lite generaliserande kan det beskrivas som att utvecklingen av elsystemet har gått från att ha varit en systemövergripande teknisk uppgift för ingenjörer till att bli en marknadsreglerande uppgift för ekonomer och jurister. I den senare fasen har en marknadsmodell med verksamhetsåtskillnad introducerats för att konkurrensutsätta olika delar av elsystemet och för att skärpa regleringen av de andra delarna. Den här utvecklingen är typisk för mogna tekniska system med låg nivå av teknisk förändring. Men denna modell gör det också svårt för enskilda aktörer att hitta systemövergripande lösningar, s.k. 'helsystemlösningar', på framväxande problem i elsystemet.

Solceller och elbilar utmaningar i elnäten

I forskningsprojektet 'Hur en förändrad nätägarroll kan bidra till en resurseffektiv och systemvänlig utbyggnad av solel', finansierat av Energimyndigheten, har vi undersökt hur rollerna och strukturerna i dagens elsystem kan förändras för en långsiktigt effektiv expansion av solceller och andra distribuerade energiresurser i Sverige. Idag finns cirka 175 nätägare med koncessionsplikt i Sverige. Bolag med nätkoncession har monopol över elnätet inom sitt geografiska område och ansvarar för leveranssäkerheten och elkvaliteten inom detta område.

"Utvecklingen av elsystemet har gått från att ha varit en systemövergripande teknisk uppgift för ingenjörer till att bli en marknadsreglerande uppgift för ekonomer och jurister."

Under de senaste åren har en snabb utveckling skett kring solceller och elbilar i Sverige. Solceller installeras ofta nära slutanvändaren, i slutet av de lokala elnäten. Om flera grannar installerar solceller på sina respektive tak kan de skapa en lokal överbelastning som nätet inte har kapacitet att hantera. Detsamma gäller för en lokalt hög koncentration av elbilar. Normalt svarar det lokala nätbolaget på dessa typer av problem genom traditionella investeringar i kapacitetsökning, det vill säga nya kablar, uppgradering av transformatorer, etc. Kostnaderna för sådan nätförstärkning fördelas sen på alla kunder i det lokala elnätet genom höjda nättariffer. Med andra ord får alla vara med och betala, oavsett om de varit med och skapat kostnaderna eller ej.

En rad förslag på åtgärder har presenterats av svenska myndigheter de senaste åren rörande hur följdkostnaderna av nätanslutna solceller

Sörbylunds Kraftstation (Foto: Per Beckman)

och elbilar kan minimeras. Många av de presenterade åtgärderna har det gemensamma problemet att de bygger vidare på dagens marknads- och regelverk snarare än att de tar utgångspunkt i den nya teknikens egenskaper. Exempelvis har solceller en helt annan karaktär med sin väderbaserade och varierande produktion än de styrbara kraftslag som dominerar elmarknaden idag. Den nya tekniken skapar helt enkelt nya typer av problem och möjligheter som kräver nya typer av lösningar.

Olika typer av innovation i elsystemet

När vi i vår studie har studerat svenska nätägare har vi funnit en heterogen grupp av bolag med stor variation i tillgång till resurser och kompetenser. De största nätägarna är Vattenfall, E.ON och Ellevio som tillsammans har hälften av landets alla abonnenter. I numerär är de kommunala nätägarna flest, totalt hundra stycken. Det finns också flera mindre elföreningar. Den minsta nätägaren i Sverige idag är Sörbylunds Elnät med en lågspänningsledning (som Vattenfall glömde köpa upp) med endast sju anslutna hushåll. Det är lätt att förstå att förutsättningarna att hantera innovation skiljer sig stort bland Sveriges olika typer av nätägare.

Flera svenska nätägare satsar idag på digitalisering för att förbättra övervakningen av sitt elnät, bättre planering och mer kostnadseffektiva investeringar. Många svenska nätägare förutspår dock att större förändringar med helt nya affärsmodeller kommer att krävas för att hantera ökningen av solceller och elbilar.

Ett typiskt elnäts-innovationsprojekt i Sverige idag följer den så kallade 'input-modellen'. I input-modellen tillskjuts externa medel för att genomföra enskilda innovationsprojektet, avskilt från resten av nätägarens verksamhet. Denna modell står i kontrast till den så kallade 'output-modellen'. I output-modellen är det resultaten av innovationsprojekten som bedöms. Nätägaren belönas om förväntade resultat överträffas, alternativt bestraffas nätägaren om uppsatta mål inte nås. Målet med output-modellen är att skapa tryck på faktisk förändring och har bland annat införts i Storbritannien. Även om output-modellen låter lovande är den svår att implementera i Sverige med våra 175 nätägare av olika typ och storlek (att jämföra med Storbritannien där de har sex olika nätägare). Output-modellen sätter också höga krav på att myndigheter har förmåga att formulera effektiva resultatmål tillsammans med nätägarna, vilket i sig är en stor osäkerhetsfaktor.

En tredje modell vore att förskjuta dagens innovationsfokus från lokalnätnivå till mikronätnivå. Detta har flera fördelar i en svensk kontext. Dels finns en svensk industri som är stark inom just mikronätområdet med inhemsk utveckling av växelriktare, batterier, elbilsladdare, etc. Till exempel är ABB en av världens största leverantörer av mikronät. Dels finns strukturerna från de gamla mikronäten i Sverige ofta kvar. Exempelvis skulle många av de elföreningar som finns i Sverige idag kunna konvertera till att bli mikronät-föreningar.

Frågan är också om en kraftig ökning av solceller och elbilar ens är möjlig att hantera långsiktigt resurseffektivt utan att tillvarata möjligheterna med mikronät. Dels är arkitektonisk innovation svår att uppnå i dagens elsystem med sin uppdelade och inlåsta marknadsstruktur, dels är radikal innovation svår att uppnå då man inte vill ta de risker som radikal innovation innebär inom dagens elsystem. Båda dessa typer av innovation skulle vara enklare att sträva efter inom autonoma och helintegrerade mikronät som är löst kopplade till omkringliggande elsystem.

“Nätägaren belönas om förväntade resultat överträffas, alternativt bestraffas nätägaren om uppsatta mål inte nås.”

Lärdomar

Sammanfattningsvis kan vi konstatera att mikronät erbjuder en potentiell väg till förnyelse av elsystemet där arkitektonisk och radikal innovation kan eftersökas utan att riskera störa elsystemets leveranssäkerhet. Tvärtom. På sikt kan en ökning av andelen mikronät ge ett mer robust och motståndskraftigt elsystem, trots en ökning av andel förnybar energi. Men då krävs att svenska myndigheter och beslutsfattare sätter sig i förarsätet för utvecklingen:

- Solceller och elbilar hanteras inte bäst genom att lägga ytterligare lager av regler på ett redan komplext regelramverk. Slopa krav på verksamhetsåtskillnad och tillåt fysisk delning av energi mellan fastigheter inom mikronät. Det möjliggör kommersiell utveckling av systemövergripande lösningar där svensk industri har stor potential att leverera.

- Skapa incitament för mikronät att vara nätanslutna och att förse med systemtjänster till lokala nätägaren. Det ger en vinn-vinn situation för både mikronätägare och lokalnätägare. Utveckla både ett standardiserat gränssnitt mellan mikronät och lokalnät och en ny typ av nättariffer som återspeglar faktiska kostnader bättre än vad dagens tariffer gör.

I början på oktober i år gick strömmen i Vattenfalls nät i Skaraborg. Efter sex minuter fick kunderna till Sörbylunds Elnät tillbaka strömmen, levererad från den lokala kraftstationen under 1,5 timma. Det finns med säkerhet fler än Sörbylunds sju anslutna hushåll som skulle vilja åtnjuta de fördelar som mikronät har att erbjuda. Men då måste vi först tillåta en sådan utveckling.

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