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Digital transformation is a core priority for many organizations, but their transformation journeys are often extremely challenging with much uncertainty and high failure rates. We describe how international energy company Shell is successfully digitally transforming its organization and operations by enabling employees to develop "do it yourself" applications that produce significant benefits through its citizen development program. Based on Shell's experience, we provide recommendations for establishing a citizen development program that empowers employees to successfully embed and drive digital transformation initiatives.[1,2]

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Importance of the Human Element in Digital Transformation

Digital transformation refers to the deep structural business changes organizations make to core processes and business models by exploiting digital tools to compete and meet customers' demands. To keep up with competitors, a business needs to have a digital strategy and make changes to the organizational structure and culture[3] but also needs to focus on adaptation, transformation, creating new customer value propositions and its value chain. Though there has been considerable focus on digital transformation in recent years, in reality, many organizations struggle to grasp what this really entails[4,5,6] from strategic, operational and

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3 Vial, G. "Understanding Digital Transformation: A Review and a Research Agenda," *The Journal of Strategic Information Systems* (28:2), February 2019, pp. 118-144.

4 Hess, T., Matt, C., Benlian, A. and Wiesböck, F. "Options for Formulating a Digital Transformation Strategy," *MIS Quarterly Executive* (15:2), June 2015, pp. 123-139.

5 Sia, S. K., Soh, C. and Weill, P. "How DBS Bank Pursued a Digital Business Strategy," *MIS Quarterly Executive* (15:2), June 2015, pp. 105-121.

6 Carroll, N., Hassan, N. R., Junglas, I., Hess, T. and Morgan, L. "Call for Papers: Special Issue—Managing and Sustaining Digital Transformations," *European Journal of Information Systems*, 2021.

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cultural perspectives.[7,8,9,10,11] Indeed, organizations often struggle to distinguish between digital transformation and well-established IT-enabled organizational transformation.[12,13] For managers who believe that digital transformation is a critical strategic journey for their organization, the pace of change can be too slow, lack any real urgency[14] or can be so fast that it lacks vision and employee engagement.

Even if an organization's digital transformation strategy gains some momentum, its efforts may become part of the 87.5% failure rate.[15] One reason for this high failure rate may be because the empirical understanding of how organizations implement digital transformation initiatives remains very fragmented.[16] Another reason may be that researchers often only get a snippet of an organization's actual transformation journey and lack any real temporal or longitudinal perspectives of the ebbs and flows involved in embedding and normalizing the transformation process.[17] From an academic perspective, Hess et al.[18] explain that "Recent work in academia has been largely concerned with providing guidance on certain aspects of digital transformation." As a consequence, executives struggle to make sense of the potential of digital transformations and how to make them work.[19] There was also an additional focus on digital transformation during the COVID-19 pandemic and on alternative views of the future of work,[20] and many organizations successfully implemented digital projects to support alternative work practices during the pandemic.

However, digital transformations are often not straightforward, especially when they involve team-related structural changes (for example, remote working during the pandemic). They are more complex and challenging than organizational transformations,[21] and different from IT-enabled organizational transformation,[22,23] which can lead to failure if digital transformations are seen as the same as IT-enabled transformations.

Wessel et al. have identified four common causes of the high failure rate of digital transformations.[24] The first is related to *unrealistic expectations*. Digital transformations are typically complex, risky, time-consuming, poorly aligned with strategy and more expensive than originally expected and planned, and thus fail to meet any expectations. The second cause of failure is due to the *limited scope* of digital transformation, which means that organizations often react to and focus on emerging digital technologies without a clear rationale for adopting and embedding new technologies that align with the organizational strategy. The third cause of failure is *poor governance*; organizations typically lack a clear governance structure for aligning new roles and responsibilities of key

7 Loonam, J., Eaves, S., Kumar, V. and Parry, G. "Towards Digital Transformation: Lessons Learned from Traditional Organizations," *Strategic Change* (27:2), March 2018, pp. 101-109.
8 Bharadwaj, A., El Sawy, O. A., Pavlou, P. A. and Venkatraman, N. "Digital Business Strategy: Toward a Next Generation of Insights," *MIS Quarterly* (37:2), June 2013, pp. 471-482.
9 Matt, C., Hess, T. and Benlian, A. "Digital Transformation Strategies," *Business & Information Systems Engineering*, (57:5), September 2015, pp. 339-343.
10 White, M. "Digital Workplaces: Vision and Reality," *Business Information Review* (29:4), December 2012, pp. 205-214.
11 Sebastian, I. M., Moloney, K. G., Ross, J. W., Fonstad, N. O., Beath, C. and Mocker, M. "How Big Old Companies Navigate Digital Transformation," *MIS Quarterly Executive* (16:3), September 2017, pp. 197-213.
12 Hanelt, A., Bohnsack, R., Marz, D. and Antunes Marante, C. "A Systematic Review of the Literature on Digital Transformation: Insights and Implications for Strategy and Organizational Change," *Journal of Management Studies* (58:5), June 2021, pp. 1159-1197.
13 Wessel, L., Baiyere, A., Ologeanu-Taddei, R., Cha, J. and Blegind-Jensen, T. "Unpacking the Difference between Digital Transformation and IT-Enabled Organizational Transformation," *Journal of the Association for Information Systems* (22:1), March 2020, pp. 102-129.
14 Fitzgerald, M., Kruschwitz, N., Bonnet, D. and Welch, M. *Embracing Digital Technology: A New Strategic Imperative*, MIT Sloan Management Review and Capgemini Consulting, October 7, 2013, available at https://sloanreview.mit.edu/projects/embracing-digital-technology/.
15 Wade, M. and Shan, J. "COVID-19 Has Accelerated Digital Transformation, but May Have Made it Harder Not Easier, *MIS Quarterly Executive* (19:3), September 2020, pp. 213-220.
16 Sia, S. K., Soh, C. and Weill, P., op. cit., June 2015.
17 Carroll, N., McLafferty, B, Conboy, K. and Donnellan, B. "Normalising a Digital Transformation," *Proceedings of 42nd International Conference on Information Systems (ICIS)*, December 2021.
18 Hess, T., Matt, C., Benlian, A. and Wiesböck, F., op. cit., p. June 2015.
19 Wessel, L., Baiyere, A., Ologeanu-Taddei, R., Cha, J. and Blegind-Jensen, T., op. cit., March 2020.
20 Carroll, N. and Conboy, K. "Normalising the "New Normal": Changing Tech-Driven Work Practices under Pandemic Time Pressure," *International Journal of Information Management* (55), Article 102186, July 2020.
21 Wessel, L., Baiyere, A., Ologeanu-Taddei, R., Cha, J. and Blegind-Jensen, T., op. cit., March 2020.
22 White, M., op. cit., December 2012
23 Sebastian, I. M., Moloney, K. G., Ross, J. W., Fonstad, N. O., Beath, C. and Mocker, M., op. cit., September 2017
24 Wessel, L., Baiyere, A., Ologeanu-Taddei, R., Cha, J. and Blegind-Jensen, T., op. cit., March 2020.

stakeholders with the digital transformation. The fourth key cause of failure is related to *cultural barriers*; organizations often fail to build a new cultural value consensus and instead retain a hierarchical culture that can create barriers to maintaining digital transformation momentum and achieving its main objectives.

Though more research is required to understand how digital transformation and workforce transformation are intertwined,[25,26,27,28] there is a growing body of evidence to suggest that business and IT leaders must recognize the importance of the human element in digital transformation initiatives. Successful digital transformation requires both a connection to the organization's workforce and employees' commitment in order to initiate, embed, integrate and scale the transformation.[29] Management must therefore empower employees to play a role in initiating and sustaining the digital transformation process.[30] In our research, we explored this issue by addressing the question: *How do organizations enable the human element for effective digital transformation?* Our research built on the work of Kohli and Johnson,[31] who investigated how to embed digital technologies to capture, integrate and deliver information through new governance policies and strengthen agility to respond to market volatility.

In this article, we explain how Shell successfully adopted *citizen development* (also known as low-code/no-code development) to ensure that its workforce transformed as its digital transformation journey progressed. (Our research methodology is described in the Appendix.) Citizen development enabled Shell to successfully unpack how digital transformation and workforce transformation are intertwined and we explain how Shell leveraged this to empower its employees to become changemakers throughout the transformation journey in a hyperagile environment. Unlike digitally savvy digital industries, energy companies are seeking ways to cut costs and become responsive to market demands. Executives across energy companies are facing unprecedented pressure to cut costs in response to market turbulence and need advice on how to undergo a digital transformation. Before describing Shell and the phases of its digital transformation journey, we first explain what is meant by citizen development.

The Emergence of Citizen Development

Although the COVID-19 pandemic accelerated the need for change through digital transformation, it highlighted the massive global shortage of skilled software developers needed to deliver and operationalize the transformations.[32,33] As a consequence, IT departments now realize the importance of making more tools and technologies accessible to business people and are seeking ways to support business teams in improving productivity and innovation. For example, teams practicing agile development often select a management tool such as Atlassian Jira, Microsoft DevOps, VersionOne and many others. These tools are used to manage projects, organize teams, capture the user story backlog and track sprints, epics and releases. Business teams are also seeking ways to report performance and productivity and many of them connect data from Jira to data visualization tools such as Tableau. However, these developments raise concerns about shadow IT—i.e., the use and management of any IT technologies, solutions, services and infrastructure without formal approval and support of the internal IT department. While shadow IT may improve

25 Kane, G. "The Technology Fallacy: People Are the Real Key to Digital Transformation," *Research Technology Management* (62:6), November 2019, pp. 44-49.

26 Eden, R., Burton-Jones, A., Casey, V. and Draheim, M. "Digital Transformation Requires Workforce Transformation," *MIS Quarterly Executive* (18:1), March 2019, pp. 1-17.

27 Frankiewicz, B. and Chamorro-Premuzic, T. "Digital Transformation Is about Talent, Not Technology," *Harvard Business Review* (6:3), May 6, 2020.

28 Wessel, L., Baiyere, A., Ologeanu-Taddei, R., Cha, J. and Blegind-Jensen, T., op. cit., March 2020.

29 Carroll, N., Hassan, N.R., Junglas, I., Hess, T., and Morgan, L. "Transform or be Transformed: The Importance of Research on Managing and Sustaining Digital Transformations," *European Journal of Information Systems*, May 2023, (32:3), pp. 347–353.

30 Carroll, N., Ó Móráin, L., Garrett, D. and Jamnadass, A. "The Importance of Citizen Development for Digital Transformation," *Cutter IT Journal* (34:3), April 2021, pp. 5-9.

31 Kohli, R. and Johnson, S. "Digital Transformation in Latecomer industries: CIO and CEO Leadership Lessons from Encana Oil & Gas (USA) Inc.," *MIS Quarterly Executive* (10:4), December 2011, pp. 141-156.

32 Eden, R., Burton-Jones, A., Casey, V. and Draheim, M., op. cit., March 2019.

33 Breaux, T. and Moritz, J. "The 2021 Software Developer Shortage Is Coming," *Communications of the ACM* (64:7), July 2021, pp. 39-41.

employee productivity and drive innovation, it can also introduce serious security risks to organizations.

In response to these issues and concerns, an increasing number of organizations are adopting *citizen development*, a new method of delivering low-code/no-code (LC/NC) development as part of their digital transformation toolkit. The key difference between shadow IT and citizen development is the IT support and training provided for business users and management's awareness of the range of tools and technologies deployed in the organization and the provision of a risk compliance structure for using the tools. Citizen development hides the sophistication and complexity of coding but empowers subject matter experts to design, develop and deploy applications into production as though they were full-on, experienced coders.

The trend toward the adoption of citizen development is being driven by growing investments in LC/NC platforms by both established and startup suppliers. These platforms leverage recent advances in technologies such as artificial intelligence and machine learning to hide code complexity. According to Gundlapalli,[34] the LC/NC platform market is projected to grow from $13.2 billion in 2021 to $45.5 billion by 2025, a compound annual growth rate of 28.1%. Gartner also predicts 65% of all software development will take place on low-code platforms by 2024.[35]

Citizen development empowers individuals within organizations to create and deliver opportunities for change and eliminate inefficient processes. The approach reduces the burden on the core IT staff and allows employees with no coding experience to create their own LC/NC applications. This allows organizations to meet growing business demands for digital solutions without overwhelming or expanding the IT department. Citizen development reduces that burden by empowering team members to create apps directly without relying on the IT department, freeing IT specialists to focus on critical projects while reducing the number of requests they have to manage. It also enables software teams to better prioritize work and reduces burnout and turnover rates for IT positions.

Citizen development therefore provides significant benefits for IT departments, which are commonly understaffed and have to deal with growing demands and expectations and often have insufficient access to resources (human, revenue and infrastructure) to meet the workload demand. To date, digital transformation efforts involving the development of innovative digital solutions to reach customers, reduce costs, transform operations and remove process inefficiencies have been seen exclusively as within the IT department's remit. The net result is that the IT organization is always in reactive mode, working to address its backlog rather than becoming a valued partner capable of solving problems and delivering innovative solutions.[36,37]

The lack of readily available IT skills has led to business teams developing their own shadow IT applications outside the control of the IT department.[38] The adoption of citizen development eradicates shadow IT practices because citizen developers become a core part of digital solution teams.

Citizen developers can be characterized as empowered problem solvers who rapidly develop applications using innovative and intuitive software to create applications that are accessible through LC/NC platforms. The rapid design, development and deployment of applications in a hyperagile manner is the organizational equivalent of project management agility. Citizen development enables hyperagility throughout the organization because the tools hide functional complexity from systems and allow change to be

34 Gundlapalli, C. *Low-Code/No-Code: Empowering Citizen Developers*, Forbes Technology Council post, February 26, 2021, available at https://www.forbes.com/sites/forbestechcouncil/2021/02/26/low-codeno-code-empowering-citizen-developers/?sh=6b921aa35e9c.

35 Vincent, P., Iijima, K., Driver, M., Wong, J. and Natis, Y. *Magic Quadrant for Enterprise Low-Code Application Platforms*, Gartner, August 8, 2019, available at https://www.gartner.com/en/documents/3956079.

36 Spagnoletti, P., Kazemargi, N. and Prencipe, A. "Agile Practices and Organizational Agility in Software Ecosystems," *IEEE Transactions on Engineering Management* (69:6), December 2022, pp. 3604-3617.

37 Urbach, N., Ahlemann, F., Böhmann, T., Drews, P., Brenner, W., Schaudel, F. and Schütte, R. "The Impact of Digitalization on the IT Department," *Business & Information Systems Engineering* (61:4), December 2018, pp. 123-131.

38 Silic, M. and Back, A. "Shadow IT–A View from Behind the Curtain," *Computers & Security* (45), September 2014, pp. 274-283.

delivered faster by nontechnical people.[39] LC/NC platforms, such as Microsoft PowerApps, Appian, Salesforce Lightning, Mendix, OutSystems, TrackVia, Kianda, Creatio, Betty Blocks, Zoho Creator, Google AppSheet and others, are driving the awareness and adoption of LC/NC in the marketplace.

LC/NC software development approaches support a variety of application types and functionalities ranging from key business transactions, auditing tools, field service management and data analytics for small to large organizations.[40] A common focus for LC/NC solutions is small-scale automation for workflows and linking key data sources to deliver more efficient solutions—e.g., generating email notifications for process delays. Organizations are increasingly adopting more sophisticated LC/NC tools such as visual analytics capabilities as well as predictive analytics and machine learning software to support data analysts. In addition, LC/NC tools are increasingly used to develop websites and mobile apps and can provide powerful features to enhance search engine optimization, social media marketing and digital analytics. LC/NC tools can also support marketers in automating marketing activities such as website personalization and email marketing.

Thus, the main impetus behind the wide adoption of citizen development is the ability to rapidly design and deploy innovative applications at a significantly lower cost without needing to have deep software expertise. Eden et al. have identified three distinct and growing markets where citizen development can deliver significant value:[41]

1. *Faster traditional development:* facilitating IT to significantly speed up traditional software delivery
2. *Business innovation:* enabling business teams to effectively and safely build their own solutions, addressing the lack of IT skills
3. *Shadow IT:* helping CIOs regain control over software created outside of, or unsanctioned by, the IT department.

About Shell

Shell is an international energy company with expertise in the exploration, production, refining and marketing of oil and natural gas, and the manufacturing and marketing of chemicals. Shell has over 80,000 employees across more than 70 countries. It uses advanced technologies and adopts innovative approaches to build a sustainable energy future. Shell also invests in renewable power, including low-carbon generation such as wind and solar, and new fuels for transport. For example, the company continues to invest in advanced biofuels and hydrogen to meet the changing energy market demands for cleaner solutions for the future.

Shell recognizes that digitalization is changing the way we live, work and think, and will be key for decarbonizing the energy supply. Based on interviews with 18 key stakeholders and other materials (see Appendix), we present a case study of how Shell is democratizing its digital transformation journey across the organization. We show how Shell's "Do It Yourself" (DIY)[42] citizen development program is playing a vital role in digital transformation. As described below, Shell's digital transformation went through four phases: 1) Sensemaking for the citizen development journey; 2) Stakeholder participation to build momentum for the DIY program; 3) Collective action to embrace and enact the DIY program; and 4) Evaluating progress to review the impact of the DIY program. Based on the insights gained from the Shell case, we have derived recommendations for organizations pursuing digital transformations that include citizen development.

Digital Transformation at Shell

Shell has been a pioneer in the development and deployment of digital technologies for

39 Cavarec, Y. and Fargis, B. From Agile to Hyperagile: *The Destination and the Journey*, paper presented at PMI Global Congress 2016—EMEA, Barcelona, Spain. Newtown Square, PA, Project Management Institute. May 13, 2016, available at https://www.pmi.org/learning/library/agile-hyperagile-destination-journey-10182.

40 For more details on LC/NC development and support, and the relationship between citizen developers and the IT organization, see Johannessen, C. and Davenport, T. *When Low-Code/No-Code Development Works-and When It Doesn't*, Harvard Business Review, June 22, 2021, available at https://hbr.org/2021/06/when-low-code-no-code-development-works-and-when-it-doesnt.

41 Carroll, N., Ó Móráin, L., Garrett, D. and Jamnadass, A. "The Importance of Citizen Development for Digital Transformation," *Cutter IT Journal* (34:3), April 2021, pp. 5-9.

42 This phrase was coined by Jay Crotts, Shell's Executive Vice President & Chief Information Officer.

Table 1: The Four Phases of Normalizing Citizen Development at Shell

Phase	Description
1. Sensemaking	Internally exploring the meaningful qualities of current practice and questioning current values, assumptions and beliefs about how best to achieve effective digital transformation. This phase promoted a culture of continuous process improvement.
2. Stakeholder Participation	Stakeholders' exploitation of digital technologies to transform values, assumptions and beliefs about optimal ways to achieve effective direction, alignment and commitment throughout the organization. Key elements included the management and systematic embedding of digital transformation through the enrollment of employees and their engagement in newly adopted digital practices.
3. Collective Action	Focus on the work individuals and teams must do to embrace and enact new practices through various digital future pathways to sustain a digital transformation. The success of this is evidenced by transformations of structures, systems, groups and processes so they conform to new cultural and behavioral patterns to meet external digital and energy market demands.
4. Evaluating Progress	Informal and formal appraisal of the value of the DIY citizen development program and reported process improvements. These appraisals provide insights into the impact of new practices arising from digital transformation on organizational structures, social norms group processes and conventions. This phase also validates the initial sensemaking process and creates a cycle for identifying continuous process improvement opportunities for managing and building momentum to sustain the digital transformation process.

decades. These technologies are driving cost efficiency, providing new revenue opportunities and changing business models. For example, Shell now has over 100 artificial intelligence (AI) applications in various stages of development and deployment across its businesses, maintains a data lake with trillions of rows of data, and monitors thousands of pieces of equipment using machine learning across upstream and downstream assets for manufacturing and in the integrated gas organization. Though it may be relatively straightforward to develop a small-scale proof of concept of a machine learning model for a specific local requirement, Shell strives to develop solutions that can be deployed globally at a rapid pace. To do this, the company is standardizing approaches and deploying common data structures, platforms, tools and ways of working across businesses so that it can deliver competitive and affordable technology in the transition to low-carbon energy systems and economies.

Shell acknowledges that digital technologies have already transformed the energy industry but realizes that much more needs to be done—for example, with digital twins, remote operations and autonomous assets. Shell recognizes that the digital transformations necessary to achieve this will require more than just a focus on technology. Deep cultural change will also be needed with a focus on people and agile ways of working. Equally important will be the need to identify areas of growth and recruit the right skillsets. For example, Shell understands the value of employing leading data scientists who can unlock value from the company's rich data sources.

Shell recognizes the critical importance of gaining different perspectives on various digital transformation pathways and of creating an environment where diverse teams enjoy working with other experts across different business units to combine commercial acumen with technical, data and energy expertise. Creating multidisciplinary teams will enable Shell to develop practical solutions and allow the teams to learn from each other and continually improve.

Digital Transformation Mission

The mission of Shell's DIY program is to: "empower every employee to digitize work processes to improve productivity, increase agility and create more value for customers."

Given the wide range of emerging and future technical innovations, it is clear that digital technologies and associated capabilities will present a significant "fork in the road" for Shell as it adapts to meet the ever-changing energy market demands. For example, according to a Digital Innovation lead at Shell:

> *"In the energy transition we will adjust our business models to meet the goals outlined in the Paris Climate Agreement and that's a change in business model for us and that translates to an operating model. Digital transformation is really thinking through how we can use data and digital technology to adapt our operating model."*

In reality, the market drivers that will shape the energy market over the next 20 or 30 years have already been unleashed and Shell's imperative is to explore how digital transformation can help it adapt. As identified above, the human dimension of digital transformation will undoubtedly be as important as code. Digital technologies are transforming consumers' and businesses' behaviors in ways that were unimaginable even a decade ago. Digital transformation in the energy industry is improving efficiency and safety and is facilitating the increased use of renewable energy.

The Importance of Data

Digital transformation at Shell is fueled by data and innovation. For example, radical transformations in IT capabilities are being driven by big data and analytics, which is in turn transforming how the Shell workforce exploits the use of digital technologies for new opportunities. The volume of big data stems from Shell's many physical assets, including refineries and wind turbines, which generate hundreds of thousands of measurements per minute. Analytics provide new insights and lead to the development of new solutions, such as predictive maintenance. In addition, there is now an expectation that this data can be processed in near real time using cloud technologies, and Shell is growing its capabilities rapidly in this domain.

Harnessing these data sources will provide new business insights into where Shell can really make an impact. The ultimate benefit from the combination of a focus on the human dimension, digital technologies and big data will be improved decision-making that drives business value across various future digital pathways. It is critical that Shell's digital transformation efforts focus on delivering more and cleaner energy solutions. And an important component of those efforts is the company's citizen development program.

Citizen Development Empowers Shell to Digitally "Do It Yourself"

Shell recognizes the importance of the human element for digital transformation and has empowered everyone in the organization by introducing its citizen development program called "Do It Yourself" software development. DIY development democratizes access to development tools and enhances digital skills among the workforce, and delivers significant improvements to services and safety, and rapid cost savings. Citizen development at Shell empowers employees who are not officially trained in IT disciplines to create and deploy applications and technology solutions to solve business challenges. The adoption of citizen development has become an important trend in industry and is considered a critical component of Shell's digital transformation journey.

The introduction of the citizen development program[43] was a carefully planned process that aimed to normalize citizen development as part of Shell's digital transformation strategy. The normalization process[44,45] had four phases, which are summarized in Table 1 and explained in detail in the following sections.

This four-phase process has enabled Shell to successfully embed and formalize its DIY citizen development program and establish a *DIY center of excellence*. In accordance with the Project Management Institute's (PMI's) definitions,[46]

43 For details about Shell's Citizen Development program, see *Low-Code/No-code Software Development*, available at https://www.shell.com/energy-and-innovation/digitalisation/digitalisation-in-action/low-code-no-code-software-development.html.

44 Carroll, N., McLafferty, B, Conboy, K. and Donnellan, B. "Normalising a Digital Transformation," *Proceedings of 42nd International Conference on Information Systems* (ICIS), December 2021.

45 Carroll, N. "Theorizing on the Normalization of Digital Transformations," *Proceedings of the 28th European Conference on Information Systems (ECIS 2020)*, 15-17 June 2020, Marrakech, Morocco.

46 The PMI's book PMI *Citizen Development: The Handbook for Creators and Change Makers* brings together the latest thinking on citizen development from industry thought leaders, no-code/low-code vendors, transformation experts and executives who oversee large technology investments.

Shell combined a centralized center of excellence with a community-based model. Modern software tools, particularly in software-as-a-service (SaaS) and platform-as-a-service (PaaS) environments, have revolutionized software development at Shell. LC/NC applications have made it possible for nearly everyone to be a developer and generate value across the business. This means that staff can create their own digital solutions with very little or no code within a safe and controlled environment. However, it does require employees to upskill and evolve their use of various technology capabilities and data sources. This was best explained by a citizen development product manager:

> *"Starting off,. it can be challenging to set a goal. You must be a little flexible and ensure that … your organization [understands] that you may have to pivot based on the data points available to you. So, it's not that once you have decided on a path you will tread that path no matter what, because this is an evolving space. We are evolving with it."*

To facilitate DIY citizen development, Shell has established a self-service portal, provides comprehensive training and nurtures DIY developer communities.

We now describe the four key phases Shell progressed through to successfully normalize its citizen development program. Based on our analysis of the Shell case, we then identify the insights gained from the case, the challenges that have to be overcome in deploying citizen development and the prerequisites for a successful citizen development program.

Phase 1. Sensemaking for Shell's Citizen Development Journey

Citizen development enables Shell employees closest to business issues to solve problems using digital solutions that they create themselves. Outsiders not familiar with citizen development may raise questions such as: *How can Shell safely unleash the potential for citizen development and by so doing, generate significant business value?* The sensemaking phase inevitably involves a focus on change, as explained by Paul Kobylanski, the general manager of DIY:

> *"At Shell, we wanted to leverage and democratize digital technology. This was driven by many factors including the growing demand in the Information & Digital Technology (IDT) department to complete and deliver numerous projects, the necessary changes in digitizing work processes and practices resulting from the COVID-19 pandemic, and … Shell's [need] to keep pace with competition and attract new talent."*

Core elements of Shell's successful adoption of citizen development were:

- Providing the components and platforms needed to enable LC/NC development
- Introducing a standardized operating model with safe boundaries (i.e., the DIY zoning model, see Figure 4 below in the description of Phase 2)
- Developing a citizen development culture and building people's capabilities
- Coaching and guiding employees to innovate and improve process efficiencies
- Establishing and nurturing citizen developer communities across Shell.

Shell's DIY citizen development program was developed with a focus on safety and building simple LC/NC applications and automation to solve real problems. The DIY center of excellence comprises different teams and roles (approximately 30 people) that focus on information risk management, learning, architecture, transformational change and product management. It also has professional developers who support LC/NC technologies and provide a continuing program of investment in project delivery.

Citizen development empowers Shell's employees to create bespoke digital solutions for their daily processes from the data available to them and thus unlock the untapped value in all aspects of the business. The overall vision for citizen development at Shell is to build new capabilities, identify ways to unleash employees' potential, establish new ways of working, enhance the company's reputation, drive digitalization and rapidly innovate to create new business value.

Figure 1: Overview of Shell's DIY Journey

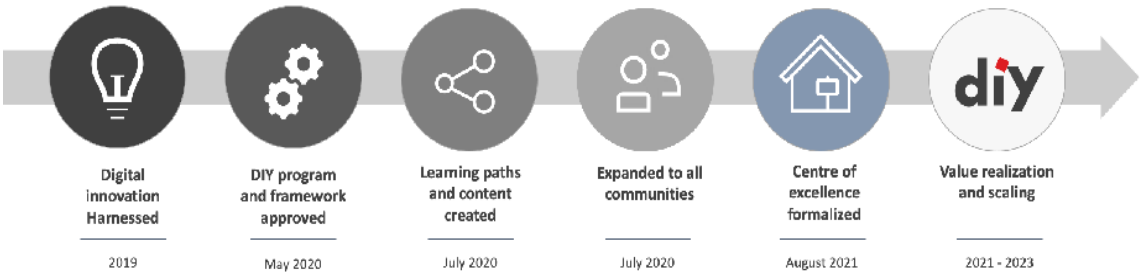


Figure 1 provides an overview of the stages in Shell's DIY journey and the time scale.

The DIY Development program was enabled through cloud, network and mobile technologies, and has now been rolled out across the organization. The COVID-19 pandemic accelerated digital transformation and the prominence of DIY development. For example, during the pandemic, there were a limited number of crews on Shell's physical assets (such as oil rigs), which reduced human contact. Because of this, it was no longer possible to do a lot of the paper-based manual and administrative work that was previously done locally. The pandemic also created a sense of urgency to find ingenious solutions to new problems. In both these areas, the LC/NC tools provided a platform for employees who were now working more remotely from home to create their own solutions. The pandemic did not affect Shell's decision to implement the DIY program but rather strengthened the need for it. As lockdowns were announced by governments across the globe, the adoption of digital technology accelerated at Shell. The rapid uptake of citizen development at Shell must be understood in this broader context. In addition, with working from home becoming the "new norm" during the pandemic, some Shell employees had used this as an opportunity to digitally upskill in many areas, including citizen development.

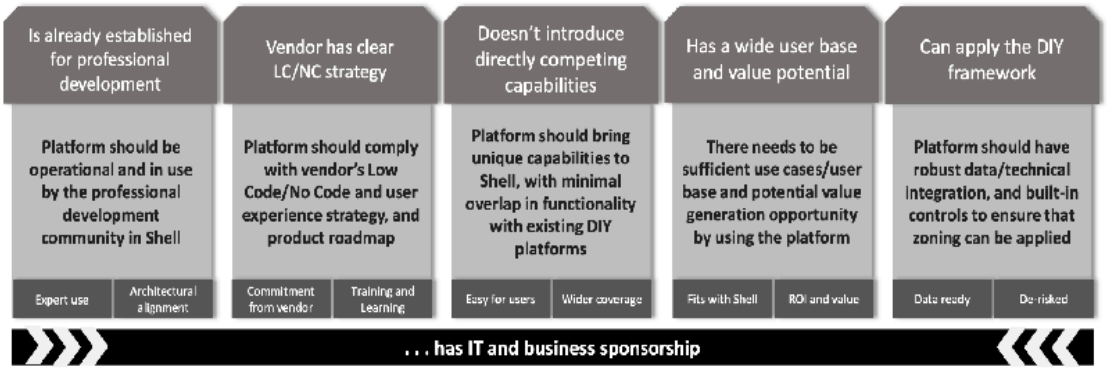
As shown in Figure 1 the DIY development program was successfully launched and formalized across the entire organization. This required significant investment in providing opportunities for employees to digitally upskill, growing global DIY communities and hosting key events such as the Shark Tank (where citizen developers could pitch their digital solutions to a live audience in order to gain exposure and support).

A key part of the DIY success story was senior executive buy-in and support, as summed up by Paul Kobylanski, the general manager of DIY:

> *"When we launched the Shell DIY program, it was supported and endorsed by the executive team, including our executive vice president & chief information officer, Jay Crotts, who are strong advocates for digitalization, with the aim of tapping into the engineers, scientists and data in Shell in response to the emerging trends around artificial intelligence, to get the most out of analytics and data modeling to drive outcomes."*

However, as with any new initiative, there will be some level of resistance to digital transformation changes, and Shell needed to sustain the energy generated by the positive uptake of the citizen development program. DIY was treated as a change program to drive digital transformation, and the DIY center of excellence had an embedded team from Shell's Transformational Change unit. One area of resistance arose from IT employees who were concerned that "DIY will take my job," but DIY actually increased rather than decreased the demand and development of new digital solutions from the IT department. Another concern was expressed by middle managers who said "I have finite resources; DIY is just a distraction." This concern was countered by creating a bootcamp specifically for middle managers that focused on their role, allowed them to experiment in a safe

Figure 2: Decision Criteria for Low-Code/No-Code Platform Selection



environment and demonstrated the value of the DIY program.

Shell has successfully addressed resistance issues by exploring ways to reduce tensions concerning digital transformation, such as identifying ways to co-create value by building on existing skillsets and celebrating employee innovation. For example, a citizen development product manager explained that:

> *"... together as a partnership, we must ensure that all the skills individuals bring to the table are utilized. And that's the idea that really helped me buy into citizen development [and move into] new and unexplored grounds."*

Encouraging employees to engage in DIY development and co-create value proved to be a very successful approach for formalizing Shell's DIY program. Two years into the program, there are 32 local DIY communities of practice, with over 170 DIY coaches delivering over 188 bootcamps and 6,500 trained developers, over 4,000 of whom are actively developing applications. Moreover, the citizen development tools are used heavily within the IT department as part of IT employees' professional development. There is a symbiotic relationship with professional developers helping to bootstrap citizen developers.

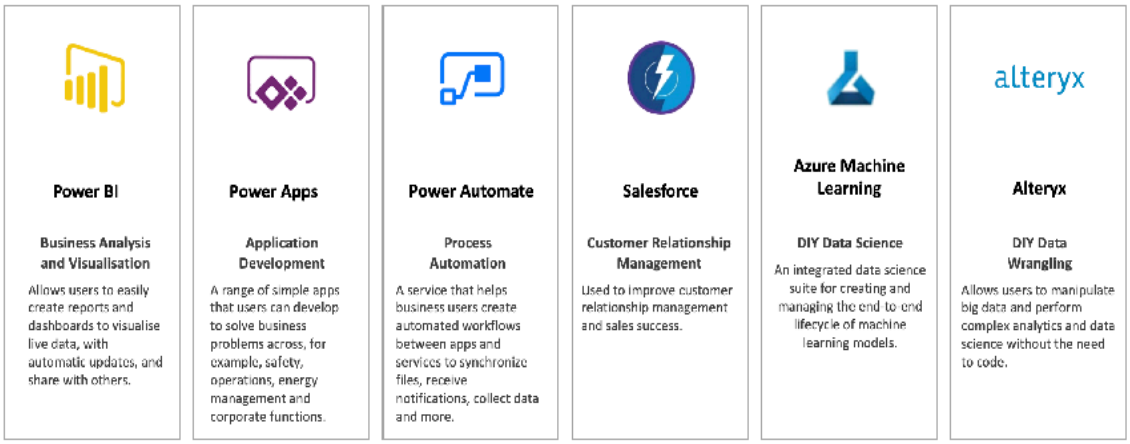
In many ways, LC/NC platforms enable advanced IT development in a more consumable way. This raises the interesting prospect of businesses becoming more tech-savvy and encouraging employees to use IT to enhance operations, which will positively reinforce the perception of the role of IT in generating business value. More importantly, citizen development is closing the gap between Shell's business and IT employees and the distinction and separation between IT and business is diminishing, or at least becoming somewhat blurred.

Note that DIY is optional for Shell's business employees. They volunteer to sign up for citizen development training events or bootcamps. Shell offers a variety of ways to learn about DIY development and supports different learning styles to suit employees around the world. This approach has also created healthy competition between businesses, which is an important part of Shell's overall digital transformation strategy. The DIY learning events are continually growing and evolving through new initiatives and innovations. In addition, Shell has found that the gamification[47] of LC/NC software development is a successful way of spreading awareness and gaining interest in citizen development.

To scale the DIY program, Shell's IDT department made significant efforts to effectively communicate the importance of DIY, the key benefits of the DIY program and citizen development. The DIY program provides many practical benefits, which include: 1)

47 Gamification is the introduction of game design elements in a nongame context. Many organizations use gamification to support employee orientation, training efforts and other organizational activities.

Figure 3: Shell's Suite of DIY Development Tools



fixing inefficient workflows, 2) automating manual processes, 3) improving the customer or employee experience, 4) visualizing data and identifying new opportunities, and 5) enhancing collaboration between teams.

As part of the sensemaking phase to initiate the DIY program, Shell defined decision criteria for platform selection, which focused on "What makes a good low-code, no-code platform?" (see Figure 2). Selecting the right platform was important at the proof-of-concept stage of the DIY program to prove the business case and build on predecessor technologies.

Shell identified several factors to consider when assessing potential platforms, including the evolution of tools, architectural standpoint, diversity of data connections, levels of integration, plug-and-play opportunities and cloud service providers. Other factors focused on the ability of platforms to link with collaboration tools such as visualization and automation so that the DIY program could be developed and made available to a diverse community (e.g., engineers and geologists).

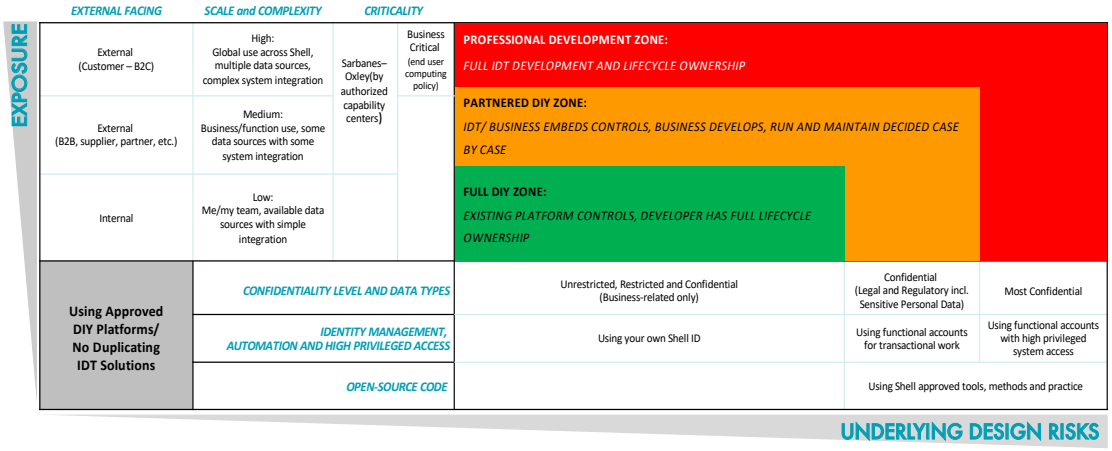
Using these selection criteria ensured that the decision to select an LC/NC platform was informed and accelerated the startup of the DIY program, improved the user experience and provided employees with technology they were familiar with. It also enabled employees to develop B2B solutions based on internal and customer data. Moreover, Shell was able to plan for a strategic partnership with the platform vendor. Mobility and security were also key factors in selecting the LC/NC platform to ensure collaboration and human engagement across large assets on a global scale and scalability to match Shell's business needs. In addition, the evolution of technology adoption improved the DIY development adoption rates, drove value and democratized the technology.

As with any technology or platform, the introduction of the LC/NC platform had to follow Shell's normal budgetary, planning, architectural and portfolio steps and required formal agreement and approval by the IDT department. Moreover, the selected platform had to fit into Shell's DIY framework and have executive business and IT sponsorship.

Phase 2. Stakeholder Participation to Build Momentum for the DIY Program

Digital transformation requires buy-in at all levels of the organization. Engaging stakeholders is therefore critical for a successful transformation. The adoption of DIY development at Shell proved to be extremely useful not only for software development but also for data science solutions. All Shell employees have access to the Microsoft Power Platform via their desktops, and to AzureML and Alteryx through a subscription-

Figure 4: Shell's DIY Zoning Model



based model. The full suite of DIY development tools is depicted in Figure 3.

The DIY community also has access to training resources ranging from business analysis, application development, process automation, customer relationship management and LC/NC data science solutions. A DIY developer described the benefits gained from using LC/NC tools:

> *"These tools were designed to help us become more efficient in our day-to-day job processes, and the big selling features for me was the environmental impact, eliminating the pen and paper mentality and the time saved from streamlining processes."*

Low-code application development is the backbone of Shell's DIY program. However, given the broad access to and use of LC/NC tools, there was a need to introduce the necessary controls and governance in line with industry-standard models from consultancies such as Gartner, Forrester and the PMI. Shell adopted a risk-based model to help mitigate the risks and ensure responsible citizen development. This became known as the "DIY zoning model" (see Figure 4) and was used to successfully balance the autonomy employees enjoyed as citizen developers against the inherent risks of DIY development.

The DIY Zoning Model Empowers Employee Innovation and Creativity

It is important to Shell that employees feel empowered to employ their innovation and creativity skills through digital tools. The motivation for introducing the DIY zoning model was to encourage stakeholder participation and not to stifle employees' innovation or creativity. Encouraging innovation and creativity means that Shell can attract very strong talent and empower employee productivity, increase agility and create more value for customers.

The DIY zoning model adopted a traffic light system to categorize the level of risk exposure and complexity:

- The full DIY green zone, which is open to all employees to develop digital solutions
- The partnered DIY amber zone, where DIY developers collaborate with specialists from the IDT department or upskill for certain digital solution developments
- The red zone, which is a non-DIY area and is limited to professional software developers.

Table 2: Risk Assessment Checklist for DIY Apps

1. There is clear business/process ownership of the app
2. There is a procedure for opportunity identification and approval
3. There is an inventory of all implemented apps
4. Design of the app is clearly documented
5. There is a controlled change management process for the app
6. Clear operational documentation is available
7. Data integrity (including interfaces) of the app is ensured
8. Access management is controlled in all environments
9. Incident management and escalation procedures are established
10. Interoperability, backup and recovery procedures are established

The zoning model also helps to safely expand the data sources that citizen developers can access. Data is a critical resource because if there is no data, the DIY program cannot operate. Citizen developers initially work within their own networks and use the data they have access to. As their competencies in developing LC/NC solutions grow, they are granted access to additional approved data sources. Bringing additional data sources onstream in a secure way is a core pillar of the DIY program. The DIY zoning model enables employees to explore ideas and experiment within preset boundaries for access to data sources.

The Zoning Model's Role in DIY App Risk Assessment

Risk management is not only important for LC/NC application development but also for identifying whether the output of an app is correct and will continue to be so into the future. Within Shell, the business and process area is responsible for ensuring the quality, security and ongoing viability of DIY apps. To assess risk, it has developed a 10-point checklist that all citizen developers must consider to ensure their apps are properly managed and the output is correct (see Table 2).

The purpose of each checklist point is described below:

1. Ensures that all apps drive value because they must have clear business or process ownership. This also encourages employees to consider the value added and the need to develop a digital solution.
2. Ensures that a procedure is in place to identify opportunities and approve the app development.
3. Ensures that all implemented apps are stored in an apps inventory and that proposed new apps do not duplicate existing ones.
4. Ensures transparency by requiring design documentation for the app.
5. Change control is a key part of any wider quality management system; the change control process ensures that any changes to a DIY app are introduced in a controlled and coordinated manner.
6. Emphasizes that continuous improvements are a key part of the DIY program and clear documentation is a vital part of this process.
7. Assures data accuracy and integrity of DIY apps over their entire lifecycle, including maintenance.
8. Focuses on access management to identify, track, control and manage authorized user access across the DIY program.
9. Focuses on incident management and escalation procedures for citizen developers who cannot resolve an incident themselves and need to hand on the task to more experienced or specialized employees within Shell.

10. Concerns the interoperability, backup and recovery procedures of DIY apps. These procedures are among the most critical operations performed and require the DIY program to maintain current, flexible, secure and speedy solutions to ensure the data from DIY apps is accessible at all times across Shell.

In line with information and security risk best practices, Shell's evaluation of DIY app risk is a multistage process. First, the DIY developer carries out an initial or early-stage risk assessment before development starts. Second, a detailed risk assessment is carried out for cases in the amber and red zones of the DIY zoning model. These second-stage risk assessments are made available to a DIY coach to review workflows. Third, each quarter, Shell assesses a sample of green, amber and red zone apps to ensure that risk assessment is being conducted and continuously monitored. Given the nature of Shell's business, risk assurance is a key element of the company's learning culture. Consistent with this culture, Shell continually coaches employees on how to identify the need for changes in the risk profile of DIY apps, which also leads to new employee behavioral patterns.

The Importance of Agile Approaches for Citizen Development

The agile nature of citizen development requires effective communication practices to build a community of developers. Citizen development follows an agile software development approach and aligns with the Agile Manifesto.[48] This manifesto comprises four foundational values: 1) individuals and interactions over processes and tools, 2) working software over comprehensive documentation, 3) customer collaboration over contract negotiation, and 4) responding to change over following a plan. Each agile methodology applies the four values in diverse ways, but all rely on them to guide the development and delivery of high-quality solutions while maintaining a user focus and continuous improvement mindset.

To promote effective communication among the community of DIY developers, Shell leveraged various social media and communication channels, including a dedicated group on the company's Yammer Enterprise Social Network and a DIY Skills Development Plan and Roadmap. Shell's DIY center of excellence also helped to promote communication. It has also established "diyXchange," an internal website that includes a library DIY apps that can be shared.

Phase 3. Collective Action to Embrace and Enact the DIY Program

A key initiative to create greater awareness of the DIY program was the introduction of LC/NC hackathons. Shell's former vice president for DIY Software Development, Nils Kappeyne, explained the importance of hackathons:

> *"Occasionally we would augment learning bootcamps with hackathons. Through these hackathon events, we … enabled participants to learn and organize things for themselves so they could upskill. We had one for global manufacturing which was called the 'Shark Tank.' The idea was essentially to add a bit of gamification to the learning and allow people to showcase their apps to senior management. This was an unexpectedly tremendous success, and you have people who are truly proud of what they have done. And rightly so because they really built some cool stuff. They get an opportunity to showcase that to senior management who were blown away by the creativity in their teams."*

The LC/NC hackathons helped to raise awareness of digital democratization and related opportunities. For example, an event called the Hive Hackathon attracted 243 people from 58 teams globally. The winning app promised immediate savings of over $400,000 and potential total savings of $1.8 million.

Since Shell started the DIY development program, citizen development solutions have saved the company millions of dollars across all lines of business, improved safety and reliability, and provided efficiency benefits. The program has also attracted talent from the digital generation. By continuing to embrace and enact the DIY

48 Beck, K., Beedle, M., Van Bennekum, A., Cockburn, A., Cunningham, W., Fowler, M., Grenning, J., Highsmith, J., Hunt, A., Jeffries, R. and Kern, J. *Manifesto for Agile Software Development*, 2001, available at http://agilemanifesto.org/.

program, these benefits are set to grow. Shell is continuing to invest in and expand its citizen development program.

Attracting Talent from the Digital Generation

Citizen development facilitates collaboration between employees, at all business levels and all levels of experience, in solving business problems using LC/NC platforms. A recent hackathon hosted by Shell Norway took this a stage further by inviting students from the University of Stavanger to collaborate with Shell employees and technical experts from Microsoft, resulting in the development of several citizen development apps in just two days. Teams of Shell employees and students worked on existing business challenges that Shell had identified as opportunities for improvement. While benefitting Shell, this also gave the participants the opportunity to upskill by using LC/NC platforms to develop prototype solutions and gaining skills in project management, agile ways of working, design thinking, and teamwork and communication through collaborating across multiple diverse teams. Yiteng Zhang, Digital Technology lead for Shell Norway and the organizer of the hackathon, described it as follows:

> *"We invited university students to join us in a hackathon to help us look at our business cases from a different angle. Our employees' expertise combined with the students' fresh ideas proved very creative as we moved [quickly] from ideation to functioning software."*

The hackathon delivered a range of excellent results with the apps now used as working solutions. The approach taken was described by a Transformational Change manager:

> *"We followed a design thinking approach, using ideation to work out what the problem [was] and brainstorming what the solution might be, but looking into more detail each step of the way and using different tools."*

The hackathon also helped attract new talent from the digital generation, as some students who participated in the hackathon have since joined Shell on internships. For graduates, or for those working in companies that restrict the use of their skills, working for Shell in an environment that empowers employees is an important aspect of the employee value proposition, and has become an attractive option for the digital generation.

Digital Transformation Requires Organizational, Behavioral and Cultural Changes

The diversity of personalities in Shell's citizen developer communities indicates how well employees have received the DIY program. DIY allows professional developers to focus on solving complex enterprise and strategic problems while business users solve tactical problems that together drive significant value across the organization. Overall, the program has allowed Shell to scale software engineering practices and introduce incremental innovations that have resulted in higher service levels and improved customer service. However, the program has also led to the establishment of new roles and responsibilities to further normalize citizen development.

The notion of "citizenship," in the context of application development or the creation of data science solutions, is new. These citizen "roles" are outside the IT department and lie within the business units. At Shell, citizen developers still fulfill their core duties, for example as mechanical engineers, procurement specialists or oil traders. The notion of citizenship is about empowering employees to do their jobs more effectively, more productively and derive more value through upskilling and using a modern LC/NC platform that enables them to develop models, build software-based solutions and visualize data in a trusted and secure way. Shell does not create new DIY software developers or DIY data scientist roles per se, nor do the business units see it in that way. Rather, DIY development is more about employees adding a new skillset and having a new perspective, enabled by the next generation of tools for the digital worker. Citizen development is viewed as part of employees' existing roles in the digital economy.

Nevertheless, Shell has created the new role of DIY coach, which has been key to the success of its DIY program. At the beginning of

Figure 5: How DIY Coaches Sustain DIY Developer Communities and the Digital Transformation Journey

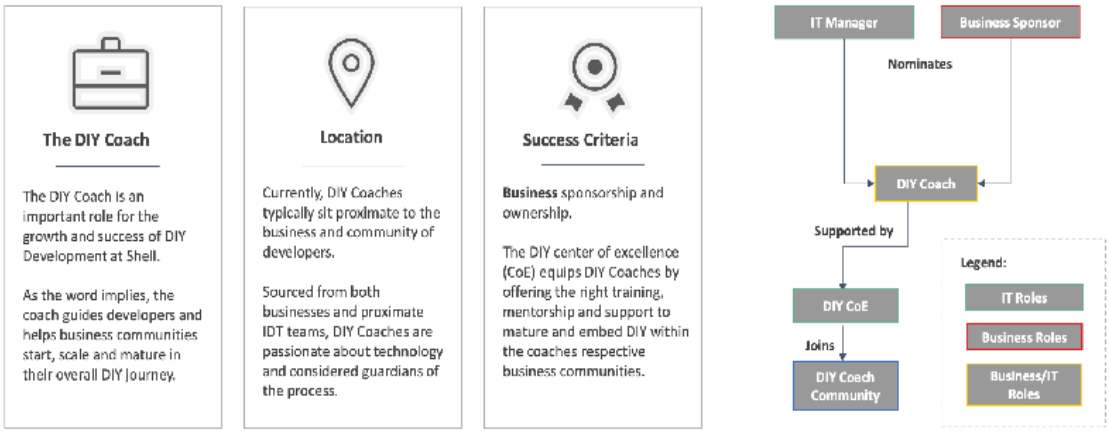
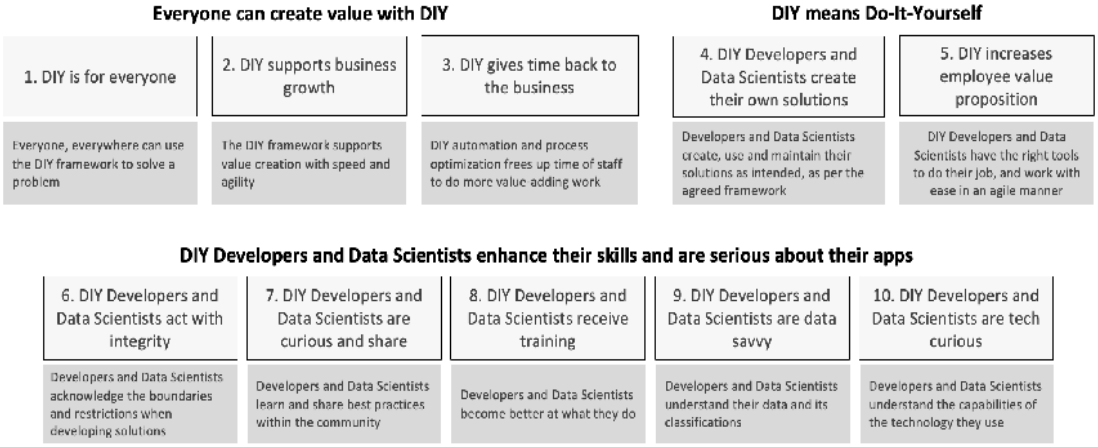


Figure 6: The 10 Principles of Shell's DIY Software Development Manifesto



the DIY program, coaches were positioned as an "IT-business interface" role to manage the relationship between IDT and the business. As the DIY program was scaled up, the role of DIY coaches was key because they managed the conversations concerning boundaries and controls. As such, they were a key part of the DIY program strategy and contributed to the implementation and scaling of the digital transformation strategy.

Together, the new roles and responsibilities of DIY developers, DIY data scientists and DIY coaches drive new behavioral and cultural changes. DIY developers and DIY data scientists are directly supported by DIY coaches, who in turn are supported by the DIY center of excellence. For example, DIY developers can seek guidance from their DIY coaches to determine whether certain data sources may be used or whether the proposed application can be shared with others, depending on its classification, the legal implications, and the target audience. The introduction of these new roles has been fundamental in ensuring that employees conform

Table 3: Sample of Shell's DIY Development KPIs

Category	Example Metrics
Training Sessions and Events (e.g., Bootcamps)	• Completed • Planned • Total number of participants • Business maturity
Usage of Power Platforms	• No. of active developers in the Green Zone • No. of active solutions in the Green and Amber Zones • Employee net promoter score
Deployment	• No. of solutions: implemented; in development; total • Total value ($ millions); implemented; in the pipeline; tracked by lines of business
Operations	• No. of DIY coaches • No. of certifications (DIY passports/DIY visas/external qualifications) • No. of apps on the diyXchange platform

to the new culture and behavioral patterns needed to meet external digital and energy market demands. For example, Figure 5 depicts how the role of DIY coach has played a critical part in sustaining DIY developer communities.

The new behavioral patterns are also critical for ensuring that digital transformation aligns with the overall business vision, as highlighted by a Shell Information Governance manager:

> *"You can't just unleash IT on the business. You need to design and think about what impact it is going to have. What does the behavioral change need to be? What are the risks? And so on. So, in the initial stages, even the ideation phase, you need to make sure that you have the right stakeholders at the table who know [about] business, IT, legal, compliance, security—whatever it might be. There needs to be a clear vision about what you want to achieve and the culture you need to achieve it."*

To ensure that employees understand and can contribute to digital transformation efforts, organizations need to publicly declare the policy and aims, especially the vision and mission, for the transformation process. During the sensemaking phase, Shell published the Shell DIY Manifesto: 10 Rules on DIY Software Development (see Figure 6). This key resource has proved to be extremely effective for guiding citizen developers on how to build, manage and run their applications. The manifesto also highlights the inclusive nature of the DIY program and the autonomy, empowerment and opportunity that employees have to upskill to solve real frontline business problems.

Phase 4. Evaluating Progress to Review the Impact of the DIY Program

Evaluating the success of a digital transformation strategy means revisiting the original mission statement. The mission should be clearly defined and serves as a guide for day-to-day operations and as the foundation for embedding new processes, practices, structures and culture. It should also motivate and inspire employee commitment to sustain digital transformation. At Shell, the DIY center of excellence's mission is to "empower every employee to digitize work processes to improve productivity, increase agility and create more value for customers." This statement provides a powerful incentive for Shell employees to fully engage with digital transformation and realize the following benefits: 1) be empowered, 2) improve productivity, 3) increase agility, and 4) create additional value for customers. Evaluating the DIY program enabled Shell to assess progress in achieving these benefits and the overall impact of new practices, organizational structures, social norms, group processes and conventions for instilling a continuous process improvement

culture. Table 3 outlines a sample of the DIY program's key performance indicators (KPIs) that are evaluated to track the uptake of DIY development across Shell at different points in time.

Shell set strategic targets, such as doubling the number of active citizen developers in 2022. It also has targets for value or returns on investment (not disclosed) and platform usage. All metrics are automated and captured through a central PowerBI dashboard. These metrics are linked to various resources such as training courses, Shell's e-learning system, and other qualitative and quantitative measures associated with the employee net promoter score (eNPS) and dashboard. This dashboard is reviewed monthly by management and is part of Shell's governance. Shell also uses this data to determine progress with DIY initiatives (e.g., engagement, experiments or project-related activities).

In addition, the DIY center of excellence actively uses dashboards that track and display metrics about people and applications. One key people-related dashboard shows the number of active citizen developers, the number of DIY coaches, the number of people using the applications and the number of people at the bootcamps, learning events and hackathons. These metrics are important because they translate directly to the number of people actively building DIY solutions. Another key dashboard, which focuses on applications, monitors and tracks the application register, the number of applications built, the use of the applications within each business, the number of applications in use and the number of those being decommissioned. This dashboard enables Shell to track the end-to-end lifecycle of applications.

Overall, these metrics show that Shell's DIY program has generated significant business value. They ensure that the DIY program maintains momentum and demonstrate that the program is delivering value to the business through cost reductions and improved reliability and efficiency. The central reporting of value is crucial for the DIY center of excellence to encourage asset managers to adopt citizen development solutions and for justifying the existence of the center to Shell's IT executive management.

The impact of the DIY program is also visible across the DIY communities. For example, a winner of "App of the Month" explained that:

> *"With these new DIY tools, it's much easier to interact with many people and be very efficient and have a database where you can store the information and see them use that information. So, I think it's very powerful in that sense [and is] making us more efficient as a team."*

Another key enabler for successful DIY applications is replication. If Shell can clone or replicate a solution, it not only multiplies the return but also standardizes ways of working.

The Shell DIY program was also designed to align with organizational performance measures in five specific areas: 1) information risk management, 2) operations, 3) business value, 4) digital transformation progress, and 5) resourcing and delivering digital futures. Performance measures for the DIY program also include: 1) ethics and compliance; 2) people, capability and skills; and 3) operating responsibly and sustainably.

The performance measures play a key role in normalizing citizen development and ensuring employees feel empowered and involved in the digital transformation process. For example, the former vice president for DIY Software Development, Nils Kappeyne, explained that:

> *"Employees are energized [by] the ability to unleash creativity, the ability to bring innovation close to people and have those people closest to the business problems solve them through the use of IT. I think we're leading in the industry's uptake of citizen development, and this has had a positive reputational impact and [is] therefore a key element in attracting talent."*

Insights from Shell's DIY Program

In this section, we describe the insights gained by Shell as it scaled up its DIY program.

Organizations Need to Transform or Be Transformed

Shell realizes that, to deliver lasting change as part of a wider digital transformation, it needs to take actions that both boost performance and inspire employees. Business models and mindsets across the energy industry need to shift to truly transform operations for the public good and to digitally transform internal capabilities, financial performance and culture. As digital technologies such as AI continue to evolve, organizations will either need to transform or spend considerable time and cost reacting to being transformed.[49]

Shell has identified significant opportunities for deploying AI and other emerging technologies such as blockchain[50] as part of its digital transformation strategy. It believes that recruiting data scientists and advances in computing capabilities and algorithms will enable AI to perform human-like tasks by exploiting big data sources. Shell's deployment of AI predictive maintenance at a global scale is an impressive achievement that is delivering significant economic, environmental and human safety benefits.[51]

These more powerful tools and features are becoming increasingly available via Shell's DIY program. With advances in technology and the power of LC/NC platforms, and with additional training, employees can create DIY AI-based applications (machine learning and natural language processing) using drag-and-drop controls.

It is also important to recognize that customers are central to how and why organizations embark on a digital transformation because it forces organizations to change their business models and adapt to new market realities. Paul Kobylanski, Shell's General Manager of DIY, said:

> *"Shell does a lot to try to understand our customers. And that's where AI comes in as well and we can use multiple sources of data to actually give a much more holistic picture of what our customer needs."*

The Need to Provide Support for DIY Developers and Coaches

Citizen developers at Shell are accountable for the full lifecycle of the DIY applications they develop. Though DIY developers must be self-supporting, they also benefit from the support of a strong DIY community and IT-endorsed guidelines, as explained by a DIY lead in Shell's IDT department:

> *"With the DIY program we have a capability in the business. We support the business as best we can from an IT perspective and can really find that balance between speed and creativity on one hand, and on the other hand between stability and safety."*

For example, DIY developers are required to enroll in the "DIY Passport Learning Path," which focuses on the basic concepts of citizen development and provides an introduction to the different platforms and tools available for DIY. It is available to everyone in Shell through an online learning management system. More advanced DIY power users, DIY data scientists and DIY coaches are required to enroll in the "DIY Visa Learning Path," which covers confidentiality, integrity and information security. All DIY developers who want to share an app must enroll in this path so that they are aware of the risks. DIY developers can also access additional external online training resources to support their efforts. Providing learning opportunities is fundamental to the success of the DIY program and encourages employees to upskill.

Shell is also rolling out the PMI's Citizen Development Practitioner course material.[52] It is also exploring ways to gamify learning and, as a result, over 2,500 employees subscribed to the 90-Day PowerBI Cloud Challenge, and 600 to the

49 Carroll, N., Hassan, N.R., Junglas, I., Hess, T., and Morgan, L. "Transform or be Transformed: The Importance of Research on Managing and Sustaining Digital Transformations," *European Journal of Information Systems*, May 2023, (32:3), pp. 347–353.

50 See Marr, B. How Shell Is Using Web3 and Blockchain for Sustainability and Energy Transition, Forbes, Jul 15, 2022, available at https://www.forbes.com/sites/bernardmarr/2022/07/15/how-shell-is-using-web3-and-blockchain-for-sustainability-and-energy-transition/?sh=bc2069356f76.

51 Naoum, N. *For Shell, AI and Data Is as Critical as Oil*, VentureBeat, June 24, 2022, available at https://venturebeat.com/2022/06/24/for-shell-ai-and-data-is-as-critical-as-oil/amp/.

52 This course provides training on the PMI's Citizen Development Methodology and Framework, which supports the development of DIY applications in a consistent, compliant and scalable manner. For more information, see https://www.pmi.org/citizen-developer/courses/developer-practitioner.

Table 4: Examples of Successful DIY Development at Shell

Application	Challenge Addressed	Addressed	Addressed
Automate a manual process and visualize data for better insights			
Pump Management Tool and Pump Card	The process for repairing pumps and rotating equipment at the Shell Deer Park Refinery, Texas, was largely paper-based and was proving costly. There was no easy way to visualize the overall health of pumps and maintenance safety risks.	Refinery engineers used PowerApps to develop a powerful "Power Automate" app to automate workflows and business processes. This app gave frontline engineers easy access to required data and helped to manage and supervise complex and time-consuming maintenance procedures.	The DIY app provided access to a single source of data, increased the efficiency of pump maintenance and reduced the risk of unplanned downtime, emergency repairs and associated costs. The refinery aims to achieve a 50% annual reduction in pump repair time using the app.
Water Discharge Application	Creating a report that states how much water, from what sources and to what location Shell discharges at its Rotterdam Energy and Chemicals Park. Shell needs to manage water discharge in compliance with government-mandated regulations. This reporting process required staff to fill out a complex macro-riddled Excel spreadsheet.	The DIY Water Discharge app provides a much easier and faster process for logging water discharges and supports both compliance and environmental goals.	Since launching the app, Shell can submit double the amount of water discharge requests to the environmental department.
Increasing Furnace Efficiency	Shell's Chemicals Park at Moerdijk (in the Netherlands) has 20 furnaces that each have 64 burners consuming about 85% of the park's total energy. Each burner needs to be modified/trimmed to multiple different settings to reduce energy consumption. Previously, a manual, industry-standard method was used to apply and document settings.	A DIY application now provides advice on specific trim settings for each furnace, allowing the furnaces to burn at optimum efficiency. The data is stored and shared to PowerBI for visualization and to estimate margins.	This application is helping the site to reduce energy consumption and operate more safely. Optimizing the trim setting for each furnace creates an estimated value potential margin for that site of up to $3 million a year.
Hurricane Recovery Dashboard	When hurricane Ida hit Shell's Norco site in Louisiana, it caused substantial damage, and the maintenance team needed to better understand the work required to restore operations. A digital solution was needed to visualize the overwhelming amount of data and information needed to prioritize the work.	A dashboard that displayed visualizations of large amounts of data to inform and support the team's recovery approach was built within a couple of days and published within six days.	Live information on the dashboard was refreshed every 24 hours and was used for communicating information about the latest status of 1,800+ maintenance jobs so the team was better prepared. The dashboard increased the team's efficiency and saved 30 minutes of work a day per person.

Table 4: Examples of Successful DIY Development at Shell (Continuation)

Application	Challenge Addressed	Addressed	Addressed
Fix an inefficient workflow saving time and money			
Lifting and Hoisting Application	While building the Shell Polymers Monaca petrochemical complex in western Pennsylvania, contractors had to carry out numerous lifting and hoisting operations. On average, a site does up to 40 lifts per day and up to 120 lifts during a turnaround. Before each lift could take place, the lifting and hoisting team had to complete a manual approval process that could take up to 2.5 hours and often required staff to travel across the site.	By eliminating a lot of travel across the site, the DIY app that automated the paper-based approval process made it easier and faster, and improved safety. This mobile app was one of the first to be DIY developed in the Americas.	The app has reduced the time taken to perform a lift from 2.5 hours to about 1 hour, resulting in significant cost savings and almost $2 million efficiency gain per year.
Fire Extinguisher and Maintenance Application	The manual processes involved in the maintenance of all 4,000 fire extinguishers at the Scotford, Canada, site was cumbersome. Each day, emergency services (ES) team members had to search a database to identify which fire extinguishers needed to be checked, print out the documents and physically check the fire extinguishers dispersed all over the site. The checks had to be documented on a paper form, which could become wet and damaged on site, and on return had to be entered into the database once physical checks were complete.	A former Scotford ES firefighter used PowerApps to create a DIY app that splits all the required checks into shifts. A team member uses the app to select a shift and is provided with a list of the extinguishers to be checked. The app autofills details such as the team member's name and GPS locations of the fire extinguishers. It also flags up when a fire extinguisher needs to be replaced, thus improving efficiency and site safety.	The DIY app reduces ES costs involved with printing out paper forms and eliminates the manual hours previously needed for data entry (an estimated savings of at least $35,000/year). The ES team is also benefitting from greater time efficiency and the removal of paper-based forms.
Fatigue Management Tracker	Shell Shipping & Maritime must maintain records of work and rest hours for seafarers to demonstrate that international standards are being complied with. Previously, there was no digital solution used for this record keeping.	A DIY app was developed to ensure better management of the time-recording document and compliance with the standards. A PowerBI dashboard was created to enable visualization of the data, with access enabled through links to a Microsoft Teams channel.	The solution helps Shell Shipping & Maritime avoid noncompliance fines. It also facilitates better management of seafarers' time allocation and improves the ability to forecast future personnel needs. The estimated benefits are in time efficiency and software cost savings.

Table 4: Examples of Successful DIY Development at Shell (Continuation)

Application	Challenge Addressed	Addressed	Addressed
Improve a customer or employee experience			
Product Carbon Footprint (PCF) Calculations Application	Customers of energy products are increasingly demanding reliable and transparent greenhouse gas (GHG) emissions footprint data of the products they purchase. Without that data, they cannot act to reduce their GHG emissions.	A DIY app was developed for sales executives and internal stakeholders for B2B marketing purposes. It allows customers to request in a streamlined way the overview of all product-related GHG emissions that occur until the product leaves Shell. This app automatically retrieves the PCF information and after an approval step, generates an email with the PCF numbers requested by the customer.	The app helps improve how Shell shares the carbon footprint data of specific products with customers (i.e., estimated CO2 emissions through the full product lifecycle). The streamlined collection and sharing of data helps customers better understand and manage their CO2 emissions and thus improves customer satisfaction and retention.
My Learning Progress AI/ML Application	At one Shell site, the learning platform used for training programs contains more than 700 videos and exercises for continual learning. The challenge was to provide learners with the means to track their progress and with recommendations for further learning.	Using PowerApps, SharePoint and Python, a DIY application user interface was developed for, and integrated into, the learning platform. An additional feature included AI/machine-learning-based personal recommendations for further learning.	The My Learning Progress app enables learners to navigate through the learning programs at speed and share their progress with line managers. Learners are also inspired to pick up additional training materials through the AI/machine-learning recommendations made.

PowerApps Cloud Challenge. As one learning advisor explained:

> *"I have seen a shift in Shell, particularly with the energy transition. The need to explore opportunities and trial things fast is becoming more and more important across our organization. We need to also understand how a tool or technology is going to help us with the energy transition. And I think that plays in favor of citizen development, and the pandemic really escalated that."*

Success Breeds Success for Digital Transformation

Two years down the line, citizen development has proven to be a real game changer for Shell, which has led to critical success at an organizational level and paved the way for success at an employee level, where employees now co-create the DIY applications that provide the momentum and underlying mechanisms for sustaining digital transformation. Table 4 provides examples of successful DIY applications at Shell, the challenges they addressed, the solutions adopted and the benefits gained. These examples illustrate how success breeds success in digital transformations that make use of citizen development.

The source material for Table 4 is the stories shared by Shell employees and the examples provide insights into empowerment, continuous learning and the sheer enjoyment of being involved in DIY development. Though Shell's size, business lines and matrix organization may be unique and there is no guarantee that other sectors can achieve similar transformations through citizen development, these examples provide a clear indication that other organizations should adopt DIY development.

Overcoming the Challenges of Deploying Citizen Development

The scale of change required for Shell to remain profitable as it transitions to supplying new forms of energy emphasizes the importance of encouraging non-IT employees to become digital transformation changemakers who develop DIY digital solutions. Shell's *powering progress* strategy is predicated on digital transformation—offering customers more digital options or options underpinned by digital technologies. This is creating a big demand for the IDT department to create, run and manage solutions. However, the DIY program is enabling non-IT employees to alleviate the pressure on IT specialists by developing smaller tactical solutions that generate value through cost reductions, improved reliability and efficiency.

Nevertheless, digital transformation is not always a smooth process and there are many challenges to using the DIY development approach. Though citizen development can help to address the IT skills gap and foster an innovation culture, LC/NC platforms are not enough to implement a successful DIY program. The challenges of citizen development and LC/NC platforms are well documented in the literature.[53] Organizations may have concerns about low application quality and inefficient workflows when non-IT professionals create an app, and the app may be less effective than expected. Moreover, if employees have the freedom to create their own apps, there is a danger that they may reinvent the wheel. As citizen developers build new applications, they may implement features and services that already exist in other apps across the organization.

Organizations may also have concerns about apps not being used because of their lack of business impact. In some cases, the first version or a major feature of a DIY app may not be used due to incorrect requirements, poor workflows or poor design of the user experience. There may also be challenges concerning the accessibility of data and arising from a sense of urgency to adopt a DIY program. There are approaches to address such challenges, but the key is to remind employees that the core focus is on the transformation process and to encourage them to engage in the DIY program. The best way of achieving this is to lower the barriers to DIY development, provide incentives to improve their processes, recognize their contributions, and communicate success stories and best practices that will help to scale the DIY program.

At Shell, the challenges of DIY development and digital transformation were captured by profiling risks in the DIY risk matrix that is used during the risk assessment stage of DIY app planning and monitoring to identify and capture the likelihood of project risks. Using a two-by-two visual representation of the risk analysis, the DIY risk matrix evaluates the potential impact and probability of perceived risks and categorizes them according to their level of probability and severity, and their acceptability levels.

Prerequisites for Successfully Adopting Citizen Development

Based on the insights from the Shell case study, we have identified the prerequisites that need to be in place for an organization to successfully adopt citizen development.

A Good Data Foundation and Appropriate Positioning and Funding

First and foremost, organizations need to have a good data foundation: DIY development is not possible without access to data. It is also important to position and promote the DIY program as a change program and ensure that DIY becomes a key part of the organization's digital transformation and digital literacy

53 See, for example: 1) Silic, M. and Back, A., op. cit., September 2014; and 2) Singh, P. *The Good and the Bad of Citizen Development*, Forbes Technology Council post, July 7, 2021, available at https://www.forbes.com/sites/forbestechcouncil/2021/07/07/the-good-and-the-bad-of-citizen-development/?sh=3b7934cc5d6a.

strategy. Management should also consider whether seed or early centralized investments are possible funding mechanisms to launch a DIY program. Another critical issue is identifying the business need and value added for DIY development and then selecting the right tools that fit with the organizational landscape.

Strong Leadership and DIY Advocates

To drive the DIY program, organizations need to have strong leadership support with clear goals that are also part of the employees' annual goals and appraisal. They also need DIY advocates who can communicate early and high-value use cases and proof points and continue to build momentum for the DIY program. And before scaling the DIY program, organizations must put proper security and controls, practices and procedures in place.

A DIY Center of Excellence

Another prerequisite for success is to establish a DIY center of excellence charged with communicating the value and benefits of citizen development and controlling the growth of the DIY program. Organizations need to decide whether to adopt a central community-based model for the center of excellence, or a combination of both, and ensure that all stakeholders understand the center's role and are empowered to contribute towards it. Shell's experience indicates that a combination of the two models is powerful because it balances speed with control. The central model enables organizations to maintain governance and control over platform choices, architecture and measurement, and set boundaries through security controls, whilst the community-based model facilitates speed of uptake and empowers transformation at a local level.

However, there is inherent tension in the combined model for a center of excellence, and Shell managed this tension by establishing the DIY Coach role. At Shell, the center of excellence is based on the hub and spoke model. If Shell were to fully manage the DIY program from the center, it would have been difficult to move with the necessary speed of transformation and support the Shell global community. There is a risk that the central organization could become too big and possibly detached, or even too restrictive. Conversely, adopting the fully community-based model would have made it more difficult to foster wider collaboration and replicate value on a global scale.

To maintain a level of quality through standards and best practices and given the novelty and potential risks of DIY development, organizations should not adopt a fully community-based model at the beginning of a DIY program. Instead, a combination of central and community-based models for a center of excellence enables organizations to make the decisions that matter at the center quickly whilst maintaining a level of shared purpose and affinity with the DIY movement.

The combined model can also foster innovation and promote more buy-in across the organization and recognizes the IT department as a valued partner. Over time, the balance between the central and community models in a DIY center of excellence can change. Moreover, the aim should be for the center of excellence not to exist forever. However, the purpose of any DIY center of excellence is to drive digital transformation to create competitive advantage and, over time, normalize citizen development throughout the organization.

Recommendations for Establishing a Citizen Development Program

Managers can find it challenging to operationalize digital transformation and embed it into their organizational culture to sustain the transformation process. Based on our analysis of Shell's successful transformation journey, we provide seven recommendations for establishing a citizen development program as an integral part of a digital transformation strategy.

1. Use Citizen Development to Prioritize and Drive the Changes Necessary for Digital Transformation

Digital transformations are considered to be key for responding to changing market needs and thus for business survival and success, but managers often lack the "glue" to deeply embed and operationalize transformation strategies. However, the pace and scale of change that IT departments are expected to deliver can

Table 5: Summary of the DIY Dilemma Arguments

Arguments against Citizen Development	Arguments for Citizen Development
New types of risk exposure	Tackles the "low hanging fruit" of value that the IT department cannot always get to
Immature governance and architectural fit	Uncovers value-generating ideas and spurs innovation
Additional complexity in application landscape	Enables agility and productivity
It's a form of shadow IT	Provides safe "containerized" environments to better harness data and digital governance
Increasing resistance to enterprise-wide IT implementations	Great for rapid prototyping
IT job insecurity or fears	Empowers employees to contribute to digital transformation and improves employee performance and app reproductivity
Resulting pressures on the IT organization	Reduces IT backlog

often cause a digital transformation to unravel. Organizations must therefore consider lean and agile approaches to incremental digital innovation, such as citizen development, to complement major strategic IT deployments. Such a combination can enable organizations to keep up with the pace of change, not through a "command and control" approach, but in a way that meets the expectations of the modern workforce.

With citizen development, business leaders can drive change without relying on scarce and expensive technology and IT specialists. Citizen development initiatives, though nascent, are gaining significant momentum and playing an increasingly important role in driving digital transformation efforts to create new ways of working and engaging with customers and colleagues. It also plays an important role in reducing current frustrations about IT backlogs because it frees up IT departments to focus on their core responsibilities. Overall, citizen development training and governance resources offer a novel pathway for organizations that want to become hyperagile.

2. Empower Employees to Create DIY Applications and Manage Change

Digitalization has transformed working practices and required employees to learn new technical skills, but many organizations do not provide opportunities to hone those skills. Digitalization is not just something that is happening to markets and large software organizations but rather it is something that all employees play a role in on many different levels. Empowering employees throughout the organization to develop innovative DIY applications will enable them to play a critical role in digital transformation. Their apps will reduce stress by fixing inefficient workflows and they will take pride in the solutions they develop. Empowering employees in this way has the additional advantage of potentially attracting new talent.

Empowering employees to upskill and develop digital solutions will not only improve their confidence and competence but will also create a positive transformative ripple effect through behavioral and cultural changes in the organization. The modern young workforce now expects organizations to provide an array of digital tools that enables them to develop digital solutions themselves—i.e., to become changemakers. Citizen development provides a safe way to achieve this because it places guardrails that ensure proper risk management and governance procedures are followed. Even so, there are still considerable arguments for and against citizen development. These arguments, which we refer to as the "DIY dilemma," are summarized in Table 5.

3. Establish the Right Governance for Citizen Development

The ongoing success of Shell's citizen development program demonstrates the importance of investing time in setting up proper governance and zoning controls. It is also critically important that training and education initiatives are central to the DIY program to ensure that all employees progress along the same path. A major incident caused by a "failed" DIY app will set the program back, so it is important to start small and evolve boundaries in line with program maturity and scaling efforts. Organizations need to ask: "What does the right governance for citizen development look like?

Citizen development governance needs to state clearly what DIY development is permissible and what is out of bounds. It should also be consistent with existing corporate controls, employee risk profiles and the authorization and license employees have to operate in various risk zones. Organizations need to have contained environments for DIY development; having everything in "one house" is much better than a heterogeneous set of business-managed applications. It is also important that organizations have the analytics and business intelligence tools to monitor and oversee what is going on in an unintrusive way.

Citizen development governance should reinforce the corporate culture, take account of any safety issues and provide a code of conduct, while also fostering an environment built on trust and psychological safety. At the start of a DIY program, the organization may set a high bar for what is permitted, but this can become less restricted as employees learn how to innovate and develop DIY apps.

However, governance can be divisive when it is misunderstood, and it may be viewed as a hindrance when not properly communicated across the organization. There needs to be a balance between enablement and mitigating risk, and if organizations overemphasize processes or put too many controls in place, the governance regime will make it extremely challenging to initiate a digital transformation and may scupper a citizen development program initiative. Shell took a calculated leap of faith when it opened up many of the DIY tools to everyone in the organization.

Finally, to provide a multi-stakeholder view on citizen development governance, organizations must ensure that conversations take place between business units, the CIO and the chief information security officer (CISO). These conversations should consider how business units put compensating controls in place as part of their own capabilities. Remember, though, that not every part of the business will be equally technically advanced and controls will need to be matched to each unit's maturity.

4. Grow the DIY Community by Supporting Citizen Developers and Recognizing and Celebrating their Achievements

Organizations typically invest heavily in identifying customer needs and behaviors to deliver a product or service to meet those needs. But they focus less on how best to identify the internal needs of employees and how meeting those needs will sustain digital transformation to meet changing customer needs. People are core to any digital transformation, especially employees who are committed to the workplace and feel responsible for and energized by the goals, mission and vision of the organization.

To harness the energy of citizen developers, Shell successfully established a change campaign to drive the upskilling needed for its digital transformation journey. Shell created a dedicated digital curriculum to support, facilitate, guide and coach its employees. It also organized bootcamps and hackathons that brought diverse groups of people together (staff and managers) so that they could learn from each other. These events increased the appetite for citizen development around the organization.

Shell's citizen development program played a key role in generating energy around digital transformation because it created a strong community and sense of belonging. To reinforce the sense of community, Shell created awareness through various events and awards for innovative solutions. This generated a lot of energy and excitement about the citizen developer community and employees wanted to be part of it. The result was that the citizen development program grew organically, driven by positive learning experiences.

We therefore recommend that organizations should put the achievements of citizen developers at the heart of their digital transformation strategy. Recognition of employee contributions will help to grow a new force of change agents. Citizen development empowers frontline staff to improve productivity, create agility and to better serve customers. People also take pride in what they create. At Shell, the bootcamps and DIY coach network provided impetus and encouragement for the program, but it was also important to put users at the center of the DIY program by getting them to tell their stories and thus feel good about their achievements.

5. Introduce an Element of Fun to Embed in the Digital Development Culture

As stated above, recognition is key to integrating and sustaining the citizen development culture. Shell has introduced an element of fun to the way it recognizes DIY developers by making citizen development community-based gamifying part of the digital transformation process. For example, it held award events with nominations in categories such as "App of the Month" to recognize and reward citizen developers. In addition to maintaining citizen developers' level of interest, these events also drove the digital transformation process forward.

Another key technique for sustaining a citizen development initiative and maintaining levels of interest is to create a culture in which citizen developers identify with each other and thus not only feel like they are part of their department but also part of the transformation journey and movement toward a more sustainable future. Communication within the citizen developer community is vital and can be done through various internal communication channels (Shell, for example, used its Yammer Enterprise Social Network). Being part of a community provides citizen developers with a sense of belonging and creates opportunities to learn, meet, share, connect, showcase work and document business cases. Ultimately, this results in various teams telling their stories of DIY apps and what can be achieved with citizen development, which maintains momentum for digital transformation.

Shell's success was also due to management setting very clear expectations and marketing citizen development internally. Though employees do not need to be software engineers to deliver digital solutions, they are expected to upskill, learn about the technology and take advantage of the learning pathways available to them.

However, Shell's experience shows that developing DIY apps that improve productivity also requires an element of fun. Gamification offers an exciting strategic approach to improve the uptake of DIY initiatives by creating new experiences in playing games or competitions in order to motivate and engage users. With the help of technology, gamification can allow organizations to turn monotonous professional tasks into fun tasks, turn lonely work into a collective challenge or a competition, and turn individual success into public recognition. Introducing an element of fun will motivate employees to get the best out of themselves in their professional roles and continue to find meaning in their role within the digital transformation process.

6. Leverage the Democratization Provided by Citizen Development for Creating Digital Solutions

Citizen development enables organizations to become more productive and achieve their goals efficiently by democratizing development. In simple terms, the democratization of technology can be considered to be a way of making digital technology accessible to everyone in the organization, not just software engineers. The Shell case study is an illustration of the democratization of application development where citizen developers rapidly create their own bespoke solutions rather than adding to the backlog of the IT department. Citizen development therefore offers a new capability to organizations that can be leveraged tactically and strategically to improve workflows. Organizations that empower all their employees to engage in citizen development can dramatically improve their performance and productivity.

The growth of citizen development provides organizations with a practical mix of speed, simplicity and flexibility as part of their digital transformation strategies. Note, however, that

citizen development is not intended to replace skilled software developers or data scientists but rather provides additional digital capabilities for creating powerful solutions that enhance business teams' productivity and performance.

7. Be Highly User-Centric

Digital transformation will only be successful if the culture and behavioral patterns in the organization change and if citizen development is normalized throughout the organization. To achieve this, organizations must adopt a highly user-centric approach that encourages employees to become increasingly invested in and fascinated by continuous improvement opportunities. One technique for fostering user-centricity is design thinking, which provides a cultural ideology and a process for solving complex problems in a highly user-centric way. The outcome of such techniques is that it embeds and normalizes continuous improvement as a cultural norm and therefore drives digital transformation forward.

Though a DIY program must be highly user-centric, citizen developers should not be penalized for failure but instead encouraged to adopt the learner mindset that is at the heart of the organization's culture. Equally important is the principle of "fail fast and learn fast." LC/NC platforms support this principle by empowering employees to create, prototype and even discard solutions. Organizations also need to provide coaching and put the correct frameworks and tools in place to support employee education and learning.

Concluding Comments

Digitalization and energy transition are two fundamental transformations that are changing the world and the energy industry. Shell's journey exemplifies how to successfully align digital transformation with changing market needs and motivate all employees to take the same journey. The Shell case highlights the capabilities and key building blocks organizations need to develop and pursue a digital transformation strategy. For Shell, one of these key building blocks has been to establish and scale up its citizen development program.

A key part of citizen development at Shell is to encourage employees to "do it yourself" and to embed DIY development in employees' work practices. Citizen development provides a set of tools that can drive efficiencies, improve operations and encourage employees to view DIY development through a lean or continuous improvement lens. Software applications, fueled by data, are now an essential part of everything employees do. Many Shell employees engage with the DIY program out of passion and a desire to make things better, which is underpinned by the key principle of having a learner mindset to keep up with the pace of change.

The Shell case demonstrates that digital transformation is now a business imperative and that organizations should actively embrace the changes driven by digital disruptions, which can be supported through citizen development.

Appendix: Research Methodology

We gathered data for the Shell case study through several qualitative methods to learn about how an organization can seize opportunities to digitally transform by empowering employees through the implementation of a DIY citizen development program. We conducted an intensive study of Shell's citizen development journey, known within the organization simply as DIY Development, to explore the rationale for the implementation of citizen development, how the initiative was sustained and how it ties in with Shell's digital transformation strategy.

We conducted 18 in-depth semi-structured interviews and discussions with key information systems and business managers and leaders. Interviewees ranged from the former vice president of DIY Software Development and senior business and technology managers to engineers in the business and frontline workers who had been awarded as DIY Heroes for their development journeys. The interview data was categorized, coded (open coding, axial coding and selective coding) and integrated to provide an explanation of the conditions, actions or interactions, and consequences of the case study actions.

To aid the triangulation of the analysis, Shell also provided access to all relevant current and archival information about its methodology, key events, approach to

citizen development and performance. This information included presentations, field notes, technical documentation, dashboards, annual reports, published statements on its websites, presentation slides, videos and other official documents such as online news articles and press releases.

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