

Large Capital Projects in the Energy Sector: Unleashing Profitability and Safety with Digital Transformation

Executive Summary

Developing large capital projects (LCPs) in the oil/gas and power industries is a complex business. Safely delivering on schedule and on budget seems to be very difficult to achieve, whether it be a new offshore exploration or production facility, a gas pipeline, a refinery, or a power plant. Often the projects are executed in remote and harsh locations, sometimes in unstable political environments. Multiple parties are involved: owners, including JVs and consortia; engineering, procurement, and construction companies (EPCs); and contractors. Large capital projects require a significant number of people, not just on the EPC side, but also on the asset owner side. These projects are so large (frequently over a billion euros) and risky and require so much capital that they can directly create or destroy company shareholder value. In addition, EPCs now face increasing competition. They need to move faster without compromising safety, and they need to generate more revenues and improve margins.

Could digital transformation be a way to increase revenues and margins for companies involved in large capital projects, while also improving project and worker safety?

To answer this question, Siemens asked IDC to create a digital maturity model for large capital projects in the energy sector and to assess the digital maturity of both EPCs and asset owners. Based on interviews with Italian players operating in both the oil/gas and power industries, and on an assessment of their financial data, IDC analyzed companies' priorities and business challenges, and assessed their digital maturity in relation to large capital projects. IDC also looked at how the levels of profitability (using an EBITDA-to-sales ratio) and worker safety (using the total recordable injury frequency) vary with the increase in digital maturity. This study shows that:

- *77% of companies involved in large capital projects (EPCs and asset owners) are about to start their digital transformation journey.* 13% of EPCs are classified as Digital Explorers (level 2 on a scale of 1 to 5), and only 10% are Digital Beginners (level 3).
- *Higher digital maturity translates into better performance.* Profitability of Digital Beginners (level 3), measured in terms of an EBITDA-to-sales ratio, is on average 3.5 points higher than for Digital Explorers (level 2).
- *Worker safety shows the same positive trend.* On average, it increases 20% from level 3 to level 4 of digital maturity.

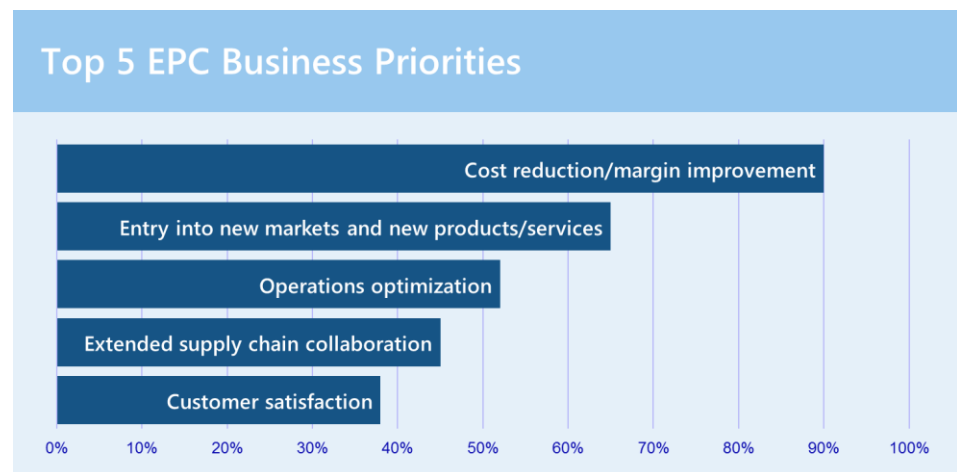
The Quest for Efficiency and New Revenue Streams is Shaping EPCs' Strategic Agenda

Competition and Speed are Changing the Rules of the Game

It is no surprise that cost reduction is the top business priority for almost all EPCs, together with the need to increase revenues by entering new markets or developing new products and services (see Figure 1). Another key issue, however, is the rapidly increasing competition. Many operations are now on a fast track due to this increasing level of competition. The general acceleration of time to market and time to value has shortened development times, adding pressure on both engineering and scheduling, with a dramatic increase in risks. The need for speed also challenges partners' onboarding, impacting formalized roles and standardized processes, and raising new requirements that don't always fit well with traditional governance models. This implies that too often new LCPs require some time to effectively organize all the partners along the value chain. Agile integration is becoming an essential differentiator in the sector, safeguarding both customer satisfaction and project efficiency.

Figure 1

Key Business Priorities in Large Capital Projects



Source: IDC, 2018; LCP Digital Maturity Assessment Study — Commissioned by Siemens PLM Software

Speed also impacts operations optimization. Despite a genuine focus on innovation and flexibility by the top management, global EPCs are pretty heterogeneous in their local operations, with branches having to deal with local constraints that are negatively impacting overall innovation and the effective reuse of technical knowledge. All players interviewed share a common story: "Our people have strong technical backgrounds and highly specialized technical skills, but when it comes to exiting the comfort zone they lack some adaptability." And that is especially true when talking about digital transformation.

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Distinctive Business Priorities Across the Large Capital Project Value Chain

To better understand the distinctive challenges of companies involved in large capital projects in the energy sector, the study created three macro-categories of players (defined as the "LCP value chain" in the rest of the document):

- **Owners.** The initiators of the large capital projects, who usually end up operating the assets once commissioned.
- **Tier 1 EPCs.** Generally responsible for the overall design of plants and complex equipment and supply maintenance services. These are very large organizations with revenues up to billions of euros, and they act as the main contractors on a global scale.
- **Tier 2 EPCs.** Generally smaller organizations than those in tier 1 that work on the design of components or relatively simple LCPs. These companies often collaborate with tier 1 players.

These days, owners need to be able to move faster than before, due to a range of exogenous factors (market conditions, geopolitical situation, technological change). As owners represent the point of origination of every business requirement, the substantial acceleration of their business processes and the drastic reduction in time to market means more pressure on EPCs. Owners' common mantra is the consolidation of a vast portfolio of different activities, maintaining a high level of operatorship only on the most profitable projects and focusing on high-margin activities.

From interviews with senior management of tier 1 EPCs, a clear common focus on innovation, including digital, is seen as the only way to strengthen their "broker" position in a value chain that is becoming even more challenging as future trends unfold. Tier 1 players show a strong strategic focus on innovation as the essential instrument for surviving international competition and staying ahead of the global market. The entry into new markets, the development of new products and services, and digital transformation imperatives are all broader perspectives and important goals to be realized in the mid to long term. Some of them are embracing an open innovation mindset, collaborating with start-ups, academia, and research centers to test POCs of new technologies and applications, while others are creating small incubators inside their organization to foster the sharing of innovative ideas.

Some tier 1 EPCs are nevertheless concerned about the risks brought about by poorly managed innovation processes, and are focusing on internal processes and project management quality improvement. Their business scouting for new market opportunities and business model innovation is more focused on the development of new knowledge-intensive business services based on field research and analytic insights.

Moving along the LCP value chain, many tier 2 EPCs, even more than tier 1, are suffering from the ever-increasing scale of international competition, with rising costs and shrinking margins. They are struggling to scale up in terms of financial and technical capabilities and cope with evolving business requirements. For these reasons, tier 2 EPCs are very focused on controlling process lead time. They are

About 80% of EPCs are struggling to acquire and develop digital skills and IT competencies required to manage and design the plants of tomorrow.

moving toward tighter integration with customers' processes, collecting the analytics to measure and showcase the quality of their service, especially to support their quality rating during contract negotiations. They are also trying to consolidate and create long-term relationships with their clients.

IT Priorities Evolving to Support New Business Challenges

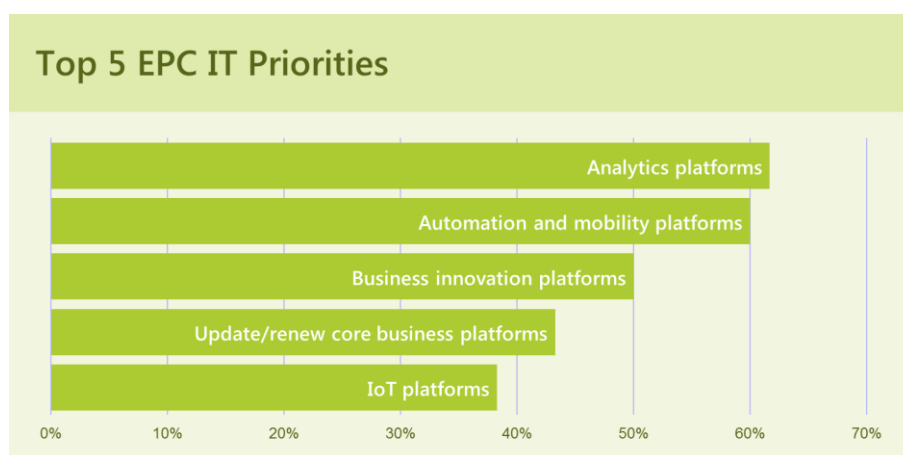
In recent years many EPCs have gone through a phase of application rationalization and consolidation of fragmented IT environments. In many cases they have renovated core business platforms and standardized basic business processes on a global scale, investing in new ERPs, design solutions, and project management and mobility platforms. They have renegotiated contracts with IT vendors to align commercial conditions with their cost-reduction goals.

As a first step toward digitization, they embedded standardization and compliance principles within their processes. Major players invested in the automation of operational workflows, trying to move a step further up the digital transformation ladder. But they soon realized that bringing automation to the next level requires the development of a new background of advanced IT skills, data analysis capabilities, and digital competencies: 95% of companies operating across the LCP value chain recognized that IT skills improvement is by far their major challenge.

To better support business priorities, LCP players are investing in a series of capabilities (see Figure 2). These include more analytics and IoT platforms to build an enterprise intelligent core, modernization of core systems of record and development of platforms for business innovation, and increased automation of processes and empowerment of people operating in the field via mobile tools and applications.

Organizations have already invested heavily and consistently in analytical technologies, both platforms and algorithms, especially in the past five years. But many still feel the need for a more organic coordination of new investments in technologies with parallel growth in skills and process redesign. Poor orchestration here is undermining investments, leading to greater complexity.

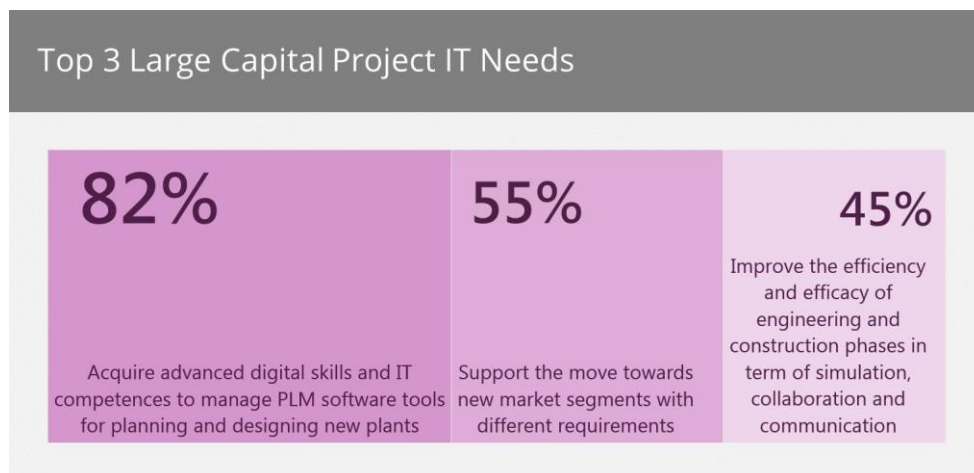
Figure 2
Key IT Priorities to Support Large Capital Projects



Source: IDC, 2018; LCP Digital Maturity Assessment Study — Commissioned by Siemens PLM Software

Looking more specifically at the needs in terms of large capital projects (see Figure 3), EPCs are still struggling to acquire or develop the digital skills and IT competencies required to manage and design the plants of tomorrow.

Figure 3
Large Capital Project IT Challenges



Source: IDC, 2018; LCP Digital Maturity Assessment Study — Commissioned by Siemens PLM Software

Digital Maturity of the LCP Value Chain

Organizations Are Evolving at Very Different Speeds

The level of maturity of the players operating across the LCP value chain has been assessed using a specific LCP maturity model developed by IDC for this study. The model considers 10 criteria (see the Appendix for the detailed methodology) and five levels of increasing maturity: Digital Resister (level 1), Digital Explorer (2), Digital Beginner (3), Digital Transformer (4), and Digital Disrupter (5).

Overall the entire LCP value chain is at the beginning of the digital transformation journey, with about 77% of it far below level 4.

A distinctive but consistent pattern emerges if the three macro-segments of the EPC value chain are separately evaluated: tier 1 EPCs on average have a higher maturity level compared with tier 2, with owners in the middle (see Figure 4).

Most of the owners are at level 2, even if they clearly stand out on a few specific criteria and capabilities: they value connected processes and have developed proprietary algorithms for advanced simulation. Despite that, they are still not putting all the pieces of the puzzle together — digital operational twins, for example, are still far from being an implemented reality.

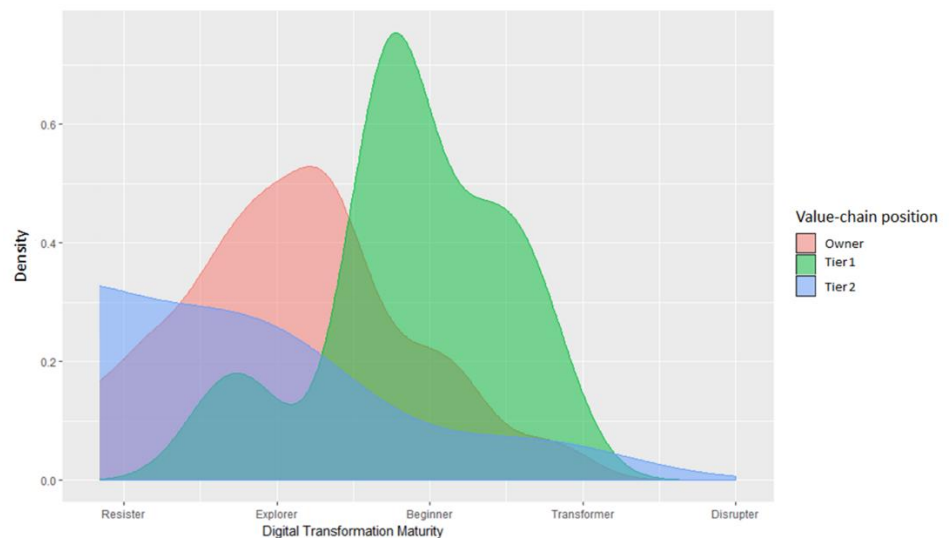
Overall maturity improves when the focus shifts to tier 1 suppliers. Most of them are at level 3. Advanced tools for digital simulations are commonly used by many different players, but mainly within the design phases. Detailed digital twins of the full asset as it should be in operations are rarely available. So, engineers still cannot fully simulate and fix construction issues in a dynamic model prior to the physical build. Additionally, many tier 1 players still lack the full integration of the costing information in these models.

77% of the LCP value chain is about to start its DX journey. 13% of EPCs are at the Digital Explorer level, while 10% are well positioned as Digital Beginners.

Digital maturity is lower (mostly level 1) among tier 2 players, with the focus of every process shifted to simpler platforms and tools. Many technical departments of tier 2 suppliers use mainly basic and standard design tools for computer-aided design and engineering, focusing on structural and kinematic calculations for single components, without any standard approach for integration with 4D or 5D variables. The main concern at this level of the value chain is the accuracy of layouts and structures without compromising safety and efficiency.

Figure 4

Large Capital Projects Value Chain — Companies' Digital Maturity



Source: IDC, 2018; LCP Digital Maturity Assessment Study — Commissioned by Siemens PLM Software

Across the LCP value chain, the ability to fully leverage the value of data and information at enterprise level, removing project silos, still needs to significantly mature.

In very few cases, a specific team or function with responsibility for digital transformation is created. In these cases, the new digital team, typically staffed with people from IT and business, is tasked with promoting technological scouting and driving innovation.

This IDC study shows that the area where on average all players are less mature is operations, which includes digital simulation practices, project and asset life-cycle management, and integration of processes. IoT maturity is also still low.

In summary, digital transformation is still not pervasive across the EPCs and is sometimes, at risk, downgraded to the pure adoption of new IT technologies.

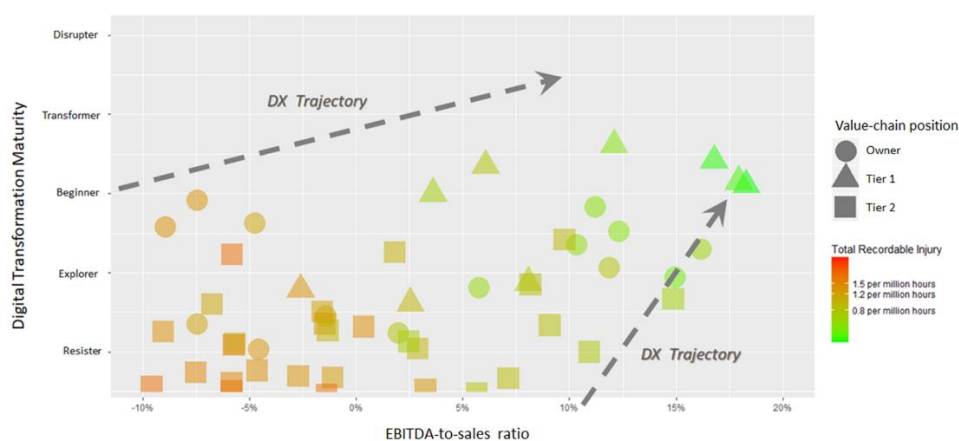
Potential DX benefits for the LCP value chain include a 2- to 3-point increase in the EBITDA-to-sales ratio and a 20% drop in risk for each step of the maturity stage.

Digital Maturity Drives Up Both Profitability and Safety

Digital transformation brings the possibility of innovating and optimizing businesses of any kind. So, could digital transformation be a way to increase the revenues and margins of the players involved in large capital projects, while improving project and worker safety?

For this study IDC correlated specific business statistics with the results of the maturity assessment. The results show that as owners and tier 1 and tier 2 suppliers progress along the different steps of maturity, they improve both economic performance and injury statistics. In its digital transformation journey, the LCP value chain can expect a significant improvement in EBITDA and total recordable injury (TRI), as shown in Figure 5.

Figure 5
Mapping LCP Value Chain Digital Maturity with Business Performances

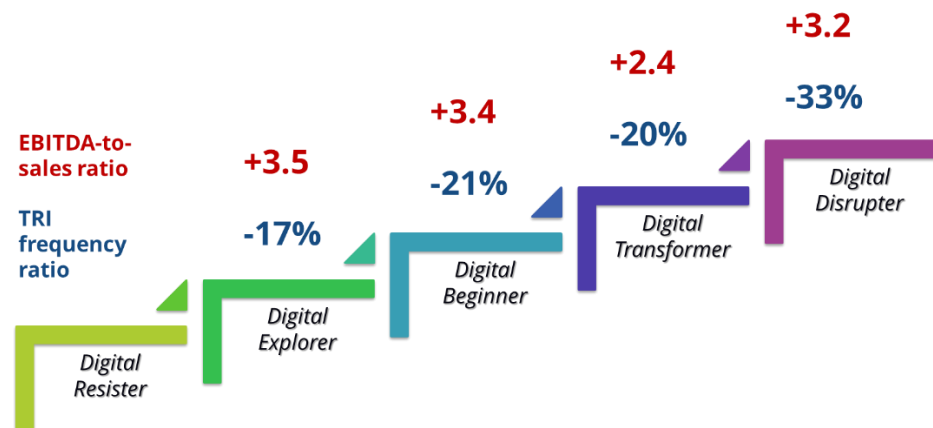


Source: IDC, 2018; LCP Digital Maturity Assessment Study — Commissioned by Siemens PLM Software

As highlighted in IDC's digital maturity model, organizations can expect to make some tangible gains from a focused approach to investments in digital technologies, including:

- **Gradual improvement in profitability.** Moving up the digital transformation maturity scale improves the EBITDA-to-sales ratio by around 2.5 to 3.5 points (model average). For instance, moving from level 2 (Digital Explorer) to level 3 (Digital Beginner) increases the ratio by 3.5 points. This is a significant increase, considering the size of these companies.
- **Gradual reduction of TRI.** Organizations that move up the digital transformation maturity scale can also expect to reduce their level of TRI by 15 to 30 points (model average). The main benefit here, of course, is in saving lives, but other benefits include a reduction in operational risks due to more organic forms of communication, collaboration, and interaction.

Figure 6
KPI Improvements Along the Digital Maturity Journey



Source: IDC, 2018; LCP Digital Maturity Assessment Study — Commissioned by Siemens PLM Software

Call to Action

To progress on the digital transformation journey, organizations need a coordinated and balanced development across the three strategic dimensions of operations, information, and relationships — the pillars used by IDC to develop the maturity model for the LCP value chain.

To "master the arts" of operations, information, and relationships, IDC recommends the following:

- Embrace digital twins.** The ability to blend the physical and digital worlds across the asset life cycle — from design to construction, operation, and decommissioning — is the ultimate stage of digital transformation. Digital twins allow EPCs to simulate the asset before actual construction and before the design becomes too advanced. By doing so, EPCs can detect potential issues and problems earlier, improving planning, construction work execution, and ultimately the LCP's overall performance.
- Take advantage of IoT development.** Sensor-based technology provides dramatic benefits to the EPC business processes. The sets of data collected can be used to increase worker safety, reduce costs, optimize workflow, avoid delays, and prevent human errors.
- Build a data-centric organization.** Information is vital to manage the asset life cycle. Access to engineering data and technical information must be managed through standard workflows envisioning different roles and tasks. Besides classification of data features, an extended use of metadata is required to track changes in data transformation during operational and management processes. Do not forget that data is the pillar to automate, simplify, and accelerate the engineer-to-order process.

- **Unleash the power of collaboration during execution.** Provide internal and external stakeholders with consistent, secure, and up-to-date access to project content, including drawings, documents, and data, as well as a master data management scheme based on standardized semantics and coding. Cloud-based platforms are powerful solutions to enhance collaboration.

Appendix

Methodology

This study is based on a mix of field interviews and simulation modeling techniques. The interviews involved managers from different parts of the LCP value chain, representing all the major market players, evenly split among owners, tier 1 suppliers, and tier 2 suppliers. While the distinction between owners and suppliers is essentially based on the ownership of assets or the exploration and production rights, the distinction between tier 1 and tier 2 is more nuanced and is based on an empirical rule of revenues (in this case, billions versus hundreds of millions of euros).

The qualitative interviews were conducted between February and March 2018, involving highly qualified senior managers holding digital roles within their respective organizations. The interviews were focused on IT and business priorities, on large capital projects' most challenging issues, and on the assessment of digital transformation readiness along specific ordinal scales.

The maturity model used by IDC during the assessment is based on three macro-dimensions — operations/execution, information management, and relationships/organization:

- **Operations/execution** is focused on five subdimensions:
 - Digital simulation practices: from the very basic level related to the use of simulation tools to create equipment models during early design phases to the most advanced level of using a digital twin with full 3D-4D-5D information.
 - PLM engineering: from the very basic level related to the plain use of PLM applications to the most advanced level of adding customization layers to deal with specific processes and requirements.
 - Complexity of visual ergonomics: from the very basic level related to the use of AR/VR technology for single equipment to the most advanced creation of virtual equivalents of plants with the integration of different domains of information.
 - Integrated engineering applications: from the very basic level related to the use of a single module to solve specific technical issues for single equipment to the most advanced level of customization of different applications.
 - Integrated maintenance and managed operations: from the very basic level related to servicing with plain and simple testing, quality

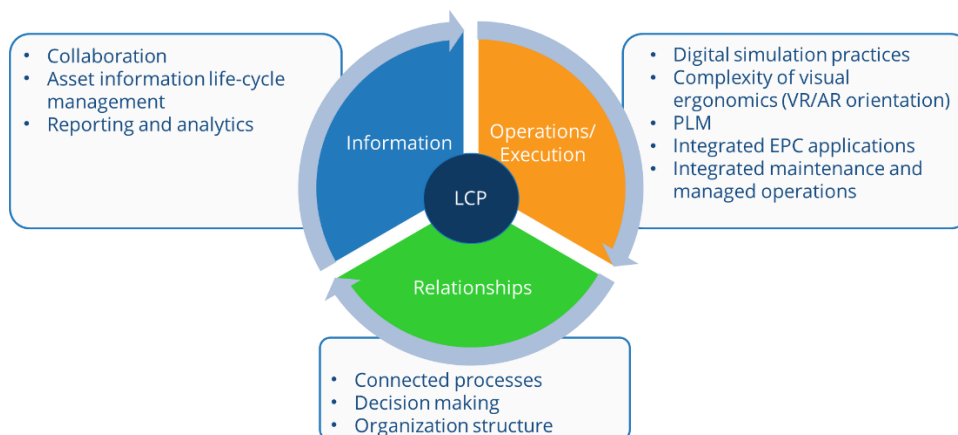
management, and technical publishing to the most advanced servicing beyond the handover phase based on pay-per-outcome models.

- **Information management** is focused on three subdimensions:
 - Collaboration: from the very basic level with information dispersed among different silos and teams to the most advanced level where engineering data and technical information are stored within a cloud architecture accessible to external partners and clients.
 - Asset information life-cycle management: from the very basic level where information discovery and data inventory are based on generic applications without specific investment to the most advanced level where information governance enables full data lineage and tracking of data transformation.
 - Reporting and analytics: from the very basic level of multiple and independent reporting systems to automated and integrated visual dashboards triggered by business events.
- **Relationships/organization** is focused on three subdimensions:
 - Connected processes: from the very basic level with different independent reporting systems to the most advanced level with automatically triggered dashboards and early warning systems.
 - Decision making: from the very basic level when decision making happens in isolation and based on sparse information and tools to the most advanced level when proactive business planning is based on continuous feedback and predictive analytics.
 - Organization structure: from the very basic level where information technology investments are highly fragmented and addressed independently by different functions to the most advanced level where there is a specific function focused on digital technologies, from project management to implementation.

Building on the information collected during the field interviews, the data has been extrapolated to the addressable market to represent the different weights of owners, tier 1, and tier 2 along the LCP value chain. The information from interviews was integrated with publicly available sources about economic and labor statistics (EBITDA and TRIFR), enabling joint representation in a simulation model of the potential association of digital maturity and systemic performances of the LCP value chain.

Figure 7

LCP Value Chain Digital Transformation: Maturity Assessment Dimensions



Source: IDC, 2018; LCP Digital Maturity Assessment Study — Commissioned by Siemens PLM Software

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