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DIGITAL TRANSFORMATION

FOUNDATIONS, STRATEGY AND PRACTICE IN ORGANIZATIONS

Written for the micro, small and medium-sized enterprises of Latin America



THE BOOK IN 12 CHAPTERS

01 Foundations
02 Technologies
03 Strategy
04 Data and AI
05 Processes
06 Customers
07 People
08 Maturity
09 Adoption
10 MSMEs
11 Governance
12 Road map

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DIGITAL TRANSFORMATION

FOUNDATIONS, STRATEGY AND PRACTICE IN ORGANIZATIONS

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DEDICATION

To the students of Business Administration at Universidad Estatal Península de Santa Elena, who remind us every semester that learning also means learning to ask better questions.

To the entrepreneurs and managers of the micro, small and medium-sized enterprises of the peninsula, who transform their businesses with more ingenuity than resources.

The authors

PREFACE

Digital transformation has become one of the most frequently cited topics in contemporary management and, at the same time, one of the least well understood. A reduced version of the concept circulates in classrooms and in companies, one that confuses it with buying equipment or with being present on social media. This book was written to offer students, teachers and managers a rigorous and usable account of the subject, from a public university on the Ecuadorian coast and with the organizations of the region in mind.

Most of the literature on the topic describes the experience of large corporations in advanced economies. Its concepts are valuable, but its examples rarely resemble the corner shop, the savings cooperative or the transport company that the student knows. The chapters therefore combine the classic frameworks with illustrative cases set in Latin American contexts, where connectivity, financing and skills cannot be taken for granted.

The book covers twelve topics in an order that moves from the conceptual to the applied. The first chapters establish the foundations and the enabling technologies; the following ones address strategy, data, processes, customers and people. Digital maturity, the theories of adoption and the particular situation of micro, small and medium-sized enterprises are studied next, and the closing chapters deal with governance, ethics, security and the road map that makes it possible to move from intention to results.

Every chapter follows the same architecture: learning objectives, development of the topic, an illustrative case, a summary, key terms, exercises and a self-assessment. The reasoned answers to the self-assessments, the worked solutions to the numerical exercises and a set of working templates are given in the appendices. This structure allows the book to be used as the main text of a course, as a reference for degree projects or as a self-study guide for anyone who runs a company.

The authors have sought a balance between rigor and clarity. The sources cited are articles from scientific journals, reference books, reports of international organizations and Ecuadorian legislation in force; the examples are deliberately simple so that attention stays on the reasoning. If, on finishing the book, readers are able to look at an organization and tell the difference between digitalizing a task and transforming a business, the book will have served its purpose.

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ACRONYMS AND ABBREVIATIONS

Acronym	Meaning
AI	Artificial intelligence
API	Application programming interface
BPM	Business process management
CAC	Customer acquisition cost
CLV	Customer lifetime value
CRM	Customer relationship management
DIKW	Data, information, knowledge and wisdom hierarchy
DMI	Digital maturity index
ECLAC	Economic Commission for Latin America and the Caribbean (in the reference list, Comisión Económica para América Latina y el Caribe)
EDI	Electronic data interchange
ERP	Enterprise resource planning
FN	False negatives
FP	False positives
GAD	Gobiernos autónomos descentralizados (decentralized autonomous governments of Ecuador)
IaaS	Infrastructure as a service
IoT	Internet of Things
IRR	Internal rate of return
ISO/IEC	International Organization for Standardization and International Electrotechnical Commission
IT	Information technology
LOPDP	Ley Orgánica de Protección de Datos Personales (Ecuadorian organic law on the protection of personal data)
MES	Manufacturing execution system
MSME	Micro, small and medium-sized enterprise

Acronym	Meaning
MVP	Minimum viable product
NIST	National Institute of Standards and Technology of the United States
NPV	Net present value
OECD	Organisation for Economic Co-operation and Development
PaaS	Platform as a service
PP	Payback period
QR	Quick response code
ROAS	Return on advertising spend
ROI	Return on investment
RPA	Robotic process automation
RUC	Registro Único de Contribuyentes (Ecuadorian taxpayer registry)
SaaS	Software as a service
SCM	Supply chain management
SEO	Search engine optimization
SMACIT	Social media, mobility, analytics, cloud and Internet of Things
SME	Small and medium-sized enterprise
TAM	Technology acceptance model
TCO	Total cost of ownership
TMS	Transportation management system
TN	True negatives
TOE	Technology, organization and environment framework
TP	True positives
USD	United States dollars
UTAUT	Unified theory of acceptance and use of technology
UTAUT2	Extension of UTAUT to the consumer context
WMS	Warehouse management system
XML	Extensible markup language

INTRODUCTION

Few expressions are repeated as often in corporate speeches and in government plans as “digital transformation”. It is invoked to explain the success of global platforms, to justify investments in technology and to design support programs for small businesses. Yet when a manager is asked what transforming digitally actually means, the answers range from buying an accounting system to opening an online store or hiring a social media specialist.

That confusion has practical consequences. An organization that equates digital transformation with technology tends to buy tools that it then does not use, to digitalize processes that it should have redesigned first and to expect immediate results from changes that demand time, learning and new ways of working. The academic literature has insisted that the phenomenon involves changes in the way value is created and captured, and not only in the technical means; along those lines, Vial (2019) describes it as a process that alters the properties of an organization through combinations of information, computing, communication and connectivity technologies.

This book sets out to offer a rigorous and usable understanding of digital transformation to undergraduate and graduate students of business administration, commercial engineering, management and related programs, as well as to managers and entrepreneurs looking for guidance for their organizations. The point of view is that of Latin America and, in particular, that of Ecuador, where micro, small and medium-sized enterprises live with gaps in connectivity, financing and skills that texts written for other economies rarely take into account.

The timing is favorable. Across the region, the digitalization of production and of services has become part of development strategies, with the explicit concern that smaller firms should not be left out of its benefits (Comisión Económica para América Latina & el Caribe, 2022). For that agenda to reach specific organizations, professionals are needed who can diagnose, prioritize and support change, and it is to their education that this text is devoted.

The journey is organized into twelve chapters grouped in four blocks. The first block establishes the foundations. Chapter 1 distinguishes digitization, digitalization and digital transformation, and places the phenomenon in the digital economy and in what has been called the Fourth Industrial Revolution. Chapter 2 presents the enabling technologies, from cloud computing to artificial intelligence, with criteria for appraising them before adopting them.

The second block deals with value creation. Chapter 3 addresses digital strategy and business models, including platforms and ecosystems. Chapter 4 takes up data, analytics and the use of artificial intelligence in decision making. Chapter 5 examines processes, enterprise

systems and the supply chain, and chapter 6 studies the connected customer, digital marketing and electronic commerce.

The third block puts people and the organization at the center. Chapter 7 analyzes digital skills, leadership, culture and change management. Chapter 8 teaches how to measure digital maturity and how to build an index of one's own, and chapter 9 reviews the theories that explain why a technology is adopted or abandoned, both at the individual and at the organizational level.

The fourth block brings the subject down to its context and to its execution. Chapter 10 examines the situation of MSMEs and of emerging economies, with particular attention to the digital divide and to staged digitalization paths. Chapter 11 addresses technology governance, cybersecurity, the protection of personal data and the ethics of artificial intelligence, with reference to the Ecuadorian regulatory framework. Chapter 12 closes the book with the road map: how to prioritize initiatives, manage the projects and assess whether the investment creates value.

Every chapter shares the same instructional architecture. They open with a short introduction and with the learning objectives; they develop the topic in numbered sections, with tables and figures prepared by the authors; and they include an illustrative case, a summary and the key terms. They close with a set of exercises organized in four groups: comprehension questions, application exercises, analysis of the case and a collaborative activity. The eight-question self-assessment makes it possible to check what has been learned before moving on.

The appendices complete that apparatus. Appendix A contains the reasoned key to all the self-assessments, and Appendix B works out, step by step, the numerical exercises proposed in the chapters, from the total cost of ownership of a cloud solution to the net present value of a digital project. The glossary brings together the definitions of the technical terms used throughout the book.

The book allows for several uses. In a sixteen-week semester course, each chapter can take up one week, with the remaining weeks devoted to assessments and to the presentation of a project applied in a real organization. In graduate programs it is worth combining chapters 3, 8, 9 and 12 with readings of the sources cited. Anyone who runs a company may start with chapters 8 and 12 and then return to the topics that their own diagnosis flags as priorities.

One effective way to make the most of the book is to pair the reading with an applied project. Students choose an organization close to them and, chapter by chapter, build its maturity diagnosis, describe its business model, map a critical process and the journey of its

customers, identify the barriers to adoption and finish with a prioritized road map assessed in financial terms. The collaborative activities in each chapter are designed to feed that project.

A few conventions make reading easier. Citations and references follow the seventh edition of the APA style; technical terms appear in italics the first time they are used and are defined in the glossary at the end of the book. The illustrative cases describe plausible but not real organizations, built for teaching purposes, so no figure in those cases should be read as an empirical datum.

Technology changes quickly and some of the tools mentioned here will be replaced by others within a few years. The concepts, the analytical frameworks and the decision methods presented in the book, by contrast, have a longer life. That has been the criterion guiding the selection of content: to give readers the questions and the tools that will allow them to judge for themselves whatever comes next.

CHAPTER 1.
FOUNDATIONS OF DIGITAL TRANSFORMATION

A family restaurant on the Santa Elena peninsula takes orders through messaging apps, collects payment by bank transfer, issues electronic invoices and posts its menu on social media: it uses digital technologies every day. Even so, it may still organize the work and make decisions the way it did twenty years ago. Between using digital tools and transforming there is a considerable distance, and confusing the two leads to investments that do not pay off as expected and to frustrations that are usually blamed on the technology.

This chapter offers the conceptual foundations that the rest of the book takes for granted. Research on digital transformation has received growing attention and deals with its technological, business and social effects (Kraus et al., 2021); that breadth helps explain why the term circulates with very different meanings in technical reports, management speeches, government plans and support programs for micro, small and medium-sized enterprises (MSMEs). Without precise definitions it is hard to diagnose where an organization stands or to check afterwards whether it has moved forward.

With that purpose, section 1.1 presents the features of the digital economy and of the Fourth Industrial Revolution, and section 1.2 distinguishes digitization, digitalization and digital transformation. Section 1.3 reviews the definitions of the last of these; section 1.4, the pressures that push firms to change; section 1.5, the relationship between technology, productivity and competitiveness, and section 1.6, the most frequent mistakes. Specific technologies are studied in chapter 2; digital maturity, in chapter 8, and the theories of adoption, in chapter 9.

By the end of this chapter, the reader will be able to:

1. Explain the features of the digital economy and of the Fourth Industrial Revolution that change the way organizations compete.
2. Distinguish digitization, digitalization and digital transformation using examples drawn from MSMEs.
3. Analyze the main definitions of digital transformation and their implications for strategy, structure and culture.
4. Identify the drivers and the pressures that lead an organization to transform itself.
5. Argue why technology, without complementary organizational change, is not enough to raise productivity, and recognize the mistakes that arise from ignoring that condition.

1.1. The digital economy and the Fourth Industrial Revolution

In the mid-1990s, when commercial access to the internet was beginning to spread, Tapscott (1996) popularized the expression "digital economy" to describe an economy in which information takes digital form, travels through networks and turns knowledge into the main source of value. Today the expression designates the set of activities that depend on digital data, communication networks and platforms that bring suppliers and buyers together. Its reach extends to agricultural exports, tourism, retail trade and public administration.

When an invoice, the photograph of a product, a customer's message and a sensor reading are encoded in bits, all of those contents can be stored, transmitted and processed with the same devices and networks. That homogeneity of the data, together with the possibility of reprogramming a single piece of equipment for different functions, makes it possible to organize digital technology in loosely coupled layers of devices, networks, services and contents (Yoo et al., 2010). In an MSME, the phone used to take orders also serves to collect payment, issue invoices and check stock.

Connectivity makes coordination between distant people and firms cheaper, and the digital adds a singular economic feature: once the original has been produced, a digital good can be copied and distributed at a marginal cost close to zero. Brynjolfsson and McAfee (2014) count that property, along with the exponential improvement of computing power and the recombination of innovations, among the forces that define the "second machine age". A course recorded once can thus be sold to a hundred or to ten thousand participants at almost no additional cost per person.

On that basis, Schwab (2016) proposed speaking of a Fourth Industrial Revolution, characterized by a fusion of technologies that blurs the boundaries between the physical, digital and biological spheres. Unlike the third, which used electronics and computing to automate production, the fourth would be distinguished by its speed, by the breadth and depth of its changes and by its impact on entire systems. Additive manufacturing, the sensors that monitor a crop and gene editing illustrate that convergence.

This notion should not be confused with Industry 4.0, a term that arose from German industrial policy to designate the smart factory, where cyber-physical systems and connected machines make flexible and individualized production possible (Lasi et al., 2014). It is the manufacturing expression of a broader change, one that also reaches firms that do not make anything; chapter 5 examines it in the context of operations.

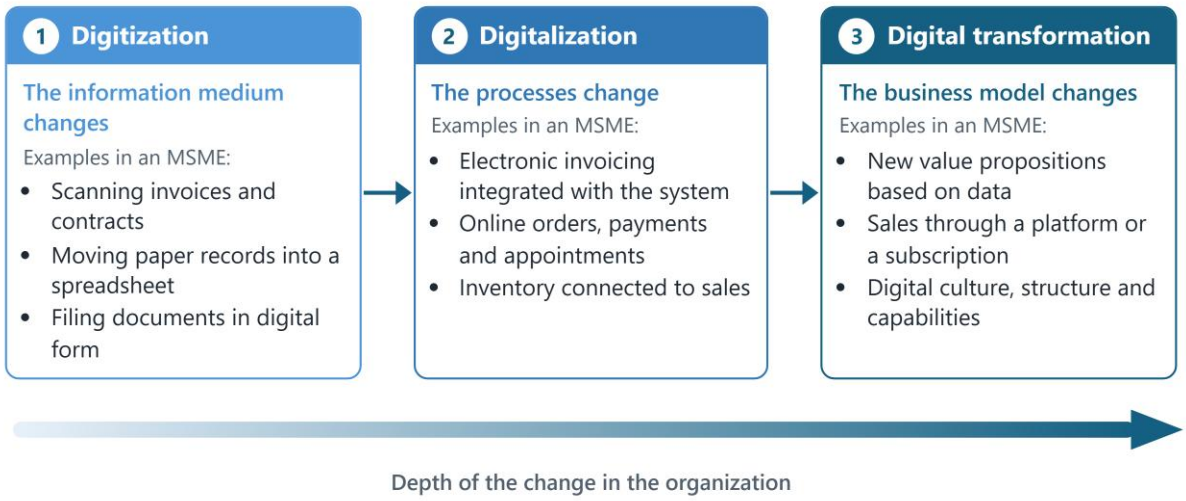
1.2. Digitization, digitalization and digital transformation

In everyday language, "going digital" covers both scanning a document and redesigning a process with the support of applications. The specialized literature separates the two meanings through the distinction between *digitization* and *digitalization*. Legner et al. (2017) call digitization the technical process of converting analog signals into digital form, and digitalization the sociotechnical phenomena that occur when those technologies are adopted and used in wider individual, organizational and social contexts. The first changes the medium of the information; the second, the way of working with it.

To those two categories, Verhoef et al. (2021) add a third and arrange the set in stages. Digitization encodes analog information in digital form; digitalization uses digital technologies to modify existing processes, such as the communication channels with customers, and digital transformation produces a change that spans the whole company and leads to new business models. Figure 1.1 represents that sequence as a passage from a change of medium to a change of model, with an increasing depth of change in the organization.

Figure 1.1

From a change of medium to a change of model: digitization, digitalization and digital transformation



Note. The authors' own work, based on Verhoef et al. (2021).

A bakery with two outlets makes the difference easy to see. Scanning suppliers' invoices and moving recipes and costs into a spreadsheet is digitization: the information changes medium, but the work stays the same. Receiving online orders that deduct inputs from the inventory and feed the daily baking plan is digitalization, because the process itself changes.

Selling subscriptions to coffee shops and hotels, with deliveries scheduled according to their consumption data, already points to a transformation, since it modifies the value proposition and the way revenue is generated. Table 1.1 summarizes the three levels with this example.

Table 1.1

Three levels of digital change: what changes, scope, example and the risk of confusing them

Level	What changes	Scope	Example in a bakery with two outlets	Risk of confusing it
Digitization	The medium of the information, which moves from paper or an analog signal to digital form	Isolated documents and tasks	Scanning suppliers' invoices and moving recipes and costs into a spreadsheet	Believing that filing in digital form already improves service or efficiency
Digitalization	Existing processes, which are carried out or coordinated with digital technologies	Processes and functional areas	Receiving online orders connected to the inventory of inputs and to the daily baking plan	Automating faulty processes and mistaking efficiency for a change of business model
Digital transformation	The value proposition, the business model, the structure and the culture	The whole organization and its relationship with customers and partners	Selling subscriptions to coffee shops and hotels, with deliveries scheduled from consumption data	Announcing it without organizational change: the discourse moves on and practices stay the same

Note. The authors' own work, based on Verhoef et al. (2021).

The three levels build on one another, but they do not form a staircase that is climbed automatically. A company may accumulate digital documents for years without redesigning a single process, or digitalize processes without altering what it offers. The bakery's subscription, in turn, would be transformative only if it reorganizes production, distribution and the duties of the staff. Chapter 8 returns to these differences in order to measure digital maturity.

1.3. What digital transformation is: definitions and approaches

Definitions of digital transformation are numerous and not always compatible. In their review of the literature, Reis et al. (2018) group their elements into three categories: the technological, centered on the use of new digital technologies; the organizational, which highlights

the change of processes or the creation of business models, and the social, attentive to its influence on the lives of customers and citizens. Each definition favors one of those perspectives, and the questions a company asks itself when it undertakes change depend on that choice.

A widely accepted definition comes from the review by Vial (2019), who understands digital transformation as a process that seeks to improve an entity by triggering significant changes in its properties through combinations of information, computing, communication and connectivity technologies. Every component has practical consequences. The definition speaks of a process, not of a project with a closing date; the entity may be a company, a network of companies or an industry; the changes reach deep properties, such as the structure, the culture or the way value is created, and they arise from combinations of technologies rather than from an isolated tool.

The synthesis by Hanelt et al. (2021) adds an organizational nuance. After reviewing an extensive and fragmented literature, its authors conclude that digital transformation moves firms toward malleable designs, able to adapt continuously, and that this movement takes place within digital business ecosystems that drive it. Put another way, the goal is not to reach a final "digitalized" state, but to acquire the capability of reconfiguring itself every time the technology, the customers or the partners change.

From the definitions above it follows that digital transformation involves, at the very least, three dimensions of the organization:

- Strategy: the way the company creates, delivers and captures value, and the decisions about where and how to compete; chapter 3 develops this dimension.
- Structure: the distribution of responsibilities, the decision rights and the coordination mechanisms, which are often reorganized around multidisciplinary teams.
- Culture: the shared assumptions about risk, error, learning and the use of data, discussed in chapter 7 together with leadership.

The phenomenon is not confined to private business. The public administration experts interviewed by Mergel et al. (2019) describe digital transformation as an effort that goes beyond moving procedures from paper to the screen and that seeks to improve service delivery in the face of citizens' new expectations. With these elements, this book understands digital transformation as the continuous process by which an organization combines digital technologies with changes in its strategy, its structure and its culture in order to create value in ways that were not possible for it before.

1.4. Drivers and pressures: customers, competition, data, technology and regulation

Few organizations transform themselves out of spontaneous conviction; what usually happens is that they respond to pressures from their environment. Rogers (2016) argues that digital technology changes the rules in five domains of strategy: customers, competition, data, innovation and value. This section groups the drivers into four fronts: customers, competitors, data and technology, and regulation.

The connected customer compares prices in seconds, reads other people's reviews, expects immediate replies and prefers to buy through the channels used every day. Those expectations are usually set by the best digital experiences the customer has anywhere, not by the habits of the industry. Digital transformation and business model innovation have radically altered consumers' expectations and behaviors and put pressure on traditional firms (Verhoef et al., 2021). A spare parts store that serves customers only over the counter and during office hours loses orders it never gets to see; chapter 6 studies the journey of this customer.

A travel agency on the peninsula today competes with the other agencies in the province and with global booking platforms that display prices, availability and reviews on a single screen. Digital competitors enter with low fixed costs, grow quickly thanks to an almost zero marginal cost and often come from other industries. The local agency keeps in its favor its knowledge of the territory and its personal service, advantages that count only if they are turned into a visible and trustworthy offering online, a matter that chapter 3 takes up from the business model side.

Data and technology act at once as a pressure and as an opportunity. Every sale, every visit to a web page and every message leaves a record that is useful for anticipating demand or adjusting prices, and whoever learns to read it decides with better information than its rivals. In addition, storage, computing power and many management applications are now contracted as a service, for a monthly fee. Chapters 2 and 4 develop both fronts.

Regulation completes the picture. In Ecuador, the tax administration has progressively extended the obligation to issue electronic invoices, and the Ley Orgánica para la Transformación Digital y Audiovisual (organic law on digital and audiovisual transformation) promotes the adoption of digital means in public and private procedures, as well as their uptake by the productive sectors (Asamblea Nacional del Ecuador, 2023). These rules push firms to convert documents into digital form and to digitalize processes, although they do not require any change of business model. The protection of customers' personal data adds requirements that are examined in chapter 11.

1.5. Technology, productivity and competitiveness

Productivity measures how much an organization produces with the resources it uses; competitiveness, its ability to sustain or expand its presence in the market profitably. The two notions are so closely linked that, for Porter (1990), the only meaningful concept of competitiveness at the national level is productivity. In the management of MSMEs, the most widely used measure is labor productivity, which relates the output of a period to the labor used to obtain it, expressed as a number of people or of hours worked:

Labor productivity = Output of the period / Labor employed (people or hours)

During the 1980s and 1990s, the relationship between investment in information technology (IT) and productivity fed what came to be called the productivity paradox: firms were buying more and more computers, yet aggregate statistics showed no clear improvement. Evidence from case studies and from firm-level econometric analysis offered an answer that still holds: the value of IT depends to a large extent on complementary organizational investments, such as new processes, ways of working and training, and a good part of its benefits is intangible and hard to measure (Brynjolfsson & Hitt, 2000).

The integrative model of Melville et al. (2004) arranges that evidence in a chain. IT technological and human resources, combined with complementary organizational resources, improve business processes, and only through them do they show up in the performance of the organization; the outcome also depends on trading partners, on the industry and on the country environment. In a restaurant, a point-of-sale system contributes little if the menu, the purchasing and the shifts stay the same, and it yields more when those processes are reorganized with the information it generates. Chapter 9 takes up this relationship from the resource-based and capabilities view.

At the level of countries the same argument reappears. According to the World Bank report on digital dividends (World Bank, 2016), the spread of digital technologies has been rapid, but their benefits in growth, jobs and services have fallen short of expectations. The report attributes that gap to weak analog complements: regulations that favor competition, skills suited to the new economy and institutions capable of accountability. In an MSME, the equivalent of those complements are the internal rules, the skills of the staff and the quality of management.

In Latin America, these conditions weigh particularly heavily. Comisión Económica para América Latina and el Caribe (2021) devotes one of the axes of its analysis to digitalization for productive development and examines the barriers that hold back the incorporation of

technologies into production chains. Chapter 10 goes deeper into those barriers for the case of MSMEs and emerging economies.

1.6. Myths and frequent mistakes

The preceding sections make it possible to recognize myths and mistakes that recur in organizations of every size. Almost all of them share the root that Kane et al. (2019) call the technology fallacy: assuming that transforming consists, above all, of choosing and installing technologies, when the decisive factor is people and the way of working. Chapter 7 develops that thesis; what matters here are four specific mistakes, which the illustrative case at the end of the section brings together.

Buying technology without a strategy

Acquiring an integrated management system or opening an online store because the competition did so leaves the essential questions unanswered: what problem is to be solved, for which customers and with what indicators the result will be measured. The firms that get the most out of the digital (Westerman et al., 2014) combine digital capabilities, in the customer experience, operations and the business model, with leadership capabilities, such as a shared vision, the engagement of the staff and clear governance of the initiatives. A purchase without a strategy covers, at best, part of the first condition and leaves the second untouched.

Digitalizing the mess

Automating a badly designed process only speeds up its defects. If a chain of three stores records the same item under different names in each outlet, the new system will multiply the inventory discrepancies; if every salesperson sets discounts at will, the application will record them accurately, but it will not bring them into order. Ross et al. (2019) call operational backbone the integrated set of processes, systems and data that ensures reliable and efficient core operations, and they place it among the foundations of a digital company. Before digitalizing, it is advisable to simplify the process and clean up the master data, a task addressed in chapter 5.

Delegating everything to the IT department

Another mistake is to hand the transformation over to the IT department or to an external supplier, as though it were a technical installation. Those areas master the infrastructure and the applications, but decisions about the value proposition, the processes and the incentives belong to top management. IT governance consists precisely of specifying the decision rights

and the accountability framework that guide a desirable use of technology (Weill & Ross, 2004); when management delegates everything to IT, those decisions are left without a clear owner. Chapter 11 deals with this governance in detail.

Expecting immediate results

The last mistake has to do with the calendar. Benefits appear when the staff learns to use the technology, the processes are adjusted and the customers change their habits, and that learning takes time; in the first months, productivity may even fall. Digital transformation is therefore better understood as a continuous process of strategic renewal, supported by dynamic capabilities that are built gradually (Warner & Wäger, 2019). Assessing it in the third month may lead to abandoning it before it pays off; chapter 12 proposes realistic indicators and time frames for measuring its progress.

Illustrative case: the distributor that mistook digitalizing for transforming

A family-owned distributor of cleaning products, based in a mid-sized city on the Ecuadorian coast, supplies neighborhood stores, restaurants, hotels and laundries. When the second generation took over the management, the company bought an invoicing and inventory system, opened social media accounts, set up a messaging line to receive orders and handed tablets to its four salespeople; the implementation was left to the supplier of the system. The new manager presented the whole package to the staff as "the digital transformation of the company" and set the first half-year as the deadline for seeing results.

A year later, invoices were being issued in electronic form and the catalog looked good with new photographs, but sales were still flat. The salespeople wrote the orders down in notebooks and typed them in at night; the inventory did not add up because the same product appeared under three different codes, and messages arriving after five in the afternoon went unanswered until the next day. At the review meeting, the dominant explanation was that "the system is no good", and there was talk of changing supplier.

An outside assessment reached a different conclusion: the company had moved documents into digital form and digitalized a few tasks, but it was still selling and deciding as before. The change of course began by cleaning up the catalog and redesigning the order process. The distributor then offered hotels and restaurants a scheduled replenishment service, calculated from their consumption history and adjusted to the beach season, and turned two

salespeople into institutional account advisors, with targets tied to repeat purchases by customers rather than to the volume of each visit.

1.7. Chapter summary

The chapter has shown that digital transformation is, above all, an organizational change that digital technologies make possible and that pressures from the environment make urgent. Telling it apart from digitization and digitalization makes it possible to diagnose the starting point honestly and to invest with judgment. These are its key ideas:

- The digital economy rests on homogeneous data, networks, platforms and goods that are reproduced at a marginal cost close to zero; the Fourth Industrial Revolution adds the convergence of the physical, digital and biological spheres.
- Digitization, digitalization and digital transformation are different levels: the first changes the medium of the information, the second the processes and the third the value proposition and the business model.
- Digital transformation is a continuous process that combines digital technologies with changes in the strategy, the structure and the culture of the organization.
- Connected customers, digital competitors, the availability of data and technology, and regulation put pressure on organizations to transform themselves.
- Technology raises productivity when it is accompanied by complementary organizational investments; without them, its effects are small or late in coming.
- Buying technology without a strategy, digitalizing the mess, delegating everything to the IT department and expecting immediate results are mistakes that stem from the technology fallacy.

Key terms: *digital economy, Fourth Industrial Revolution, Industry 4.0, digitization, digitalization, digital transformation, marginal cost, labor productivity, complementary investments, analog complements, operational backbone, technology fallacy.*

1.8. Exercises and activities

Comprehension questions

1. Which features of the digital economy allow a digital good to reach thousands of customers without its costs growing in the same proportion?
2. How does the Fourth Industrial Revolution differ from Industry 4.0?

3. What distinguishes digitization from digitalization? Give an example of each in a commercial MSME.
4. Which elements of the definition of digital transformation adopted in this book set it apart from the mere purchase of technology?
5. Why does investment in information technology not translate automatically into higher productivity? Explain the role of complementary investments.

Application exercises

1. Classify the following initiatives of a neighborhood stationery store as digitization, digitalization or digital transformation and justify each answer with the criteria in table 1.1: a) scanning the delivery notes and filing them in the cloud; b) connecting the till to the inventory so that orders to suppliers are generated automatically; c) turning the printed catalog into a digital file; d) offering schools an annual school supplies management service, with volume prices, scheduled deliveries and consumption reports; e) receiving school supply lists by messaging app and confirming their availability against the online inventory.
2. A distributor similar to the one in the illustrative case measured its order taking and recording process at three points in time. In the initial situation, six employees worked 180 hours a month each, including closing overtime, and processed 1,620 orders a month. In scenario A, a year after installing a sales application without modifying the process, the same six employees, working the same hours, processed 1,701 orders a month. In scenario B, after redesigning the process, cleaning up the product codes and training the team, five employees working 160 hours a month each processed 2,160 orders, while the sixth person moved on to serving institutional customers. Calculate: a) productivity per employee and per hour at each point in time; b) its percentage change in A and in B with respect to the initial situation; c) how many orders a month the team in A would have to process to match the productivity per hour of B; d) interpret the results in the light of section 1.5. *Worked solution in Appendix B.*
3. Choose an organization you know (an MSME, a cooperative or a public agency) and rate from 1 (low) to 5 (high) the intensity of each of the four fronts of pressure described in section 1.4. Justify each score with an observable fact and indicate which front calls for the most urgent response.
4. Write a one-page memorandum addressed to the owner of an appliance store who wants to buy an integrated management system because "everybody has one". The

memorandum must point out which of the mistakes in section 1.6 the owner risks making and put forward three questions that should be answered before the purchase.

Analysis of the case

1. Which of the distributor's actions correspond to digitization, which to digitalization and which point to a digital transformation? Justify the classification with table 1.1.
2. Which of the mistakes in section 1.6 appear in the first stage of the case, and which facts reveal them?
3. Which of the drivers in section 1.4 help explain the company's change of course?
4. Propose two indicators that make it possible to check, after a year, whether the scheduled replenishment service improved productivity and the relationship with institutional customers.

Collaborative activity

1. In teams of three or four students, interview the owner or the manager of a local MSME, take stock of the digital tools it uses and classify them into the three levels of table 1.1. Expected output: a two-page report with the completed table and a reasoned recommendation about the company's next step.
2. Prepare a debate between two teams on the statement "the Ecuadorian MSME needs more technology before organizational change". Expected output: a one-page record with the three strongest arguments on each side and the sources from the chapter that support them.

Self-assessment

1. Which of the following actions is an example of digitization?
   a) Integrating order taking with the inventory by means of an application
   b) Scanning paper invoices and saving them as digital files
   c) Offering a scheduled replenishment service based on consumption data
   d) Redesigning the dispatch process to shorten delivery times

2. According to the widely accepted definition reviewed in section 1.3, digital transformation is:
    a) The acquisition of the latest technologies in order to modernize the equipment and the image of the company
    b) The replacement of manual tasks by software in a specific area of the organization
    c) The migration of all the company's systems to cloud services contracted by subscription
    d) A process that improves an entity through significant changes in its properties, driven by combinations of technologies
3. Which feature characterizes the Fourth Industrial Revolution?
    a) The fusion of technologies that blurs the boundaries between the physical, digital and biological spheres
    b) The electrification of factories, which made mass production on assembly lines possible
    c) The use of electronics and computing to automate industrial production
    d) The complete replacement of human work by industrial robots and autonomous software
4. Why may an investment in information technology fail to raise productivity?
    a) Because the price of equipment and software is usually too high for an MSME
    b) Because the internet connection of MSMEs is always slow and inadequate
    c) Because complementary organizational investments are missing, such as process redesign and training
    d) Because equipment depreciates and becomes obsolete before it can be put to good use
5. That a digital good has a marginal cost close to zero means that:
    a) Its selling price necessarily tends to zero as the number of buyers increases
    b) Developing the first version of the good requires no significant initial investment
    c) Producing and distributing one more copy adds hardly any cost once the original has been created
    d) Its total cost is always lower than that of any equivalent physical good

6. Which of the following initiatives corresponds to digitalization?
   a) Receiving online orders that automatically deduct inputs from the inventory
   b) Scanning the company's recipes and saving them in a shared folder
   c) Turning the business into a subscription service with scheduled deliveries
   d) Printing a better quality product catalog and handing it out to customers
7. Why is delegating digital transformation to the IT department a mistake?
   a) Because the IT department always lacks the necessary technical skills
   b) Because hiring external suppliers is cheaper than training one's own staff
   c) Because the IT department should not take part in transformation projects
   d) Because decisions about the value proposition, the processes and the incentives belong to top management
8. Which of the following is a regulatory driver of digital transformation?
   a) Customers' preference for buying through messaging apps
   b) The obligation to issue electronic invoices
   c) The arrival of competitors that sell only online
   d) The fall in the cost of data storage
9. A firm buys new computers for all its staff but keeps the same processes and the same way of working. Which concept from this chapter best describes what should be expected?
   a) An immediate rise in productivity
   b) The technology fallacy: technology alone does not transform
   c) A network effect among employees
   d) A reduction in the marginal cost of production
10. Why do the benefits of a digital investment usually take time to show up in productivity figures?
   a) Because the technology depreciates before it pays off
   b) Because staff always resist change
   c) Because complementary investments in processes, data and skills are needed
   d) Because productivity indicators do not measure digital activities

11. Which of these situations is digitalization rather than digitization?
    a) Storing scanned contracts in a shared folder
    b) Photographing products for the printed catalog
    c) Moving the inventory from a notebook to a spreadsheet
    d) Having a customer order deduct stock and generate the purchase order
12. An MSME claims that its digital transformation consists of opening a business account on social media. According to the chapter, the main problem with that claim is that
    a) social media do not work for selling in small markets
    b) it mistakes a contact channel for a change in the business model and its processes
    c) a digital presence only works in large firms
    d) the cost of running social media always exceeds the benefit

CHAPTER 2.
ENABLING TECHNOLOGIES

The previous chapter established that digital transformation is, above all, a change in the way an organization creates value, and that technology by itself does not produce it. This chapter looks closely at that technology. In his review of the literature, Vial (2019) speaks of "combinations" of information, computing, communication and connectivity technologies, and the word matters: no tool works in isolation. Artificial intelligence (AI) needs data, data travels over networks and networks require protection.

For whoever runs an Ecuadorian micro, small or medium-sized enterprise (MSME), the problem is rarely a shortage of offers. Suppliers offer cloud systems, sensors, AI assistants or blockchain solutions, and every proposal comes with similar promises. What is usually missing is a criterion for telling what each technology really does, what conditions it demands and what problem it solves in a company of five, forty or a hundred and fifty people. Building that criterion is the purpose of the pages that follow.

The route starts with the technology architecture, which arranges the pieces in layers. Five families of technologies follow: cloud computing, the Internet of Things, AI, blockchain and automation through *software* robots and physical robots. Connectivity and cybersecurity are then examined, conditions without which none of them works reliably. The chapter closes with a method for appraising a technology before adopting it, applied to the case of a pharmacy chain.

By the end of this chapter, the reader will be able to:

1. Describe the layers of the technology architecture of the digital firm and the function each one performs.
2. Tell apart the service and deployment models of cloud computing according to how responsibilities are shared between the client and the provider.
3. Explain how the Internet of Things, artificial intelligence, blockchain and robotic process automation work, what they are used for and what their limits are in organizations of the region.
4. Recognize connectivity and cybersecurity as baseline conditions for any digital initiative.
5. Appraise a technology before adopting it with criteria of problem, total cost of ownership, maturity, risks, suppliers and skills.

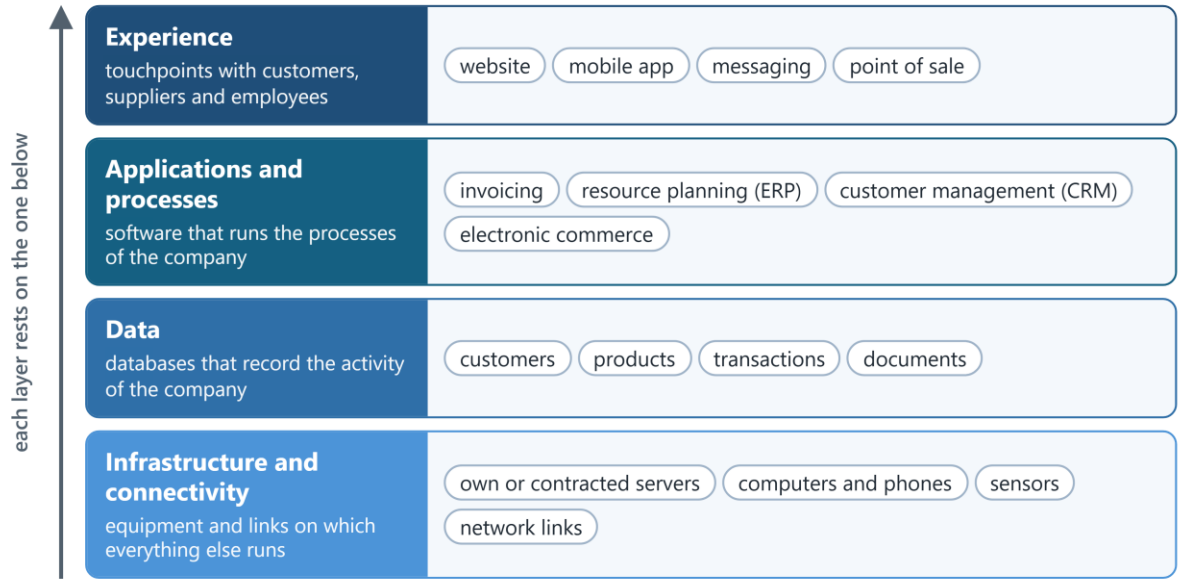
2.1. The technology architecture of the digital firm

A technology architecture is the way the digital resources of an organization are organized and connected: equipment, networks, data, applications and channels. Thinking of it in layers shows that every technical decision rests on another one. If the inventory of an online store is badly recorded, or if the connection fails, the customer perceives it as an order that never arrives.

Figure 2.1 presents four layers. At the base are infrastructure and connectivity: own or contracted servers, computers, phones, sensors and network links. Above sits the data layer, with the databases that record customers, products, transactions and documents. The third layer brings together the applications that run the processes, from invoicing to enterprise resource planning (chapter 5). At the top is experience: the touchpoints with customers, suppliers and employees, such as the website, the mobile app, messaging or the point of sale.

Figure 2.1

Layers of the technology architecture of the digital firm



Note. The authors' own work.

The layers are not welded to one another, and much of the digital potential lies in that independence. Yoo et al. (2010) describe digital technology as a layered modular architecture (devices, networks, services and contents) that is loosely coupled, in which one and the same piece can be combined with others it was not designed for. Thus the sales data of a bakery can

feed the accounting system, a dashboard of indicators and a messaging campaign at the same time, without rebuilding any of those systems.

On this basis operate the technologies that the management literature groups under the acronym SMACIT: social media, mobility, analytics, cloud and Internet of Things. To take advantage of them, Ross et al. (2019) propose redesigning the company with several components, among them an operational backbone, which integrates the systems and data of daily transactions, and a digital platform, made of reusable pieces that allow new offerings to be launched quickly. The lesson for a small company is one of sequence: before opening channels it is advisable to have the data on customers, products and sales clean and connected.

2.2. Cloud computing: service and deployment models

Cloud computing makes it possible to use infrastructure and applications without buying them. The reference definition, prepared by Mell and Grance (2011) for the National Institute of Standards and Technology of the United States (NIST), describes it as a model for on-demand network access to shared, configurable resources, such as servers, storage or applications, that are allocated and released rapidly. The same definition attributes five essential features to it: on-demand self-service, broad network access, resource pooling, rapid elasticity and measured service.

2.2.1. Service models

The service models differ in the part of the technology stack that the provider administers. In infrastructure as a service (IaaS), the company rents computing, storage and network, and controls the operating system and the applications. In platform as a service (PaaS), it receives an environment ready for developing and running its own applications. In *software* as a service (SaaS), it uses a complete application, such as an invoicing system, in exchange for a subscription. Figure 2.2 summarizes that sharing of responsibilities.

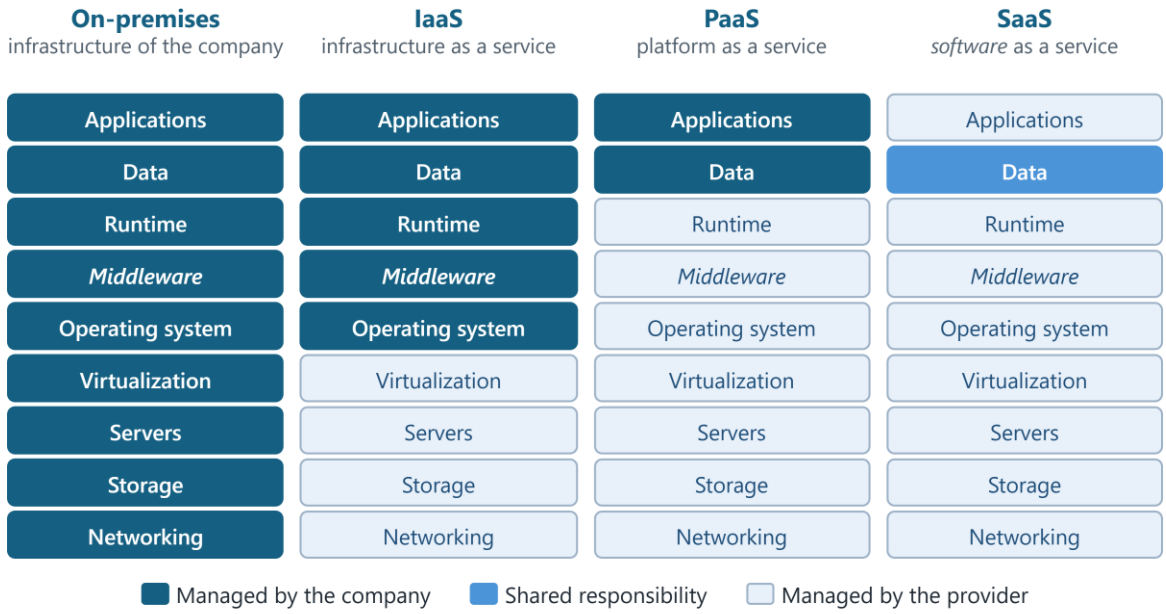
The figure also marks an important nuance: no model transfers all the responsibility. Even in SaaS, the user company decides who has access, with which credentials and what data are uploaded, while the provider answers for the infrastructure and for the application. A well-protected service can be left exposed by a careless configuration on the client side, such as a document folder shared with public access or the account of a former employee that nobody deactivated.

2.2.2. Deployment models and advantages for the MSME

Depending on who shares the infrastructure, the cloud allows four deployment models: public, open to any client on the provider's premises; private, reserved for a single organization; community, shared by related entities, such as a group of cooperatives; and hybrid, which combines two or more of the previous ones. An MSME usually starts with the public cloud, whereas an entity with strict regulatory requirements reserves certain data for a private cloud.

Figure 2.2

Cloud service models and the sharing of responsibilities



Note. The authors' own work, based on Mell and Grance (2011).

The appeal for the MSME is economic and operational. Armbrust et al. (2010) identify three novelties of the model: the appearance of unlimited resources on demand, the elimination of an up-front commitment and payment for use for as long as needed. Part of the investment in equipment becomes an operating expense, and the company gains managed backups, automatic updates and access from any branch. The same authors warn of obstacles: the availability of the service, the difficulty of moving the data to another provider and the confidentiality of the information.

2.3. Internet of Things: connected objects and cyber-physical systems

The Internet of Things, known by the acronym IoT, extends the network to physical objects able to identify themselves, measure their surroundings and communicate. In the review

by Atzori et al. (2010), the central idea is the pervasive presence of tags, sensors, actuators and phones that, thanks to unique addressing schemes, interact with each other and cooperate to reach common goals. A temperature sensor in a cold room stops being an isolated thermometer when its readings arrive at an application that warns the person in charge before the product spoils.

The fields of application are very diverse. Xu et al. (2014) document industrial uses in health, the food supply chain, mining and transport, and warn that technical standardization, security and privacy remain open challenges. In the region there is no shortage of examples within reach of a small company: soil moisture sensors on a cocoa farm, satellite trackers on delivery motorcycles, energy meters in a bakery or temperature recorders in the truck that carries fish from the port.

When connected objects, besides reporting, act on the material process, we speak of cyber-physical systems, in which computing and physical processes are integrated through cycles of measurement, calculation and control. An irrigation pump that switches on according to the measured moisture illustrates the idea. Lasi et al. (2014) place these systems, which chapter 5 studies in operations, among the central concepts of Industry 4.0, together with the smart factory and the self-organization of production.

Connecting objects has less visible demands. The data they generate must be stored, interpreted and turned into decisions; if nobody attends to them, the sensors only produce alarms that are ignored. The devices need power and coverage in places where both are scarce, and each one adds an entry point for attacks, especially if it keeps the factory password.

2.4. Artificial intelligence and machine learning

AI brings together methods that let a machine carry out tasks usually associated with human intelligence, such as recognizing images, understanding a text or choosing between alternatives. The textbook by Russell and Norvig (2021) organizes the field around the notion of a rational agent, that is, a system that perceives its environment and acts to obtain the best expected result given an objective. That formulation sets aside the question of whether the machine “thinks” and focuses attention on what it does and on how its performance is measured.

Much of today’s AI rests on machine learning: algorithms that improve their performance as they process examples, instead of following hand-written rules. Of its three main families, the most widely used is supervised learning, as Jordan and Mitchell (2015) point out. In it, the algorithm learns from labeled cases, such as loans repaid or defaulted, in order to

predict the label of new cases. Unsupervised learning looks for groups without prior labels, such as customers with similar buying habits, and in reinforcement learning an agent adjusts its behavior according to the rewards it obtains.

The applications available correspond to what is called narrow AI, specialized in specific tasks, which Kaplan and Haenlein (2019) distinguish from a general intelligence that does not yet exist. In small businesses, that AI almost always arrives embedded in services that are already contracted: the accounting system that suggests the account for each expense, the online store that recommends products or the messaging service that answers frequent questions. Developing a model of one's own, the subject of chapter 4, demands sufficient and reliable historical data, as well as people able to validate its results.

2.4.1. Generative AI and its limits

With generative AI, machines produce new content, such as text, images, code or audio, from instructions in natural language, thanks to models trained on enormous collections of data. In well-defined tasks, the evidence is encouraging. In an experiment with professionals writing documents typical of their occupation, Noy and Zhang (2023) observed that access to a conversational assistant reduced working time, improved the quality of the texts according to evaluators from the same occupation and narrowed the distance between participants.

A field study in a customer support service reached a similar conclusion. Brynjolfsson et al. (2025) found that an assistant based on generative AI increased the number of cases resolved per hour, above all among novice and less skilled agents, with a minimal effect among the most experienced ones. The tool can therefore speed up the learning of new staff, provided that someone with experience reviews its suggestions.

The limits weigh as much as the promises. These models can generate false statements with a convincing appearance, the so-called hallucinations, and they rarely explain how they arrived at an answer. Uploading customer data or strategic information to a public AI service may also breach confidentiality. The multidisciplinary review by Dwivedi et al. (2021) identifies challenges such as bias, the lack of transparency, data privacy and the effects on employment, which chapter 11 examines from the standpoint of ethics.

2.5. Blockchain and distributed ledgers

A blockchain is a distributed ledger: a database replicated among several participants, in which transactions are grouped into blocks and are only incorporated when the network validates them by consensus. Each block contains the cryptographic digest (*hash*) of the

previous one, so altering a past record would mean rebuilding the chain in plain sight of everyone. That property makes it useful for recording facts that several parties need to share without depending on a trusted intermediary. There are public networks, open to anyone, and private or consortium networks, restricted to authorized members.

One of the most studied business uses is traceability in the supply chain. Treiblmaier (2018) proposes examining that impact from established theories, such as transaction cost theory or principal-agent theory, in order to separate the technical potential from the effective value. In the region, a plausible application is the shared record of the origin of a lot of fine cocoa or shrimp, which the foreign buyer can consult, accompanied by smart contracts: programs that release a payment or issue an alert when an agreed condition is met.

The guarantee the chain offers has a precise scope: it prevents a record from being altered after it has been entered, but it does not ensure that the data entered are true, and a falsely declared origin is preserved with the same fidelity. Some public networks consume a great deal of energy, and the impossibility of erasing conflicts with the right to have personal data deleted. For an isolated MSME it is rarely justified; its natural place is in collective initiatives led by trade associations, exporters or buyers.

2.6. Robotic process automation and robotics

Robotic process automation (RPA) does not involve physical machines: it consists of programs, called *software* robots, that repeat on the screen what an employee would do, such as copying the data of an invoice into the accounting system. For van der Aalst et al. (2018), it is an “outside-in” approach, because it operates on the existing interfaces without modifying the information systems, as traditional automation does require.

Not every process lends itself to this treatment. The review by Syed et al. (2020) brings together the features of a good candidate: repetitive, high-volume tasks, clear rules, structured digital data and stable processes with few exceptions, such as the daily reconciliation of payments received by a distributor. A changing process, or one that depends on a person’s judgment, turns out to be fragile, and it is enough for a bank to redesign its portal for the robot to stop. Chapter 5 returns to RPA and process mining.

With physical robots, a similar logic moves to the material world. Industrial robots and collaborative ones, designed to work alongside people, sort, pack or weld with constant precision, and drones inspect crops or roofs. Frank et al. (2019) propose a framework in which these front-end technologies, oriented to smart manufacturing, rest on base technologies such as IoT,

cloud services, big data and analytics. In a small plant, the usual barriers are the investment, the maintenance and the adaptation of the space.

2.7. Connectivity and cybersecurity as baseline conditions

Almost all the technologies described assume a stable connection. If the link goes down, the cloud becomes unreachable, the sensors stop reporting and the *software* robot cannot reach the portal it consults. That is why speed, latency, reliability and a backup link matter, aspects in which gaps persist, as chapter 10 analyzes.

The connection, however, barely opens the door. Digital benefits also depend on analog complements, such as regulations that favor competition, skills and institutions that are accountable (World Bank, 2016). An MSME with fiber optics but without trained staff or orderly processes gets little out of it.

Alongside connectivity, cybersecurity is the other baseline condition. Every layer of the architecture adds attack surfaces, and size protects nobody, because automated attacks do not distinguish between a multinational and a hardware store. The usual threats are well known: phishing emails that steal passwords, ransomware that encrypts information in exchange for a ransom and equipment that is never updated.

The basic defenses are well known too, and their cost is low compared with the damage they prevent: two-factor authentication, timely updates, offline backups that are tested regularly and permissions limited to what is needed. To organize this management, the NIST cybersecurity framework in its version 2.0, which chapter 11 develops, proposes six functions: govern, identify, protect, detect, respond and recover (National Institute of Standards and Technology, 2024).

2.8. How to appraise a technology before adopting it

Table 2.1 brings together what the previous sections covered: what each technology does, a possible use in an MSME, its requirements and its main risks. It is a starting point. The decision to adopt calls for a more orderly examination, which can be organized into six questions to be answered before any contract.

Table 2.1

Enabling technologies: functions, uses, requirements and risks in the MSME

Technology	What it does	Possible use in an MSME	Requirements	Main risks
Cloud computing	Offers infrastructure, platforms or applications over the network, paid according to use	Invoicing, inventory and data backup contracted as SaaS	Stable connection and a contract with exit rules	Dependence on the provider and on the connection
IoT (Internet of Things)	Connects objects that measure their surroundings and transmit data	Temperature control in cold rooms	Power, coverage and someone to attend to the alerts	Vulnerable devices and data that nobody uses
Machine learning	Learns patterns from historical data in order to predict or classify	Demand forecasting or appraisal of loan applications	Sufficient and reliable data; validation by experts	Bias and prediction errors that go undetected
Generative AI	Generates text, images or code from instructions	Draft replies, product descriptions and summaries	Human review and rules on what data are uploaded	Hallucinations and leaks of confidential information
Blockchain	Keeps a shared record that cannot be altered afterwards	Traceability of lots required by foreign buyers	A network of partners and governance rules for the consortium	False data at the source and coordination costs
RPA	Imitates on the screen the repetitive tasks of an employee	Reconciliation of payments and recording of orders	A stable process, with clear rules and digital data	Fragility in the face of changes in the interfaces
Physical robotics	Carries out material tasks with constant precision	Packing or sorting in a small plant	Investment, space and technical maintenance	Underuse and stoppages for lack of spare parts

Note. The authors' own work.

The six questions, in the order in which they should be answered, are the following:

1. **Problem.** Which specific difficulty of the business is being solved, and with what indicator will the improvement be measured?
2. **Total cost.** How much does it cost to acquire, install, operate and, if the time comes, abandon the technology over its useful horizon?

3. **Maturity.** Is it proven in similar organizations or still experimental, and is there a market of providers and of support?
4. **Risks.** What happens if it fails, if information leaks or if the provider disappears, and what legal obligations are triggered?
5. **Providers.** Do they offer local support, allow the data to be exported and commit in the contract to verifiable service levels?
6. **Skills.** Who will operate and maintain it, and what training does the team need in order to make the most of it?

For the second question there is a tool of its own. The total cost of ownership (TCO) adds up the outlays associated with a technology over its useful horizon, including those that do not appear in the provider's quotation:

$$TCO = \text{Initial costs} + \Sigma\ \text{Annual operating costs} + \text{Exit costs}$$

Among the costs that are usually forgotten are data migration and cleansing, training, the hours the staff devotes to the transition, additional connectivity and the exit, that is, what it would cost to move the data to another provider. In its simple form, TCO adds values from different years without discounting them; chapter 12 incorporates the time value of money. The first application exercise of the chapter compares, with this method, an in-house server and a SaaS service.

These questions weigh more heavily in the small company, where a poor choice commits a large part of the budget. Moreover, small and medium-sized enterprises (SMEs) adopt advanced technologies more slowly than large ones, and the distance grows with the sophistication of the technology (OECD, 2021). A limited pilot, with indicators defined in advance, reduces the risk before the solution is extended. The digital maturity at the outset (chapter 8) and the factors of adoption (chapter 9) complete the analysis.

Illustrative case: a chain of three pharmacies that migrates its system to the cloud

A family business operates three pharmacies in a mid-sized city in the Ecuadorian highlands. Its inventory and invoicing system ran on a server installed in the back room of the main store, and the branches connected to it by remote desktop. Backups were recorded every week on an external drive that the administrator took home. A power surge damaged the server disk and left the three stores unable to issue invoices for two days.

Management compared two options with the total cost of ownership method: renewing the server or contracting a pharmacy system in SaaS mode with electronic invoicing included.

With similar costs over three years, it chose the second one for the continuity of the service and the managed backups. Before migrating it cleaned up the catalog, which had duplicate products and lots whose expiry date was not recorded, and ran both systems in parallel for two weeks. It also contracted a second internet link, activated two-factor authentication and checked in the contract where the data on customers and prescriptions would be hosted, as well as how they could be exported.

The changes were felt in daily operations: the inventory of the three branches is consulted on a single screen, transfers between stores are recorded instantly and the system gives notice when a lot approaches its expiry date. New dependencies also appeared. Each additional user makes the subscription more expensive, and the continuity of sales now depends on connectivity and on the provider, two risks that management decided to review every month.

2.9. Chapter summary

Enabling technologies are worth what they allow to be combined. None of them transforms an organization on its own, and all of them demand orderly data, a reliable connection, adequate protection and people able to use them. The central ideas of the chapter are the following:

- The technology architecture is organized in layers of infrastructure, data, applications and experience; a failure at the base propagates upward.
- The cloud offers infrastructure, platforms or applications as a service, and in every model the client keeps responsibility for access, configuration and data.
- IoT and cyber-physical systems join the physical world with the digital one, but their data only create value if someone interprets them and acts.
- The AI available is narrow and learns from data; generative AI raises productivity in well-defined tasks, although it demands human review because of its errors and biases.
- Blockchain secures the integrity of a shared record, not the truthfulness of the data at the source, and it pays off more in collective initiatives.
- RPA automates repetitive tasks on the existing interfaces and physical robotics does the same with material tasks; both require stable processes.
- Every adoption should go through six questions: problem, total cost of ownership, maturity, risks, providers and skills.

Key terms: *technology architecture, SMACIT, cloud computing, IaaS, PaaS and SaaS, IoT (Internet of Things), cyber-physical system, machine learning, generative AI, blockchain, robotic process automation, cybersecurity, total cost of ownership.*

2.10. Exercises and activities

Comprehension questions

1. What function does each of the four layers of the technology architecture perform, and why does a failure at the base end up affecting the customer's experience?
2. Which responsibilities does the user company keep in the IaaS, PaaS and SaaS models, and which ones does the provider take on?
3. What distinguishes a cyber-physical system from a connected sensor that only transmits readings?
4. Why does generative AI require human review even when the evidence shows productivity improvements in well-defined tasks?
5. What does a blockchain guarantee about the data it records, and what can it not guarantee?

Application exercises

1. Total cost of ownership. A pharmacy chain with 12 users compares two options for its inventory and invoicing system. Option A, an in-house server: equipment, USD 5,200; operating system and database licenses, USD 1,800; installation and configuration, USD 900; technical support, USD 1,800 a year; power and air conditioning, USD 600 a year; offsite backups, USD 420 a year; replacement of disks in the second year, USD 650. Option B, a SaaS service: USD 32 per user per month; data migration and training, USD 1,100 once; backup internet link, USD 30 a month. Exit costs are assumed to be zero and flows are not discounted. a) Calculate the TCO of each option over three years. b) Obtain the absolute and relative difference. c) Determine the monthly fee per user that makes both options equal. d) Recalculate over five years, assuming the server is not renewed, and comment on the result. *Worked solution in Appendix B.*
2. Classify the following services as IaaS, PaaS or SaaS and state which responsibilities the user company keeps in each one: an online accounting system paid by subscription; the rental of a virtual server to host an online store; a managed environment for programming an ordering application; a corporate email service; and a storage space for backups that is paid according to the capacity used.

3. Choose an administrative process of an MSME you know, or else the reconciliation of card payments in a hardware store, and assess whether it is a good candidate for RPA using the features set out in section 2.6: volume, rules, type of data, stability and exceptions. Close with a justified half-page recommendation.
4. An association of cocoa growers receives a proposal to record its lots on a blockchain in order to sell them to European buyers. Apply the six questions of section 2.8 and write a one-page recommendation for the board specifying what additional information should be requested from the provider.

Analysis of the case

1. Which layers of the technology architecture changed with the migration of the pharmacy chain, and which ones stayed the same?
2. Which service model and which deployment model did management choose, and which security responsibilities remain in the hands of the company?
3. Which criteria from section 2.8 did management apply before deciding, and which one would have been worth strengthening?
4. Which monthly indicators would be worth defining in order to watch the dependence on connectivity and on the provider?

Collaborative activity

1. In teams of three or four people, select a local MSME, draw up the inventory of its technology architecture by layers and choose two technologies from this chapter that could solve a specific problem of that company. Appraise them with the six questions of section 2.8. Expected output: a three-page report with the diagram of layers, the appraisal and a prioritized recommendation.
2. Organize a debate on the use of generative AI in the customer service of an MSME: one group defends immediate adoption and the other, a gradual adoption with rules of use. Expected output: a one-page policy of use agreed by both groups.

Self-assessment

1. In the layered technology architecture, where are the databases that record customers, products and transactions located?
   a) In the experience layer
   b) In the data layer
   c) In the infrastructure and connectivity layer
   d) In the applications layer
2. In a SaaS service, which responsibility does the user company keep?
   a) The maintenance of the provider's servers
   b) The updating of the application
   c) The air conditioning of the data center
   d) The management of access, credentials and the data uploaded
3. Which of the following processes is the best candidate for robotic process automation?
   a) The daily reconciliation of payments with fixed rules and digital data
   b) The negotiation of prices with a new supplier
   c) The design of an advertising campaign
   d) The handling of complaints that require a supervisor's judgment
4. What characterizes a cyber-physical system?
   a) It transmits sensor readings to a spreadsheet
   b) It stores its data in a public cloud
   c) It integrates computing and physical processes through cycles of measurement and control
   d) It completely replaces the operators of a plant
5. A model learns from loans already classified as repaid or defaulted in order to predict the outcome of new applications. Which type of learning does it use?
   a) Reinforcement learning
   b) Unsupervised learning
   c) Generative AI
   d) Supervised learning

6. According to the experimental and field evidence reviewed in the chapter, who obtains the greatest improvements with generative AI?
   a) The most experienced workers
   b) Workers with less experience or lower initial performance
   c) The managers of the company
   d) No group shows measurable changes
7. What can a blockchain guarantee?
   a) That a record is not altered without the participants noticing
   b) That the data entered are true
   c) That the network consumes no energy
   d) That personal data can be deleted on request
8. When calculating the total cost of ownership, which items are usually left out and should be included?
   a) The purchase price of the equipment
   b) The monthly subscription fee
   c) Data migration, training and the exit cost
   d) The provider's profit margin
9. A firm contracts an invoicing system that it accesses through a browser, with nothing to install and no servers to administer. Which service model is it using?
   a) IaaS
   b) PaaS
   c) SaaS
   d) Private cloud
10. What is the essential difference between the internet of things and a cyber-physical system?
    a) The internet of things connects objects, and the cyber-physical system also acts on the physical world using those data
    b) The internet of things is industrial and the cyber-physical system is domestic
    c) A cyber-physical system does not need connectivity
    d) There is no difference: they are two names for the same technology

11. When assessing a technology before adopting it, the total cost of ownership requires adding to the purchase price
    a) only the annual maintenance
    b) implementation, data migration, training, support and exit costs
    c) just the licenses for the next five years
    d) the opportunity cost of not adopting it
12. What should an MSME considering generative artificial intelligence answer first?
    a) Which model is the most advanced on the market
    b) Which specific, repeated task it wants to solve and how it will measure the result
    c) How many competitors are using it
    d) Whether to hire a full-time specialist

CHAPTER 3.
DIGITAL STRATEGY AND BUSINESS MODELS

A hardware store in Machala opens an online shop, a restaurant in Salinas joins two delivery apps and an agricultural cooperative in Los Ríos contracts a cloud management system. All three decisions bring in technology, but none of them answers on its own the central question of this chapter: how the organization will create value in a digital environment, through which channels it will deliver that value to its customers and in what way it will get paid for it.

Chapter 1 defined what is meant by digital transformation and chapter 2 described the technologies that support it. To organize the management decisions that give them meaning, the approach of Rogers (2016) is useful; he argues that the digital alters five domains of strategy: customers, competition, data, innovation and value.

By the end of this chapter, the reader will be able to:

1. Explain the shift from an information technology (IT) strategy, subordinated to the business, to a digital business strategy that integrates both.
2. Apply the four dimensions of a digital transformation strategy to the analysis of a specific organization.
3. Describe the business model of a micro, small or medium-sized enterprise (MSME) with the nine-block canvas and formulate the digital question of each block.
4. Compare digital business models according to their revenue logic and calculate the break-even point of a subscription model.
5. Analyze how platforms and network effects work, and tell disruptive innovation apart from open innovation.

3.1. From IT strategy to digital business strategy

For decades, technology occupied a supporting place in the firm. In the value chain proposed by Porter (1985), technology development appears among the support activities, at the service of the primary activities that run from inbound logistics to after-sales service. Management practice translated that position into a functional IT strategy, in which top management set the objectives of the business and the IT department then chose the equipment and software that best served them, with efficiency as the dominant criterion.

That division of labor lost its meaning when technology became part of what the company sells. An insurance agency in Cuenca that quotes online or a bakery that takes orders by messaging app uses technology to compete, and for them choosing a tool amounts to deciding about the channel, the service and the price.

On that diagnosis, Bharadwaj et al. (2013) proposed merging IT strategy with business strategy into a digital business strategy, understood as an organizational strategy formulated and executed by leveraging digital resources to create differential value. Four themes characterize it: a scope that goes beyond functional areas and the boundary of the firm; a scale that grows or shrinks quickly thanks to the cloud and to network effects; a greater speed for launching products, deciding and coordinating with partners; and new sources of value creation and capture, such as information and multi-sided models.

Digital business strategy and digital transformation strategy are close concepts, although not equivalent. While the first defines how the company will compete once the digital is part of its offering, the second organizes the path toward that position. Both fit the framework of Vial (2019), in which digital technologies bring about disruptions, organizations respond with strategies and those responses modify their paths of value creation, while at the same time forcing them to manage structural changes and internal barriers.

3.2. Dimensions of a digital transformation strategy

If digital business strategy answers how to compete, the digital transformation strategy answers how to get there. Its function is to coordinate, prioritize and set in motion the changes the company undertakes with digital technologies. Because it cuts across the organization, it must be aligned with the marketing, operations or IT strategies rather than replace them. To analyze it, Matt et al. (2015) propose four dimensions that condition one another, because a decision taken in any of them widens or narrows the options of the rest.

Each dimension requires management to answer one central question:

- *Use of technology*: what attitude does the company take toward new technologies and what capability does it have to exploit them, as a pioneer or as a follower of already proven standards?
- *Changes in value creation*: how far do the new digital activities depart from the traditional business, and where will the revenue come from?
- *Structural changes*: where will the new activities be placed within the organization, and which processes and skills will have to be modified?

- *Financial aspects*: how much pressure does the current business exert to change, and with what resources will the change be financed?

In an MSME, the first dimension rarely raises the option of leading technological development, and the sensible course is usually to adopt standardized solutions and concentrate ambition on their use. The second is more delicate. A distributor of veterinary supplies that sells online to small cattle farmers gains a source of revenue, but it may take sales away from its field salespeople if it does not review their commissions.

As for structure, the classic dilemma is whether to integrate the digital activities into the existing organization or to separate them into a unit of their own (Matt et al., 2015). Integration makes coordination easier; separation protects the initiative from routines that could suffocate it. In the MSME, that unit is usually one person with time set aside and the owner's backing, and its continuity rests on leadership and culture, the subjects of chapter 7.

On the financial side, pressure works in two directions. A core business losing margin pushes the firm to transform, but that same weakness reduces the money available to do so. It is therefore advisable to stagger the investment, a criterion that chapter 12 develops when dealing with the road map. In a study of small and medium-sized Chinese firms, Cheng et al. (2024) observed that a strategic vision about digitalization favors transformation through resource orchestration, that is, through structuring, bundling and leveraging resources.

3.3. The business model and its canvas

Strategy takes shape in a business model. For Teece (2010), every company uses, explicitly or implicitly, a model that defines how it delivers value to the customer, how it induces the customer to pay for that value and how it converts those payments into profit. That model reflects management's hypothesis about what the customer wants and about the profitable way of serving them. The same author warns that the model is more generic than the strategy, since the latter decides how to differentiate and how to protect the model from imitation.

The term became popular with the internet and without a shared definition. After reviewing the literature, Zott et al. (2011) found that disagreement, but they identified four common points: the model is a unit of analysis distinct from the product and from the firm, it takes a systemic view of how business is done, it gives a central place to activities and it explains both value creation and value capture. That last point matters in the digital world, where an application may be useful to thousands of people without any of them paying for it.

To describe a model, one of the most widespread tools is the canvas of Osterwalder and Pigneur (2010), who define the business model as the logic by which an organization creates,

delivers and captures value. The canvas breaks that logic into nine blocks: customer segments, value proposition, channels, customer relationships, revenue streams, key resources, key activities, key partnerships and cost structure. The blocks on the right describe the customer and revenue side; those on the left, the infrastructure that supports the offering and determines the costs.

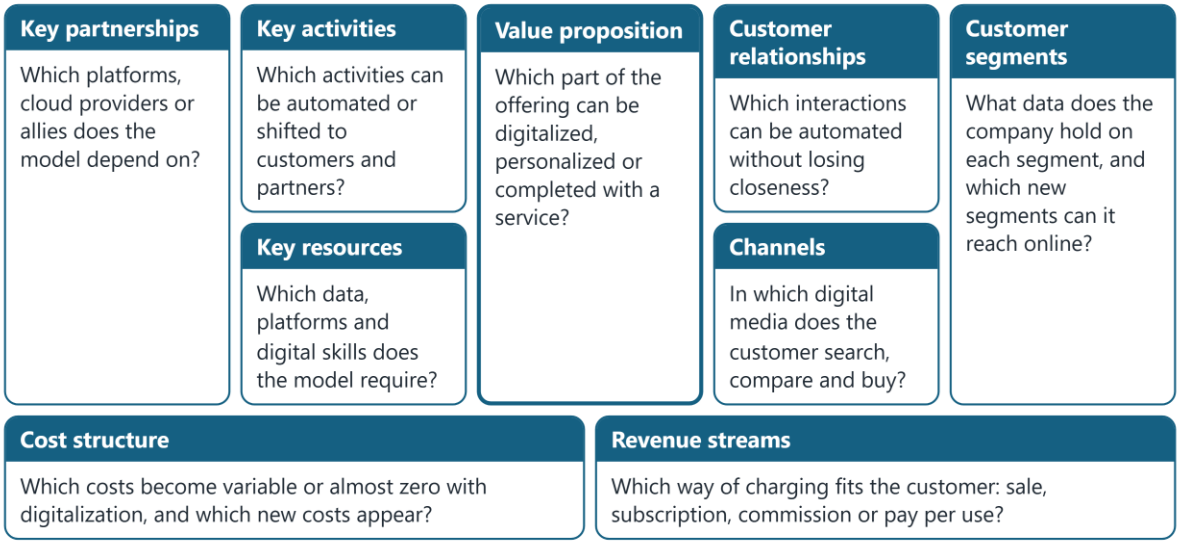
Figure 3.1 adds to each block a question that forces one to think about its digital dimension:

- *Customer segments*: what data does the company hold on each segment, and which new segments can it reach online?
- *Value proposition*: which part of the offering can be digitalized, personalized or completed with a service?
- *Channels*: in which digital media does the customer search, compare and buy?
- *Customer relationships*: which interactions can be automated without losing closeness?
- *Revenue streams*: which way of charging fits the customer: sale, subscription, commission or pay per use?
- *Key resources*: which data, platforms and digital skills does the model require?
- *Key activities*: which activities can be automated or shifted to customers and partners?
- *Key partnerships*: which platforms, cloud providers or allies does the model depend on?
- *Cost structure*: which costs become variable or almost zero with digitalization, and which new costs appear?

Used well, the canvas works as a set of assumptions waiting to be tested. An inn that writes “domestic tourists” in the segments block says very little, whereas “families from Guayaquil who travel on public holidays and book through social media” is an assumption that its own bookings can confirm or refute. Among the limits of the canvas are its static character, the absence of competitors and the little visibility it gives to dependence on external partners.

Figure 3.1

The business model canvas with its digital questions



Note. The authors' own work, based on Osterwalder and Pigneur (2010).

3.4. Digital business models

When is a business model digital? When technology takes part in the way value is created, delivered or charged for. The variants differ above all in their revenue logic, that is, in what is charged, to whom and how often. Table 3.1 summarizes seven frequent models with a generic example and their conditions of viability; in practice, it is common for a company to combine two or more.

3.4.1. Subscription and freemium

In the subscription model, the customer pays a periodic fee in exchange for continuous access to a product or service, such as cloud accounting software or a monthly box of organic produce. Its appeal is recurring revenue; its weak point, the churn rate, which measures the proportion of subscribers who cancel in each period. Three variables, the price, the variable cost of serving each subscriber and the fixed costs of the service, determine the break-even point:

Break-even subscribers = Fixed costs of the period / (Price - Variable cost per subscriber)

The formula is best read with an example. An application that charges USD 20 a month, spends USD 5 per customer and bears fixed costs of USD 3,000 a month obtains USD 15 of margin per subscriber and needs 200 subscribers to cover its costs. With monthly churn of 5%,

it would lose ten a month and would have to acquire another ten just to hold its ground. The second application exercise works through a complete case.

Table 3.1

Digital business models: revenue logic, generic example and conditions of viability

Model	Revenue logic	Generic example	Conditions of viability
Subscription	A periodic fee for continuous access to a product or service	Cloud invoicing software for microenterprises with a monthly fee	Low churn rate, value perceived every month and a recoverable acquisition cost
Freemium	A free basic version; revenue from the minority who pay for advanced features	Appointment app for barbershops with a paid professional plan	Minimal cost per free user, a clear difference between plans and sufficient conversion
Direct electronic commerce	Margin on the sale of the firm's own products in an online store	Fine cocoa producer that sells bars on its own website	Reliable logistics, secure payments, buyer trust and shipping at a reasonable cost
Online marketplace	Commission on each sale made between third parties	Portal that brings furniture workshops together with buyers across the country	Enough sellers and buyers, quality control and protected payments
Platform	Commissions, access fees or advertising for enabling interactions between groups	App that connects freight carriers with exporters	Critical mass on each side, rules of participation and positive network effects
Servitization	Charging for use, availability or outcome instead of selling the good	Supplier of irrigation pumps that charges per cubic meter pumped	Sensors and connectivity, clear contracts and capital to finance the equipment
Data as a product	Sale of aggregated information or of analyses derived from operations	Network of neighborhood stores that sells anonymous demand reports	Quality data, anonymization, a legal basis for processing and the trust of data subjects

Note. The authors' own work. The examples are generic and do not correspond to real companies.

The *freemium* model (a word formed from *free* and *premium*) offers a basic version free of charge to a wide base of users and charges for an advanced version that only a minority contracts. In the catalog of patterns of Osterwalder and Pigneur (2010), it is a case in which paying users finance those who do not pay. It works if serving a free user has a minimal cost

and if the paid version offers what the intensive user values. When the free version solves too much, almost nobody pays; when it is too limited, almost nobody adopts it.

3.4.2. Electronic commerce and online marketplaces

In direct electronic commerce, the company sells its own products in an online store and earns the margin on each sale, just as in traditional commerce. Opening the store is cheap today; what is demanding for an MSME is sustaining what happens after the purchase, which includes preparing the order, delivering it on time, collecting payment securely and handling returns. Chapter 6 examines that operation and the metrics that show whether the channel makes or loses money.

The online marketplace, by contrast, does not sell products of its own. It brings together independent sellers and buyers, charges a commission on each transaction and grows without inventory. Its weakness is that revenue amounts to a small fraction of the value that flows through it; with a commission of 10%, it has to intermediate ten dollars in sales for every dollar it wants to earn. It therefore needs volume on both sides at once, a problem it shares with other platforms.

3.4.3. Servitization and data as a product

A maker of irrigation pumps can charge per cubic meter pumped, and a supplier of refrigeration equipment for shrimp packing plants, per ton kept at the agreed temperature. Both practice servitization, which consists of selling the result of the good instead of the good itself. Sensors and connectivity make it possible, since they give the product what Yoo et al. (2010) call a layered modular architecture (device, network, service and content), to which services can be added without redesigning the physical object. In exchange, the company takes on the performance risk and finances equipment it no longer sells.

Finally, the data-as-a-product model turns the information generated by operations into an offering of its own. A network of neighborhood stores sharing the same sales system, for example, could sell distributors aggregated and anonymous reports on demand by area. The model demands quality data, rigorous anonymization and a legal basis for any processing of personal data, in the terms of the Ley Orgánica de Protección de Datos Personales (Asamblea Nacional del Ecuador, 2021), which chapter 11 examines.

This model also raises ethical dilemmas. In her critique of surveillance capitalism, Zuboff (2019) warns against the appropriation of human behavioral data to manufacture marketable

predictions. For an MSME, the practical lesson is to treat customer data as an asset held in custody, whose use must be explainable to the people it belongs to.

3.5. Platforms, ecosystems and network effects

Online marketplaces belong to a wider family of businesses, platforms, whose value grows with the number of participants they attract and with the quality of their interactions. Understanding them requires a look at their economic logic, at the network effects that explain their growth and at the ecosystems in which the MSME takes part.

3.5.1. Platforms and two-sided markets

For Parker et al. (2016), a platform is a business that creates value by facilitating interactions between external producers and consumers, and it differs from the linear chain firm (the *pipeline*), which controls a sequence of activities from the input to the customer. On a platform, much of the value is produced outside the company. Drivers, hosts or sellers provide the supply, and the platform devotes itself to attracting them, connecting them with demand and taking care of every exchange.

When the platform brings together two groups that need each other, we speak of a two-sided market. As Rochet and Tirole (2003) showed, the challenge is to bring both sides on board and, to achieve it, the way prices are split between the groups matters, as well as their level. Hence one side usually pays little or nothing, as happens with card networks, which charge mainly the merchants.

3.5.2. Network effects

A network effect exists when the value each participant obtains depends on how many participants there are. It is direct when it comes from the same group, as in instant messaging, and cross-side when the growth of one side attracts the other. In a freight app, more affiliated carriers reduce the waiting time of exporters, and more exporters attract carriers. Figure 3.2 represents both effects.

Network effects can also turn negative when low-quality sellers proliferate. At the beginning, by contrast, the problem is scarcity, because no buyer goes to an empty marketplace and no seller signs up where there are no buyers, a dilemma known as the chicken-and-egg problem. Among the ways out described by Parker et al. (2016) are subsidizing the side that is most sensitive to price, seeding supply with the firm's own resources, concentrating on a small

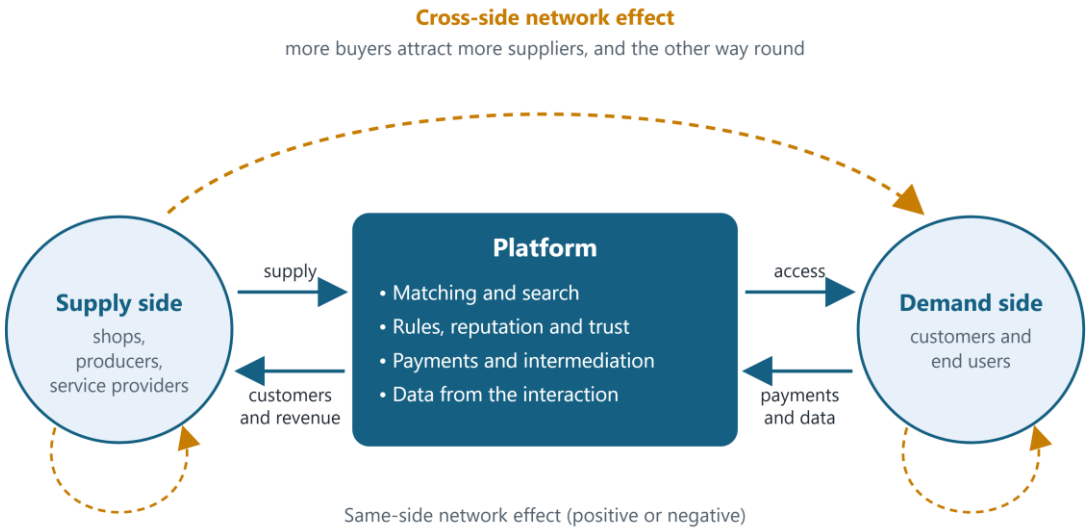
community until critical mass is reached and relying on existing networks, such as trade associations or messaging groups.

3.5.3. Ecosystems and the position of the MSME

Other platforms serve as a base for innovation. In their study of innovation ecosystems, Gawer and Cusumano (2014) distinguish internal platforms, common assets with which a company develops a family of products, from industry platforms, on which other companies build complementary innovations. An electronic invoicing service with open application programming interfaces (APIs) works as an industry platform, since its value grows with every add-on that third parties build on it.

Figure 3.2

Two-sided platform and network effects



Note. The authors' own work, based on Parker et al. (2016).

The notion of an ecosystem widens the focus. According to Adner (2017), an ecosystem is the alignment structure of the set of partners that need to interact for a value proposition to materialize. The definition forces one to ask who else must do their part for the offering to reach the customer. A cooperative launching mobile phone payments in a rural parish needs network coverage, shops that accept the payment method and a bank that credits the money on time.

An MSME usually joins ecosystems orchestrated by others, such as online marketplaces or delivery apps, rather than building a platform of its own. That participation can transform it, as Li et al. (2018) documented in small Chinese firms that came to export through electronic commerce thanks to the support of the platform provider and to the renewal of their owners' mindset and capabilities. Dependence has its costs, because the orchestrator can raise commissions, change the algorithm that ranks the offerings or keep the customer data. Operating on several platforms and cultivating a channel of one's own softens that risk.

3.6. Disruptive innovation and open innovation

Platforms and digital models are, in themselves, innovations. From the field of innovation management, Nambisan et al. (2017) define digital innovation as the creation of offerings, processes or business models that result from the use of digital technology, and they attribute two features to it: its outcomes have less clear-cut boundaries, because a product can keep changing after it has been launched, and the capacity to innovate is distributed among actors inside and outside the firm.

3.6.1. Disruptive innovation

Few words are used as loosely as disruption, which has, however, a precise meaning. In studying why well-managed companies fail, Christensen (1997) distinguished sustaining technologies, which improve the attributes that mainstream customers already value, from disruptive ones, which at first perform worse on those attributes but offer others, such as a lower price, simplicity or convenience, and win their first customers in new or unattractive markets. Over time, the disruptive offering improves until it satisfies the mainstream customer, while established firms, busy with their most profitable customers, react too late.

Table 3.2 summarizes the differences. For an MSME, the theory allows two readings. The defensive one warns that a travel agency focused on its long-standing customers may fail to notice that direct online booking already satisfies a good share of travelers. The offensive one suggests entering through the segment that large companies neglect, such as the microenterprises that never bought an accounting system.

3.6.2. Open innovation

The second idea concerns the organization of the process of innovating. Against the closed model, in which the firm generates ideas with its own research and takes them to market by its own means, Chesbrough (2003) proposed open innovation, according to which firms can

and should combine internal and external ideas, as well as internal and external paths to market. That implies flows of knowledge inward, from universities, suppliers, customers or start-ups, and outward, through licenses, alliances or spin-offs.

The MSME, which rarely has a research department, finds in openness a practical way to innovate. A garment workshop can design clothes with its customers in an online community, and a dairy plant can develop a traceability system with a university. Opening up demands the capacity to absorb what comes from outside and clear rules about the ownership of what is created jointly; chapter 10 describes the support available for that purpose.

Table 3.2

Sustaining innovation and disruptive innovation: distinctive features

Feature	Sustaining innovation	Disruptive innovation
Initial performance	Superior in the attributes that mainstream customers already value	Inferior in those attributes, although with other advantages
Advantages it offers	More performance, more features or better quality	Lower price, simplicity, smaller size or convenience
First customers	The most demanding and profitable customers	New or underserved customers
Initial margin	High and attractive for the established firm	Low and unattractive for the established firm
Response of the established firm	It invests and usually leads the improvement	It puts off the response and reacts too late
Generic example	Accounting system with more modules for medium-sized firms	Mobile app for basic invoicing for microenterprises

Note. The authors' own work, based on Christensen (1997).

Illustrative case: from an agency to a platform of local experiences on the Santa Elena peninsula

A family tour operator on the Santa Elena peninsula sold beach and whale-watching packages for years through hotels and online agencies that retained a high commission. Margins were narrowing and visitors were asking for experiences that the packages did not offer: going out to sea with artisanal fishers, cooking an encebollado with a cook from the village

or walking the trails with local guides. The manager, the founder's daughter, decided to turn that demand into a different model.

With the business model canvas, the team identified two sides, the visitors looking for authentic experiences and the local providers with no sales channel of their own. The operator set up a booking site with online payment, registered the first providers free of charge, trained them in photography, customer service and electronic invoicing, and set a commission of 15% per booking. To overcome the chicken-and-egg problem, it seeded supply with its own tours and asked two allied hotels to recommend the experiences. Visitors' ratings decided the order in which each provider appeared.

Eighteen months later, supply had grown, but demand was still tied to the high season and some visitors hired the provider directly on their second visit, outside the platform. The operator kept selling packages to sustain its cash flow while the new model matured, and it changed its indicators. It stopped counting packages sold and began to measure repeat bookings, average rating and active providers per month. The open question is whether the community will see the platform as an ally or as yet another intermediary.

3.7. Chapter summary

Decisions about technology have become decisions about the business. Digital business strategy sets how the company will compete, the digital transformation strategy orders the path in four dimensions and the business model translates both into a concrete logic of creating, delivering and capturing value. The key ideas of the chapter are the following:

- IT strategy is no longer a functional strategy subordinated to the business: in digital business strategy, technology and business are decided together.
- A digital transformation strategy must balance the use of technology, changes in value creation, structural changes and financial constraints.
- The business model is a hypothesis about how to create, deliver and capture value; the nine-block canvas helps to make it explicit and to put it to the test.
- Digital models differ in their revenue logic. In a subscription, the break-even point is expressed in number of subscribers, and the churn rate sets how many new customers are needed to sustain it.
- Platforms create value by facilitating interactions between external groups; cross-side network effects explain their rapid growth and also the difficulty of launching them.

- The MSME usually takes part in ecosystems orchestrated by others; it is wise to make use of them without giving up a channel of its own or the direct relationship with its customers.
- Disruptive innovation describes a precise pattern of competition, and open innovation offers the MSME a way to innovate with external knowledge.

Key terms: *digital business strategy, digital transformation strategy, business model, business model canvas, freemium, online marketplace, servitization, two-sided market, network effects, ecosystem, disruptive innovation, open innovation.*

3.8. Exercises and activities

Comprehension questions

1. Why did IT strategy stop being conceived as a functional strategy subordinated to the business? Explain the four themes that characterize digital business strategy.
2. What are the four dimensions of a digital transformation strategy, and why does a decision taken in one of them condition the others?
3. What is the difference between a business model and a strategy? Illustrate the answer with two companies that share the same model and compete in different ways.
4. Why do two-sided markets face the chicken-and-egg problem, and what alternatives do they have for overcoming it?
5. Which features define a disruptive innovation, and how does it differ from open innovation?

Application exercises

1. Choose an MSME you know (a bakery, a hardware store, a repair shop or an inn) and describe its current business model with the nine blocks of the canvas. Then answer for each block the digital question of figure 3.1 and point out the two blocks in which technology could change the way value is created or captured the most.
2. *Break-even point of a subscription model.* A technology company in Guayaquil offers small restaurants an online ordering system for a subscription of USD 39 a month. Serving each customer costs it USD 9 a month (cloud hosting, support and the payment gateway commission) and its monthly fixed costs amount to USD 7,200. a) Calculate the contribution margin per subscriber and the break-even number of subscribers. b) If 4% of the subscribers cancel every month, calculate how many new customers the company must acquire each month to keep the break-even base. c) The company is

considering launching a free version: each free user would cost it USD 0.30 a month and 5% of the active users are expected to pay. Recalculate the break-even point in paying subscribers and the total number of active users that it implies. *Worked solution in Appendix B.*

3. *Online marketplace with commission revenue.* An online marketplace brings together tagua and wood craft workshops with buyers across the country. It charges sellers a commission of 12% on each sale; the average purchase is USD 25 and each transaction costs it USD 0.90 in payment processing and anti-fraud verification. Its monthly fixed costs are USD 4,400. a) Calculate the margin left by each transaction. b) Determine how many monthly transactions it needs to cover its fixed costs. c) Calculate the gross value of the sales that must flow through the platform and explain what that result implies for its launch strategy. *Worked solution in Appendix B.*
4. Classify the following businesses according to the models of table 3.1 and justify the revenue logic of each one: a) a transport cooperative that charges a monthly fee for monitoring its members' vehicles in real time; b) a free cycling routes app that charges for advanced features; c) a machinery company that no longer sells its grain dryers and charges farmers per hundredweight dried; d) a portal that connects owners of beach apartments with tourists and charges a commission per booking.

Analysis of the case

1. Identify the two sides of the platform the operator built, the cross-side network effect it sought to activate and the side it decided to subsidize. Was that choice the right one?
2. Analyze the case with the four dimensions of a digital transformation strategy. Which dimension was left least resolved, and what consequences could that have?
3. The operator kept selling packages while the platform grew. What advantages and what risks does sustaining both models at once have?
4. Propose three measures to reduce the risk of visitors and providers closing deals outside the platform without damaging the relationship with the community.

Collaborative activity

1. In teams of three or four members, choose a sector of the region (artisanal fishing, community tourism, retail trade or agriculture) and design the digital business model of an MSME in that sector with the canvas of figure 3.1. Expected output: the complete canvas, the revenue logic with its break-even point and a list of the three riskiest assumptions, with the way of testing them.

2. Exchange the work with another team, which will act as an investment committee and write a one-page report with the strengths of the model, its main risks and a reasoned recommendation. Expected output: the evaluation report and a corrected version of the model.

Self-assessment

1. What characterizes a digital business strategy?
   a) It is a functional strategy that the IT department derives from the commercial objectives.
   b) It is the merger of IT strategy and business strategy to create differential value with digital resources.
   c) It is the purchasing plan for equipment and software for the coming years.
   d) It is the technical description of the architecture of the information systems.
2. Which of the following options is not one of the four dimensions of a digital transformation strategy?
   a) Use of technology.
   b) Structural changes.
   c) Financial aspects.
   d) Market share of the industry.
3. What does a business model mainly reflect?
   a) Management's hypothesis about what the customer wants and about how to serve them profitably.
   b) The organization chart of the company and the way responsibilities are split among its areas.
   c) The list of technologies the company has acquired and the budget set aside to maintain them.
   d) The annual sales plan by product and by channel, with the targets of each salesperson.

4. A subscription costs USD 25 a month, the variable cost per subscriber is USD 10 and monthly fixed costs amount to USD 4,500. How many subscribers are needed to reach the break-even point?
   a) 180 subscribers.
   b) 450 subscribers.
   c) 300 subscribers.
   d) 129 subscribers.
5. In a two-sided market, why is it common for the platform to charge one of the groups little or nothing?
   a) Because the split of prices between the sides matters, and making access cheaper for the more sensitive side attracts the other.
   b) Because regulation obliges platforms to offer the service free of charge to final consumers.
   c) Because serving that group generates no cost that the platform has to recover.
   d) Because charging both sides would give rise to negative network effects that would destroy the platform.
6. An app that connects carriers with exporters observes that, as more carriers join, exporters wait less and sign up in greater numbers. Which phenomenon does the situation describe?
   a) An economy of scale in production.
   b) A direct or same-side network effect.
   c) A cannibalization of sales.
   d) A cross-side network effect.
7. Which feature characterizes a disruptive innovation in its early stage?
   a) It improves performance in the attributes that the most demanding and profitable customers already value.
   b) It performs worse on those attributes, but offers a lower price or simplicity and attracts new customers.
   c) It always arises in the research laboratories of the large companies of the industry.
   d) It demands from the outset a larger investment than the technology it replaces.

8. What best describes open innovation?
    a) Publishing all the company's patents and code free of charge so that anyone can use them.
    b) Innovating only with the internal research department and protecting every idea with patents.
    c) Combining internal and external ideas, as well as internal and external paths to market.
    d) Copying competitors' innovations once the market has validated them.
9. A repair shop stops selling spare parts one by one and starts offering an annual maintenance plan with scheduled check-ups. Which change of model does this represent?
    a) Freemium
    b) Servitization
    c) Two-sided market
    d) Open innovation
10. What distinguishes a digital business strategy from an IT strategy?
    a) A digital strategy is defined by the systems department
    b) A digital strategy fuses the technology decision with the business decision instead of aligning one with the other
    c) An IT strategy is more expensive
    d) A digital strategy only applies to firms born on the internet
11. On a lodging booking platform, each new hotel makes the platform more useful for travelers and the other way around. What is this called?
    a) Indirect network effect
    b) Economies of scale
    c) Disruptive innovation
    d) Decreasing marginal cost
12. According to the concept of disruptive innovation, a disruptive offering usually starts
    a) by beating the leader on every attribute
    b) in the most demanding and profitable segment
    c) by serving undemanding or unserved customers with a simpler and cheaper proposition
    d) with a patent that prevents imitation

CHAPTER 4.
DATA, ANALYTICS AND ARTIFICIAL INTELLIGENCE FOR DECISION MAKING

Every organization decides daily how much to buy, who should be granted credit, what price to set or which order to fill first. In many MSMEs of the region, those decisions rest on the owner's experience and on records scattered across notebooks, invoices and spreadsheets. The digitalization of sales and payments changed that starting point: almost any company now generates a trail of data that, well managed, can improve the quality of its decisions.

This chapter explains how one moves from data to decisions. It first distinguishes data, information, knowledge and wisdom, and examines what changes when data become massive. It then presents business intelligence, the types of analytics and the capabilities an organization needs in order to take advantage of them; it discusses the place of artificial intelligence (AI) in management and ends with data governance and data quality.

The technologies that store and process data, including generative AI, were described in chapter 2; the enterprise systems that produce them are studied in chapter 5, and the protection of personal data and the ethics of AI, in chapter 11. Here the focus is the decision: what question is to be answered, with what data, with what method and under whose responsibility.

By the end of this chapter, the reader will be able to:

1. Distinguish data, information, knowledge and wisdom, and explain why data must be managed as an asset.
2. Describe the characteristics of big data and the challenges they pose to organizations in the region.
3. Tell descriptive, diagnostic, predictive and prescriptive analytics apart, and associate each type with the management question it answers.
4. Analyze the components of analytical capability and the available evidence on the effects of AI on productivity.
5. Evaluate a classifier with the confusion matrix and propose data governance and data quality practices that turn the dashboard into a habit of decision making.

4.1. Data as an asset: data, information, knowledge and wisdom

A datum is the record of a fact: the figure "12" in the quantity column of an invoice or the date of a dispatch. On its own, it does not indicate what should be done. When the invoices

of a month are grouped by product and compared with those of the previous month, information appears: one item sold more and another one, less. There is knowledge when someone interprets that information with their experience and understands the cause, for example, that the fall coincided with the opening of a nearby competitor. Wisdom shows in the decision taken with that knowledge and in the ability to anticipate its consequences.

This sequence is known as the DIKW hierarchy, after the initials of *data, information, knowledge* and *wisdom*. In reviewing how the most widely used information systems and knowledge management textbooks present it, Rowley (2007) found that the model is accepted almost without discussion: information is usually defined in terms of data, knowledge in terms of information and wisdom in terms of knowledge. There is, by contrast, less agreement about the processes that turn one level into the next, and wisdom barely receives attention in those texts.

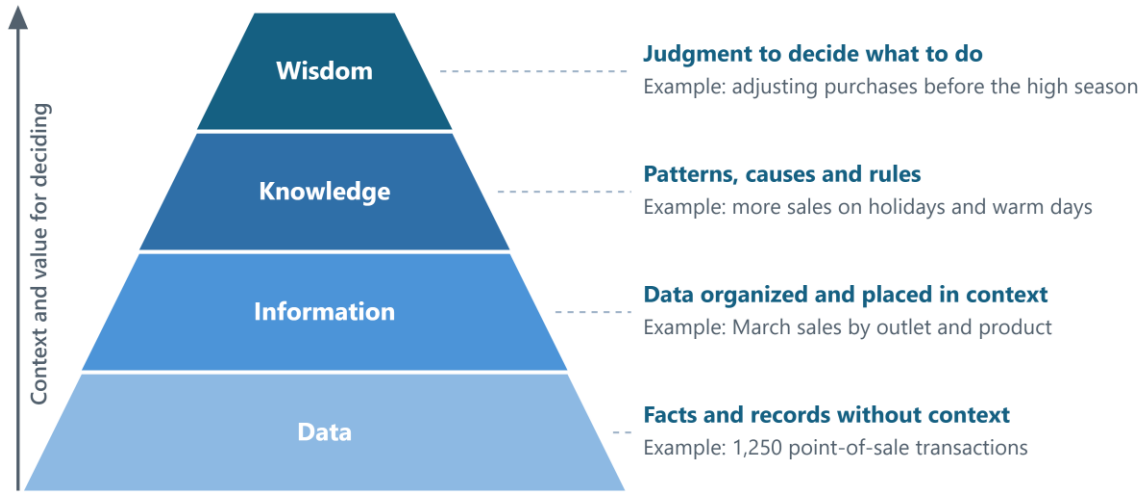
Figure 4.1 represents the hierarchy as a pyramid: records abound at the base and at the top there are few judgments, but they are of greater value to whoever has to decide. Each level demands a different kind of work. Capturing and ordering data is a technical task, whereas turning information into knowledge requires well-framed questions and knowledge of the business.

Treating data as an asset means managing them as seriously as inventory or receivables: knowing which ones exist, where they are, how much it costs to maintain them and what value they can generate. Along those lines, Provost and Fawcett (2013) argue that both data and the capacity to extract useful knowledge from them should be considered strategic assets. The nuance matters: the asset is not the accumulated file, but the combination of relevant data with people and methods able to turn them into decisions.

Unlike a physical asset, a datum can be used many times and in several areas without wearing out, but it loses value when it ages or contains errors. An out-of-date price list does not merely stop being useful: it leads to bad decisions. For that reason, section 4.6 deals with data quality.

Figure 4.1

The data, information, knowledge and wisdom hierarchy



Note. The authors' own work, based on Rowley (2007).

4.2. Large volumes of data: characteristics and challenges

The expression *big data* spread as a name for datasets that, because of their size and the pace at which they are generated, overwhelm traditional storage and analysis tools. They come from electronic transactions, sensors, mobile phones, social media and commerce platforms, and they are often a by-product of daily activity that nobody designed to be analyzed.

After systematically reviewing the available definitions, Fosso Wamba et al. (2015) propose understanding big data as a holistic approach to managing, processing and analyzing five Vs (volume, variety, velocity, veracity and value) in order to obtain actionable insights, measure performance and sustain competitive advantages. Volume refers to the quantity of records; variety, to the mixture of structured and unstructured formats, such as messages, audio files or photographs; velocity, to the frequency with which the data arrive and must be processed. Veracity refers to their accuracy and reliability, and value, to the usefulness they produce.

For an MSME, the last two Vs weigh more than the first three. Few small firms handle volumes that demand specialized infrastructure, but all of them need truthful data and a collection effort that translates into better decisions. A restaurant that puts together the orders from a delivery app, its customers' reviews and the till sales is already facing a problem of variety, even if all its records fit on a laptop.

The challenges of big data go beyond the technical. Integrating sources that use different codes for the same product, protecting personal data, having staff able to analyze them and bearing the cost of the tools are frequent obstacles. In examining the situation of developing countries, Hilbert (2016) warns that the familiar concerns about privacy and the shortage of talent are aggravated there by structural deficits in infrastructure, economic resources and institutions. The result, according to the author, is a new form of digital divide: the one that separates those who can inform their decisions with data-based knowledge from those who cannot.

That divide has concrete expressions in Latin America, where large companies with teams specialized in analytics coexist with many MSMEs that still keep their basic records on paper or in isolated files. Chapter 10 analyzes the digital divide at its different levels; here it is enough to keep in mind that access to data does not guarantee that they will be put to use.

4.3. Business intelligence and types of analytics

Business intelligence brings together the processes, tools and practices that integrate the data of an organization in order to report on its performance and support decisions. In its classic form it combines a data warehouse, which consolidates the information of the transactional systems, with reports, queries and dashboards. In tracing the evolution of the field, Chen et al. (2012) distinguish three stages: one centered on structured data managed with relational databases, another that incorporates the unstructured content of the web and a third one based on data generated by mobile devices and sensors.

Analytics widens that scope. For Davenport and Harris (2007), it consists of the extensive use of data, statistical and quantitative analysis, explanatory and predictive models, and fact-based management to drive decisions and actions. The definition stresses the destination of the analysis, which is the decision, and makes it possible to order the techniques according to the type of question they help to answer.

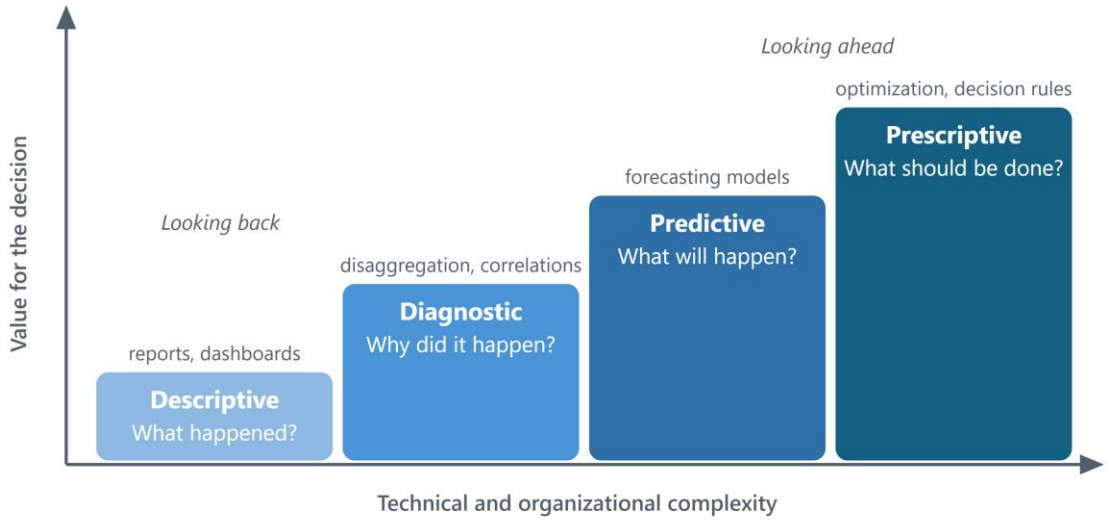
By the question it answers, analytics is usually classified into four types, which figure 4.2 arranges by their complexity and by the value they can add:

- **Descriptive:** answers what happened. It summarizes sales, costs or complaints through totals, averages, trends and comparisons between periods.
- **Diagnostic:** answers why it happened. It breaks the data down, crosses variables and tests hypotheses in order to explain a deviation.
- **Predictive:** answers what is likely to happen. It estimates sales, default risks or customer churn with statistical or machine learning models.

- **Prescriptive:** answers what should be done. It recommends the best action among alternatives, given certain objectives and constraints, through optimization or simulation techniques.

Figure 4.2

Types of analytics by their value and their complexity



Note. The authors' own work.

The figure does not describe a staircase that must be climbed in full or in strict order. A good part of the decisions of an MSME is well resolved with quality descriptive analytics, and a forecast built on faulty records produces errors with an appearance of rigor. What the sequence does show are dependencies: predictive analytics needs a reliable history of data, and prescriptive analytics also requires knowing the costs, the constraints and the objectives the company wants to optimize.

An example shows how the four types link up. A bakery with three outlets observes in its weekly report that the bread left over at closing time increased in one of them (descriptive). On crossing the data by shift and by product, it discovers that the increase is concentrated in the bread baked in the afternoon (diagnostic). With the sales history by day and the calendar of public holidays it estimates the demand of the following week (predictive) and, with that estimate and the cost of each type of bread, it calculates how much to bake in order to balance the risk of leftovers against the risk of running out (prescriptive).

4.4. Analytical capabilities of the organization

Buying a business intelligence tool is simple; building the capability to use it in order to decide better requires another kind of effort. From the resource-based view, which is developed in chapter 9, Gupta and George (2016) identify seven resources that, combined, form big data analytics capability: three tangible ones (data, technology and basic resources such as investment and time), two human ones (technical and managerial skills) and two intangible ones (a data-driven culture and the intensity of organizational learning). Their study found that this capability is associated with better market and operational performance.

In technology, an MSME today faces fewer barriers than it usually assumes. A well-structured spreadsheet, an invoicing system that exports its records and a cloud visualization tool are enough to start, as long as sales, purchases and collections share the same product and customer codes.

Talent is harder to bring together. It combines technical skills, to prepare data and build models, with managerial skills, to pose good questions and turn results into decisions. In a small company the profile of the translator is valuable: someone who knows the business and understands enough about data to ask for the right analysis and to notice when a result makes no sense.

Harder still is building a culture of decision making. An organization has one when important decisions are discussed with evidence and the opinion of whoever holds the highest position does not close the conversation before the data are reviewed. That culture is built by example: managers who ask for the data before giving an opinion and who acknowledge, without looking for culprits, when an intuition turned out to be wrong.

How quickly does this way of deciding spread? With data from a representative sample of manufacturing plants in the United States, Brynjolfsson and McElheran (2016) documented that data-driven decision making spread rapidly within a few years. Adoption was more likely in larger plants and in those that already had complements such as information technologies and better-educated workers. For an MSME, the lesson is one of sequence: analytics pays off more when it arrives after the records have been put in order and the staff who will use it has been trained.

For years, research on analytics looked first at technology and then at the organization. In their systematic review, Mikalef et al. (2018) observe that the emphasis has been on the technical aspects of big data, with scant attention to the organizational changes they imply and to the way of exploiting them strategically. For the manager, the consequence is direct: before

choosing a tool it is worth defining which decisions are to be improved and how it will be known whether they improved. Chapters 7 and 8 go deeper into culture, leadership and the measurement of digital maturity.

4.5. Artificial intelligence in management: uses, limits and evidence on productivity

The concepts of AI, machine learning and generative AI were presented in chapter 2. One idea is worth recalling: as Jordan and Mitchell (2015) explain, machine learning deals with building systems that improve automatically with experience, that is, with data. From a management standpoint, a model of this kind is a form of predictive analytics that learns patterns from past cases in order to apply them to new ones.

In an MSME, the uses of AI can be modest and specific: classifying customers by their risk of non-payment, anticipating the demand for perishable products, detecting unusual expenses or reading and sorting invoices. Generative AI added tasks of writing, summarizing and conversational support. In every case, the value depends on there being a well-defined decision or task that the model improves and on there being enough data to evaluate its results.

4.5.1. How a classifier is evaluated

A classifier assigns each case to a class: a customer who will pay on time or late, a transaction that is normal or suspicious. To evaluate it, what it predicted is compared with what happened in cases that were not used to train it. The result is arranged in a four-cell confusion matrix: true positives (TP), cases of interest that the model detected; false positives (FP), cases it flagged without their being so; false negatives (FN), cases of interest it let through, and true negatives (TN), cases it correctly ruled out.

With those four quantities, accuracy, precision and recall are calculated:

$$Accuracy = (TP + TN) / (TP + FP + FN + TN)$$

$$Precision = TP / (TP + FP)$$

$$Recall = TP / (TP + FN)$$

Each metric answers a different question. Accuracy indicates what proportion of the total was classified correctly; precision, what proportion of the alerts turned out to be true, and recall, what proportion of the cases of interest was detected. When the class of interest is infrequent, accuracy is misleading: if one in ten customers pays late, a model that declares everyone punctual is right nine times out of ten without detecting a single late payer. The metric to

prioritize depends on the cost of each error; in collections, letting a late payer through usually costs more than an unnecessary phone call.

4.5.2. Evidence on productivity and limits

On generative AI there are already experimental results, although recent ones. In an experiment with college-educated professionals performing writing tasks typical of their occupation, Noy and Zhang (2023) found that access to a conversational assistant reduced the time devoted to each task and raised the quality of the texts. The study showed, moreover, that the performance gap between participants narrowed.

A second study observed the use of the tool in real working conditions. In analyzing the staggered introduction of a generative AI assistant among customer support agents, Brynjolfsson et al. (2025) found that productivity, measured as cases resolved per hour, increased on average, although with very uneven effects: agents with less experience and lower previous performance improved in speed and in quality, whereas the most experienced ones barely gained speed and showed small drops in quality. The authors also found signs that the assistant facilitated the agents' learning.

These results invite measurement before generalization, because the effects vary with the task and the person, and greater speed does not always mean better quality. AI also poses challenges of another nature. In a work that brings together the perspectives of experts from several disciplines, Dwivedi et al. (2021) stress that its potential to augment or replace human tasks must be assessed realistically, along with social, economic, ethical, organizational, data-related and legal challenges.

At the scale of an MSME, those challenges take concrete forms. A model trained on biased data can discriminate against certain customers without anyone noticing; a generative assistant can give convincing but false answers, and customer data entered into external tools without safeguards can end up exposed. Every AI application therefore needs a human owner who reviews its results and answers for the decisions taken with them. The ethics of AI and the protection of personal data are developed in chapter 11.

4.6. Data governance and data quality; from the dashboard to the habit of deciding with data

4.6.1. Owners, definitions and quality

Data governance is the set of roles, rules and decision rights that establishes who defines each datum, who captures it, who answers for its quality and who may use it. Chapter 11 deals with the governance of technology in general; applied to data, its central question is one of accountability. An MSME does not need committees: it is enough for every important set of data, such as customers, products or prices, to have an owner who sets its definitions and a person in charge of keeping it up to date.

If the sales area records a sale when the order is issued and accounting does so when it is invoiced, the two reports will show different figures and both will look correct. That is why agreeing on definitions is part of data governance: a simple dictionary, with the name, the definition, the source and the owner of each indicator, avoids those discrepancies and gives the dashboard credibility. When the data refer to people, their processing must also comply with the Ley Orgánica de Protección de Datos Personales (Asamblea Nacional del Ecuador, 2021).

Data quality is judged by fitness for the intended use and is usually broken down into dimensions: accuracy (the datum corresponds to reality), completeness (no records or fields are missing), consistency (the same fact is recorded in the same way in every system), timeliness (the datum is available when it is needed), uniqueness (each entity appears only once) and validity (the datum respects the permitted format and range). Since errors are born at the point of capture, validation rules when entering the data and drop-down lists instead of free text pay off more than massive clean-ups before each report.

4.6.2. The dashboard as a decision routine

A dashboard is useful when it answers questions that someone needs to answer in order to decide. The frequent mistake is the opposite one: gathering every possible chart and hoping that decisions will appear by themselves. For an MSME, a good dashboard fits on one screen, brings together between five and ten indicators and assigns to each one a formula, a question, a review frequency and an owner. Table 4.1 proposes management indicators with that structure; digital marketing metrics are dealt with in chapter 6, and the transformation scorecard, in chapter 12.

Table 4.1

Management indicators: formula, question they answer and review frequency

Indicator	Formula	Question it answers	Frequency
Change in sales	(Sales of the period - sales of the previous period) / sales of the previous period × 100	Are sales growing or falling, and at what pace?	Weekly and monthly
Gross margin	(Sales - cost of sales) / sales × 100	How much is left of every dollar sold after covering the cost of the product?	Monthly
Inventory turnover	Cost of sales / average inventory	How many times is the inventory renewed in the period?	Monthly
Days of inventory	Average inventory / cost of sales × days of the period	How many days of sales does the available inventory cover?	Weekly for perishables; monthly for the rest
Shrinkage	Value of the product written off / value of the product received × 100	What share of what was bought is lost before being sold?	Daily or weekly
Orders complete and on time	Orders delivered complete and on the agreed date / total orders × 100	Is what was promised to the customer being delivered?	Weekly
Days of collection	Accounts receivable / credit sales × days of the period	How long does it take to collect a credit sale?	Monthly
Forecast error	|Actual sales - forecast sales| / actual sales × 100	How reliable is the forecast that guides purchasing?	Weekly

Note. The authors' own work.

Moving from the dashboard to the habit depends more on routines than on software. It helps to set a rhythm, for example, a short meeting every Monday with the same indicators, and to close each review with specific decisions, each one with its owner, written down in a record. Afterwards it is worth going back over those decisions and comparing what was expected with what happened: that comparison produces learning, because it makes it possible to tell whether the forecast failed, whether the decision was poor or whether the environment changed.

Forecasts require that discipline too. Recording each week what was forecast and what actually happened makes it possible to calculate the error and to know when the model is enough and when it should be corrected with the judgment of someone who knows the market,

for example, on public holidays or during a fishing ban. The illustrative case that follows shows that transition in a small company.

Illustrative case: the sales dashboard and the forecast of a seafood distributor

A family seafood distributor in the province of Santa Elena buys fish, shrimp and shellfish from artisanal fishers and local producers, and sells them to restaurants, hotels and stores on the peninsula. For years, the owner decided how much to buy each day according to his experience and his customers' phone calls. Two problems kept recurring: product that spoiled before being sold and incomplete orders on the weekends of highest demand.

His daughter, who had just graduated in business administration, gathered two years of electronic invoices and delivery notes in a spreadsheet. Before analyzing she had to clean up: there were customers registered under several names, products with different codes depending on the salesperson and deliveries whose date was never written down. With the cleaned data she put together a weekly dashboard with five indicators: sales by product and by customer, change against the previous week, gross margin, shrinkage and orders delivered complete.

She then built a simple forecast: for each product, the average of the sales on the same day of the week over the previous four weeks. The model worked well in normal weeks, but it underestimated demand during Carnival and overestimated it during the ban on one of the products. The family decided to keep it, correct it with a calendar of public holidays and fishing bans, and review its error every Monday together with the dashboard. Months later, the weekly meeting started with the data and shrinkage had fallen, although the owner still adjusted some purchases according to his intuition.

4.7. Chapter summary

Throughout the chapter the route has been followed that runs from the record of a fact to a better-informed decision. That route demands quality data, well-framed questions, methods suited to each question and an organization willing to review its decisions in the light of the evidence. AI widens what can be done with data, but it removes none of those conditions.

- A datum becomes information, knowledge and wisdom thanks to technical work and human judgment; the asset is the combination of relevant data and the capacity to use them.

- Big data are described by five Vs; for an MSME, veracity and value matter more than volume.
- Descriptive, diagnostic, predictive and prescriptive analytics answer different questions and demand, in that order, more reliable data and more skills.
- Analytical capability combines technology, talent and a culture that discusses decisions with evidence.
- A classifier is evaluated with the confusion matrix; accuracy is misleading when the class of interest is infrequent.
- The experimental evidence shows productivity gains with generative AI, but uneven ones across people and tasks; that is why every adoption must be measured.
- Data governance and data quality, together with review routines, turn the dashboard into a habit of decision making.

Key terms: *DIKW hierarchy, big data, business intelligence, descriptive analytics, diagnostic analytics, predictive analytics, prescriptive analytics, analytical capability, data-driven decision making, confusion matrix, data governance, data quality.*

4.8. Exercises and activities

Comprehension questions

1. What is the difference between data, information, knowledge and wisdom? Illustrate each level with an example taken from a commercial MSME.
2. Why do veracity and value weigh more than volume when a small company assesses its data?
3. Which question does each type of analytics answer, and which requirements does each type add with respect to the previous one?
4. Why is buying a business intelligence tool not enough to create analytical capability? Answer on the basis of the tangible, human and intangible resources studied in the chapter.
5. What do the studies reviewed show about generative AI and productivity, and what nuances do they introduce about who benefits most?

Application exercises

1. A bookshop and stationery store in Salinas is preparing for the school season. Classify each question according to the type of analytics it demands and justify the answer: a) how many notebooks were sold last season?; b) why did the backpacks run out two

weeks earlier than the previous year?; c) how many units of each school supply list will be sold this year?; d) what quantity should be ordered from each supplier in order to cover demand without exceeding the purchasing budget?

2. A beverage distributor in the province of Santa Elena sold 42,500 dollars in January, 47,600 in February and 44,030 in March; in March of the previous year it had sold 39,800 dollars. Calculate: a) the percentage change of February with respect to January and that of March with respect to February; b) the year-on-year change of March; c) the forecast for April with a simple three-month moving average; d) the absolute percentage error of the forecast if actual sales in April were 46,200 dollars. Interpret whether the fall in March amounts to a warning sign. *Worked solution in Appendix B.*
3. A distributor of agricultural supplies trained a model to anticipate which invoices will be paid more than 30 days late. In a test set of 500 invoices, the model flagged 80 as risky, of which 48 were paid late; of the 420 it considered punctual, 16 were also paid late. Build the confusion matrix, calculate accuracy, precision and recall, compare the accuracy with that of a model that declares every invoice punctual and explain which metric the collections area should watch. *Worked solution in Appendix B.*
4. An extract from the customer database of a hardware store shows the same customer with three different codes, Registro Único de Contribuyentes (RUC) numbers with fewer than thirteen digits, sales from the last week that have not yet been uploaded, dates written in two formats and customers with no city. Identify the quality dimension affected in each case and propose a control rule and an owner to prevent it.

Analysis of the case

1. Which type of analytics do the weekly dashboard and the forecast of the distributor represent? Justify the answer with figure 4.2.
2. Which data quality dimensions were affected before the dashboard was built, and which control rules would stop the problems from reappearing?
3. Why did the forecast fail during Carnival and during the fishing ban? What additional information could the model incorporate without becoming complex?
4. Which indicators from table 4.1 would be worth adding to the company's dashboard, and how often should they be reviewed?

Collaborative activity

1. In teams of three or four members, interview the person who runs a local MSME, identify three decisions they take frequently and the data the company already generates,

and design a one-page dashboard with a maximum of eight indicators. Expected output: a draft of the dashboard and a card for each indicator (formula, question, frequency, source and owner), in no more than three pages.

2. With the same company, write a short policy for the use of generative AI stating the permitted tasks, the data that must not be entered into external tools and who reviews the results. Expected output: a one-page policy and a five-minute presentation to the group.

Self-assessment

1. According to the DIKW hierarchy, what distinguishes information from data?
   a) It is a datum saved in a cloud system so that everyone can consult it.
   b) It is a set of data organized and placed in context in order to answer a question.
   c) It is a datum that is more than a year old and has already been audited.
   d) It is the judgment that makes it possible to choose between courses of action.
2. Which of the five Vs of big data refers to the accuracy and reliability of the data?
   a) Volume
   b) Velocity
   c) Variety
   d) Veracity
3. A company wants to know why returns increased in one of its branches. Which type of analytics does it need?
   a) Diagnostic
   b) Descriptive
   c) Predictive
   d) Prescriptive
4. Among the resources that form the analytical capability of an organization, which one is intangible?
   a) The company’s data warehouse
   b) The technical skills of the team
   c) The data-driven decision culture
   d) The budget allocated to analytics

5. A model flags 50 customers as likely to leave the company and 35 of them do leave. Which metric can be calculated with those data, and what is its value?
   a) Recall of 0.70
   b) Accuracy of 0.70
   c) Precision of 0.70
   d) Precision of 0.35
6. What did the study on a generative AI assistant in customer support find?
   a) The greatest improvements occurred among agents with less experience and lower previous performance.
   b) The greatest improvements occurred among the most experienced and best-performing agents.
   c) Productivity did not change, although customers were more satisfied with the service.
   d) The assistant replaced human agents in most of the conversations.
7. What function does data governance perform in an organization?
   a) Acquiring and renewing the licenses of the analytics tools.
   b) Replacing the obligations imposed by the personal data protection law.
   c) Designing the graphic appearance and the colors of the dashboard.
   d) Assigning who defines, captures, corrects and uses each set of data.
8. What is the best sign that a dashboard has become a habit of decision making?
   a) It includes more than twenty indicators that are updated in real time.
   b) It is reviewed at a fixed rhythm and each review ends in decisions with owners.
   c) It uses traffic-light colors and automatic alerts on all its indicators.
   d) It was developed by an external provider with experience in analytics.
9. A dashboard shows that sales fell by 12% in March. That information on its own corresponds to which type of analytics?
   a) Descriptive
   b) Diagnostic
   c) Predictive
   d) Prescriptive

10. In the confusion matrix of a model that flags orders at risk of being returned, what is the practical consequence of a false negative?
    a) An order is reviewed that did not need reviewing
    b) An order that will end up returned is let through
    c) The model becomes slower
    d) The record is duplicated in the database
11. Which data quality problem is illustrated by the same customer appearing three times with different spellings?
    a) Lack of accuracy
    b) Lack of completeness
    c) Lack of uniqueness
    d) Lack of timeliness
12. The chapter argues that a dashboard only changes something when
    a) it updates in real time
    b) it is connected to the ERP
    c) it becomes part of a decision routine with an owner, a frequency and an action attached
    d) it includes predictive analytics

CHAPTER 5.
PROCESSES, OPERATIONS AND THE DIGITAL SUPPLY CHAIN

An order that reaches a spare parts distributor by messaging app may pass, before leaving the warehouse, through a sales notebook, a spreadsheet and the accounting system, and require two phone calls to confirm the customer's credit. Each handover adds waiting time and opens the door to a typing error. None of that appears on the organization chart, but the customer perceives it in the delivery time and the company pays for it in working hours that add no value.

This chapter deals with that operational back room. Chapter 1 distinguished digitalization, which changes the way processes are carried out, from transformation, which alters the model of the organization; here we examine how work is measured and improved when processes rely on systems and automation. The transformation of core operations is, together with the customer experience and the business model, one of the three areas in which companies build digital capabilities (Westerman et al., 2014).

The chapter moves from the individual process to the network of firms. It first presents the process view and its management cycle; it then reviews enterprise systems, automation and process mining. After that it takes the analysis to the plant, with Industry 4.0, and to the relationship with suppliers and customers, with the digital supply chain. It closes with electronic documents and administrative procedures, a field in which Ecuadorian regulation is already pushing the change.

By the end of this chapter, the reader will be able to:

1. Explain the process view of an organization and the phases of the business process management lifecycle.
2. Distinguish the functions of the main enterprise systems and the conditions on which their implementation depends.
3. Assess which tasks are worth automating and what process mining adds to the knowledge of the real flow of work.
4. Analyze how Industry 4.0, traceability and electronic documents transform operations and the supply chain.
5. Calculate and interpret the cycle time, the capacity and the cost per order of a process before and after automating it.

5.1. The organization seen as processes and business process management

The formal structure of a company is drawn by functions, such as sales, warehouse, production or accounting. Work, by contrast, flows horizontally and crosses those boundaries. Dumas et al. (2018) define a business process as a collection of events, activities and decision points involving actors and objects that produces an outcome of value for at least one customer. One example is the order-to-cash process, which starts with the customer's request, ends when the money reaches the account and runs across areas that rarely observe the whole journey.

Looking at the organization as processes changes the management question: besides knowing whether each area does its task, what matters is whether the whole journey delivers what the customer expects in time, cost and quality. The most expensive problems usually hide in the handovers, such as the order waiting for the credit manager's signature or the invoice typed in twice. The value chain already described the firm as a system of activities whose linkages also generate competitive advantage (Porter, 1985).

5.1.1. The business process management lifecycle

Business process management (BPM) turns that outlook into a method. Its lifecycle, represented in figure 5.1, starts with the identification of processes and the choice of those where intervention is worthwhile (Dumas et al., 2018). Discovery follows, documenting how the work is really done (the "as is" process), and then analysis, which locates the problems and estimates their impact. Redesign formulates the process "as it should be", implementation introduces the organizational and technological changes, and monitoring and controlling measures the results and restarts the cycle.

The order of the cycle holds a practical lesson: redesign decides what is worth automating, and the technology is installed afterwards, in the implementation phase. An MSME that buys a system before documenting its process configures it on assumptions and usually reproduces on the screen the waiting times and duplications it had on paper. Chapter 1 included that mistake, "digitalizing the mess", among the most frequent ones; the process management cycle is the systematic way of avoiding it.

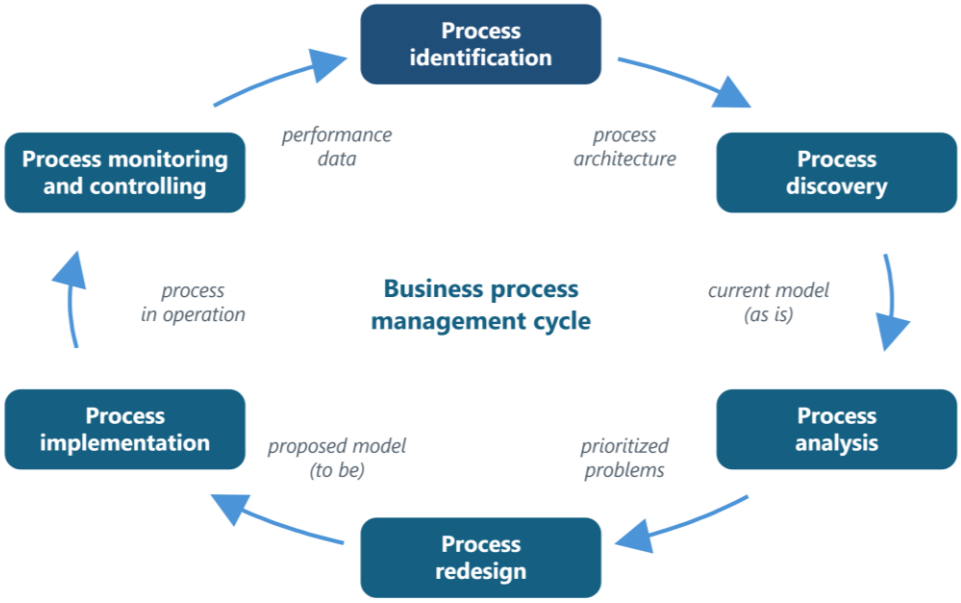
5.1.2. How the performance of a process is measured

Analysis needs measures. The four usual dimensions of performance are time, cost, quality and flexibility, and improving one usually demands concessions in another (Dumas et al., 2018); automating, for example, makes routine operations cheaper, but it may take away flexibility in the face of exceptions. The most widely used measure of time is cycle time, which

includes the work and the waiting of each case. Cycle time efficiency compares effective work with the complete cycle and is usually low in administrative processes, where a case spends more time in a tray than in someone's hands.

Figure 5.1

The business process management lifecycle



Note. The authors' own work, based on Dumas et al. (2018).

$$\textit{Cycle time} = \Sigma \text{ activity times} + \Sigma \text{ waiting times}$$

$$\textit{Cycle time efficiency} = (\Sigma \text{ activity times} / \text{Cycle time}) \times 100$$

Capacity answers a different question: how many cases a resource completes in a period. It is obtained by dividing the available time of the resource by the working time each case demands from it, and the capacity of the whole process is set by the most limited resource, the bottleneck. From that follows a rule that section 5.3 will take up again: speeding up an activity that is not the bottleneck saves working hours, but it does not increase the orders the process completes each day.

$$\textit{Capacity} = \text{Available time of the resource} / \text{Working time per case}$$

5.2. Enterprise systems: ERP, CRM and supply chain management

When each area works with its own tool, the company accumulates islands of information: sales in one spreadsheet, inventory in another, invoicing in an accounting program.

Enterprise resource planning (ERP) systems solve that fragmentation with a common database and modules for finance, purchasing, inventories, production, sales and human resources. Each transaction is recorded only once, where it happens, and remains available to every area. A sale, for example, updates the inventory, the account receivable and the accounting records at the same time.

Around the ERP sit specialized systems. Customer relationship management (CRM) systems record contacts, sales opportunities, complaints and after-sales service; their use in marketing is studied in chapter 6. Supply chain management (SCM) systems plan demand, purchasing and replenishment, and they rely on execution tools such as the warehouse management system (WMS), the transportation management system (TMS) and, in industry, the manufacturing execution system (MES).

The value of these systems depends less on the software than on the discipline they impose. With the data and processes they put in order, they make up the operational backbone presented in chapter 1, which Ross et al. (2019) consider necessary but not sufficient: it provides reliability and efficiency, but not the speed that digital offerings demand, the task of the digital platform described in chapter 2. An online store that promises next-day delivery fails if the inventory in the system does not match the one on the shelf; the customer suffers in the store a problem born in the backbone.

Table 5.1 summarizes the processes each type of system supports, the benefits that can be expected and the conditions on which they depend; those conditions matter more than the brand of the product. Implementing an ERP requires agreeing on common processes, cleaning up the master data of customers, products and suppliers, and deciding when the process is adapted to the system and when the system is customized, an option that makes the project more expensive and complicates updates. Cloud versions (chapter 2) reduced the up-front investment for the MSME, although not the organizational effort.

Table 5.1

Enterprise systems: processes they support, benefits and conditions for success

System	Processes it supports	Expected benefits	Conditions for success
ERP	Finance, purchasing, inventories, production, sales and payroll on a common database	A single datum, faster accounting closings and control of costs and inventories	Processes agreed before configuring, clean master data and sponsorship from management
CRM	Prospecting, sales opportunities, after-sales service and handling of complaints	A complete history of each customer and orderly follow-up of sales and complaints	Disciplined recording of every contact and integration with sales and invoicing
SCM	Demand forecasting and planning of purchasing, production and replenishment	Fewer stockouts and less capital tied up in inventory	Reliable sales history and collaboration with suppliers and main customers
WMS and TMS	Receiving, putaway, picking and dispatch; routes, vehicles and deliveries	Accurate inventory, faster picking, lower cost per delivery and traceability	Coded products and locations, barcode readers and connectivity in the warehouse and on the road
MES	Production orders, shop floor control, quality and batch records	Visibility of progress, less waste and genealogy of each batch	Automatic data capture on the shop floor and integration with the ERP

Note. The authors' own work.

5.3. Process automation and process mining

Automating consists of moving to a system activities that a person used to carry out. The options include a workflow engine that distributes tasks and watches deadlines, direct integration between applications through application programming interfaces (APIs) and the *software* robots examined in the following subsection.

5.3.1. Robotic process automation

Robotic process automation (RPA), presented in chapter 2, makes use of *software* robots that operate the screens of other applications as a person would. From a process management standpoint, what matters is where it fits. In his editorial on the subject, van der Aalst et al. (2018) places it in the "long tail" of work: the most frequent case types justify traditional automation, the exceptional ones stay in the hands of people and, in between, there remains

work that is repetitive but not so frequent, in which the employee serves as the "glue" between systems. That middle stretch is the natural ground of robots.

Sequence matters as much as choice. The review by Syed et al. (2020) gathers the recommendation to optimize the process before automating it and warns that every unforeseen exception demands the intervention of a person and takes benefit away from the automation. In an MSME, consolidating every morning the sales of several branches or updating the status of orders on the portal of a large customer are reasonable candidates; deciding on an incomplete credit application is not, because it requires judgment.

The economic appraisal compares the cost per case (for example, per order) before and after the change. In its simplest form, it adds the value of the working time each case consumes and the share of the monthly cost of the solution that corresponds to it:

$$\textit{Cost per order} = \Sigma\ (\text{minutes of work} \times \text{cost per minute}) + \text{Monthly cost of the solution} / \text{Orders of the month}$$

Two warnings go with the calculation. The saving in minutes becomes a saving in money only if the time freed up is reassigned to useful tasks, and the capacity of the process grows only when the automation acts on the bottleneck. The first application exercise of the chapter puts both ideas to the test; the financial appraisal of the investment belongs to chapter 12.

5.3.2. Process mining

Enterprise systems leave a trace of every operation: who recorded the order, when the credit was approved, at what time the truck left. Process mining takes advantage of those traces to reconstruct how the work is really done. In the systematization of van der Aalst (2016), the discipline has three uses: discovery, which generates a model of the process from the data; conformance checking, which contrasts what happened with the prescribed process; and enhancement, which enriches the model with times, frequencies and resources in order to locate bottlenecks.

The raw material is the event log, in which each row indicates, at the very least, the case, the activity performed and the moment it occurred; the person responsible and the cost widen the analysis. Table 5.2 presents a fragment with three orders of a distributor. Even with so little data, three variants appear: a standard route, another with rework in the credit approval and a third one that skips that control.

Table 5.2

Fragment of an event log of the order process of a distributor

Order	Activity	Time	Area
2101	Order recording	08:10	Sales
2101	Credit approval	09:25	Credit
2101	Picking	11:05	Warehouse
2101	Invoice issue	11:40	Invoicing
2101	Dispatch	13:20	Logistics
2102	Order recording	08:30	Sales
2102	Credit approval	09:50	Credit
2102	Credit approval	12:15	Credit
2102	Picking	14:00	Warehouse
2102	Invoice issue	14:25	Invoicing
2102	Dispatch	16:40	Logistics
2103	Order recording	09:05	Sales
2103	Picking	10:20	Warehouse
2103	Invoice issue	10:45	Invoicing
2103	Dispatch	12:35	Logistics

Note. The authors' own work with hypothetical data. Each time corresponds to the moment the activity was recorded in the system; all the events took place on the same day.

A real log usually contains thousands of cases, and its variants can be counted in dozens. Against the interviews of traditional discovery, which collect the version each area offers of its own work, here the model emerges from the recorded evidence. The technique also helps to choose what to automate and to check afterwards whether the automation delivered what it promised; it thus links the analysis and monitoring phases of the cycle in figure 5.1.

5.4. Industry 4.0 in operations

Industry 4.0 already appeared in chapter 1 as the smart factory, in which cyber-physical systems and connected machines make flexible production possible, and its technologies were described in chapter 2. What matters here is its effect on operations. Lasi et al. (2014) explain the impulse of the phenomenon from two sides: market pull, which asks for shorter

development cycles, customized products, flexibility and efficient use of resources, and technology push, with more automation, more networking and ever smaller components.

The framework of Frank et al. (2019), summarized in chapter 2, distinguishes front-end technologies, oriented to smart manufacturing, from the base technologies that support them. Their study of manufacturing firms offers a finding that is useful for management: the adoption of the former was systemic, with smart manufacturing at the center, whereas big data analytics, the layer that turns what connected machines record into decisions, still showed low implementation.

In the plant, sensors installed on machines and cold rooms make it possible to move from corrective to predictive maintenance; machine vision inspects quality on the line itself; vertical integration connects the shop floor with the ERP, and horizontal integration links the company with suppliers and customers. A digital twin, a virtual replica of a line, serves to try out changes before carrying them out. For a small dairy plant in the highlands, the first step may be measuring the temperature of its tanks and receiving an alert on the phone.

Before investing it is worth knowing where one stands, and that is what the readiness and maturity models for Industry 4.0 are for, such as the one by Schumacher et al. (2016), which chapter 8 examines. The connected plant also brings two risks: dependence on technology providers and exposure to cyberattacks that previously did not reach the machines, a subject addressed in chapter 11.

5.5. The digital supply chain: visibility, traceability and resilience

The supply chain brings together the organizations that take part from the raw material to the final customer, joined by flows of materials, information and money. In its traditional form, each link knows only the orders of the next one and plans on the basis of them. That blindness feeds the bullwhip effect: small variations in consumer demand are amplified as orders move up the chain, and the manufacturer ends up with surpluses and shortages. Sharing data on real demand softens the distortion.

The digital supply chain replaces that sequence of blind links with a network that shares information. Büyüközkan and Göçer (2018) define it as an intelligent and efficient process aimed at generating new forms of revenue and value with novel technological and analytical methods, and they specify that what is digital lies in the way the processes of the chain are managed, whether the goods are physical or digital. Its first practical conquest is visibility: knowing, almost in real time, where the inventory is, what state each order is in and when each shipment will arrive.

Traceability is the ability to follow a batch backwards, to its origin, and forwards, to its recipients; for Ecuadorian exporters of shrimp, bananas or cocoa it is a requirement of buyers and health authorities. Chapter 2 presented blockchain as a shared record for that purpose. Its adoption raises structural questions, about how relationships and costs between partners change, and management questions, about the resources and networks it demands (Treiblmaier, 2018). An immutable record, even so, does not guarantee the truthfulness of the data entered.

A resilient chain anticipates disruptions, absorbs them and recovers from them. The region offers plenty of examples: rains that cut roads, strikes, port congestion or the bankruptcy of a single supplier. Ivanov et al. (2019) study the ripple effect, the propagation of a disruption across the network, and analyze how analytics, real-time tracking, additive manufacturing and Industry 4.0 change the assessment of that risk. Visibility shortens the response time, although it does not replace alternative suppliers or safety stock.

For the MSME, the digital chain starts with the basics: an accurate inventory, product codes shared with its large customers and electronic catalogs from its suppliers. There are frugal engineering proposals that digitalize inventory management with modest resources in emerging economies (Rossit & Bidanda, 2026); chapter 10 develops that approach and chapter 6 deals with the logistics of electronic commerce.

5.6. Electronic documents and the digitalization of administrative procedures

Every process leaves documents in its wake, from purchase orders and invoices to delivery notes and contracts. It is worth distinguishing the digitized document, a scanned image that someone must read, from the structured electronic document, whose fields a system processes without typing them in again. Large companies have exchanged structured documents for decades through electronic data interchange (EDI). In the cases studied by Iacovou et al. (1995), whose adoption model chapter 9 takes up, several small firms planned to print the messages they received and process them by hand; the structured format thus lost its advantage.

The electronic invoice generalizes that logic. It is a receipt issued in a structured format, usually extensible markup language (XML), signed electronically and validated by the tax administration, which in Ecuador, as seen in chapter 1, has gradually widened the obligation to issue it. Saving paper is its smallest benefit: the invoice received can enter accounts payable without typing and the one issued feeds accounts receivable. If it is printed and typed in again, the procedure is digitized, but the process remains manual.

The electronic signature completes the circuit. Unlike a scanned handwritten signature, which anyone can copy, it is based on a digital certificate issued by an accredited certification

authority, identifies the signatory and makes it possible to check that the document did not change after being signed. With it, purchase orders, contracts, payrolls and applications are approved without printing a single sheet. In Ecuador, the Ley Orgánica para la Transformación Digital y Audiovisual (Asamblea Nacional del Ecuador, 2023) promotes its use within a broader framework of support for digital transformation.

Procedures with the State follow the same rule as company processes: first they are simplified and then they are digitalized. Uploading to a platform a procedure that demands copies of documents another public body already holds shifts the burden to the user without reducing it; interoperability between institutions makes it possible to consult the datum at its source. The economic benefit of the digital comes, above all, from making information and transactions cheaper (World Bank, 2016). The protection of the personal data contained in those documents is studied in chapter 11.

Illustrative case: a shrimp processing plant that digitalizes the receiving of raw material

A shrimp processing and exporting plant on the Gulf of Guayaquil receives trucks every night with crates of product on ice, sent by supplying shrimp farms. Until recently, receiving was written down on paper forms: weight per crate, pond of origin, temperature and the result of the quality sampling. The forms reached the office at the end of the shift and were typed in the following day. On the days of greatest harvest the trucks waited at the gate, settlements with the producers were delayed by weight discrepancies and reconstructing the origin of a batch for an importing customer took days.

The operations management applied the process management cycle before buying equipment. The survey showed that the effective work of receiving took up a small fraction of the cycle time and that each datum was written down three times. The redesign introduced advance notice of each harvest through an online form, a scale connected to a tablet that captures the weight without typing, photographs of the sampling and a label with a QR code that links each batch with the shrimp farm, the pond and the date. The data pass directly to the ERP, which calculates the settlement of each producer.

The first months were not easy. The wireless signal in the receiving area made it necessary to install antennas and to provide for an offline mode, and the most senior supervisor distrusted the scale until its calibration was compared with the previous one. With the process stabilized, the waiting time of the trucks went down, settlements are issued the same day

and the origin of a batch is looked up in minutes, an advantage that shows in the buyers' audits.

5.7. Chapter summary

The chapter went through the operational dimension of digital transformation, from the individual process to the network of firms. One and the same criterion runs through its sections: understand and measure the process, redesign it and, only then, choose the technology that supports it. The key ideas are the following:

- The process view follows the complete journey of a case across the areas; the most expensive problems are usually in the handovers.
- The process management cycle (identification, discovery, analysis, redesign, implementation, monitoring and controlling) places technology in the implementation phase.
- Cycle time, its efficiency and the capacity of the bottleneck make it possible to measure the effect of a change before and after carrying it out.
- ERP, CRM and supply chain systems integrate data and processes; their value depends on clean master data and on agreed processes.
- Robotic automation occupies the middle stretch of the "long tail" of work and pays off more if the process is redesigned first; process mining shows with data how the work is really done.
- Industry 4.0 and the digital supply chain pursue visibility, traceability and resilience; in the MSME they can start with modest steps.
- The electronic invoice and the electronic signature yield their benefit when the document is integrated into the system and is not typed in again.

Key terms: *business process, business process management (BPM), cycle time, bottleneck, enterprise resource planning (ERP), robotic process automation (RPA), process mining, event log, Industry 4.0, traceability, ripple effect, electronic signature.*

5.8. Exercises and activities

Comprehension questions

1. How does the functional view differ from the process view, and why do handovers between areas concentrate a good share of the problems of a process?

2. What is done in each phase of the business process management lifecycle, and why is technology brought in during the implementation phase?
3. What does it mean for an ERP to record each transaction only once, and why is the operational backbone necessary but not sufficient for competing with digital offerings?
4. What place does robotic process automation occupy in the "long tail" of work, and what does process mining add to the choice of the tasks worth automating?
5. What is the difference between visibility, traceability and resilience in the digital supply chain, and why does an immutable record not guarantee the truthfulness of the data?

Application exercises

1. A distributor of aquaculture supplies in Machala handles 1,100 orders a month over 22 working days. Its process has four activities, with these working times per order: manual recording, 6 minutes; checking of credit and stock, 9 minutes; picking in the warehouse, 20 minutes; and issuing the invoice, 5 minutes. Between one activity and the next the order waits, on average, 90, 120 and 45 minutes. Recording, checking and invoicing are handled by two administrative assistants, and picking, by three warehouse workers; each person has 420 productive minutes a day. A minute of work costs USD 0.10 in administration and USD 0.08 in the warehouse. The company is appraising an order portal integrated with its ERP and with electronic invoicing, which costs USD 440 a month: with it, recording would fall to 1 minute, checking to 2 and invoicing to 1; the waiting times, to 10, 40 and 30 minutes; picking would not change. Calculate, before and after the change: a) the cycle time and its efficiency; b) the daily capacity of each team and of the process, the bottleneck and whether the process covers demand; c) the cost per order. Interpret the results. *Worked solution in Appendix B.*
2. With the event log of table 5.2, whose prescribed model requires credit to be approved before the order is picked: a) calculate the cycle time of each order, from recording to dispatch, and the average of the three; b) identify the variants of the process and indicate which one shows rework and which one departs from the model; c) calculate the time elapsed between the two approvals of the order with rework; d) propose a control for each problem detected. *Worked solution in Appendix B.*
3. An accounting firm in Portoviejo is appraising the automation of six tasks: downloading daily the electronic receipts received by its clients and recording them in the accounting system; reconciling bank movements with the accounting records; answering client queries about tax deductions; preparing the payroll from the biometric clock records;

reviewing lease contracts to detect risky clauses; and sending reminders of tax filing deadlines. Classify each task according to how suitable it is for robotic process automation, justify the classification with the criteria of chapter 2 and with the idea of the "long tail" of subsection 5.3.1, and indicate which one should be redesigned before being automated.

4. Draw the map of the supply chain of a product of the region (cocoa, coffee, shrimp or bananas), from the producer to the final customer. At each link, point out what datum is recorded for traceability, what electronic document accompanies the handover and what disruption could affect it; then propose one visibility measure and one resilience measure for the most vulnerable link.

Analysis of the case

1. Which phases of the process management cycle can be recognized in the intervention of the processing plant, and which indicators would be worth following in the monitoring and controlling phase?
2. Why did the finding that each datum was written down three times weigh more than the purchase of a new scale? Relate the answer to cycle time efficiency.
3. How does the QR code label contribute to traceability backwards and forwards, and what limitation does the system keep if a shrimp farm reports the pond of origin incorrectly?
4. What continuity and cybersecurity risks does the new receiving process introduce, and what measures would reduce them?

Collaborative activity

1. In groups of four members, choose an administrative process of the university or of a nearby MSME (enrollment, purchasing or handling of complaints), map its current journey through interviews and observation, measure the cycle time of at least five cases and propose a redesign. Expected output: a five-page report with the diagram of the current and the proposed process, the table of times and the cycle time efficiency before and after.
2. Organize a debate on this question: is a small exporter better off investing in a blockchain for traceability or in a batch record integrated with its ERP? Expected output: a one-page record with the arguments of each position and a reasoned recommendation.

Self-assessment

1. According to the process view, where are the most expensive problems of a process usually concentrated?
   a) In the activities carried out by management
   b) In the handovers between areas
   c) In the tasks with the longest working time
   d) In the support processes
2. In which phase of the process management lifecycle is the process documented as it is actually carried out?
   a) Identification
   b) Analysis
   c) Discovery
   d) Monitoring and controlling
3. A process adds up to 40 minutes of work and 160 minutes of waiting. What is its cycle time efficiency?
   a) 20%
   b) 25%
   c) 40%
   d) 80%
4. What happens to the capacity of a process if an activity that is not the bottleneck is automated?
   a) It increases in the same proportion as the time saved
   b) It stays the same, because it is set by the most limited resource
   c) It falls, because the automation adds steps
   d) It doubles if the cost per order is halved
5. According to the idea of the “long tail” of work, which cases does robotic process automation serve best?
   a) The most frequent case types, which justify integrating the systems
   b) Exceptional cases, which are resolved with judgment case by case
   c) Repetitive work that is not frequent enough to justify traditional automation
   d) Cases that leave no record at all in the company’s systems

6. In process mining, which technique contrasts the recorded behavior with the prescribed model?
    a) Conformance checking
    b) Discovery
    c) Enhancement
    d) Simulation
7. What does the ripple effect in a supply chain describe?
    a) The reduction of costs when inventories are shared
    b) The amplification of demand as orders move up the chain
    c) The replacement of distant suppliers with nearby ones
    d) The propagation of a disruption across the network
8. Why does an electronic invoice that is printed and typed in again waste the electronic document?
    a) Because it loses its tax validity when printed
    b) Because the electronic signature expires with printing
    c) Because the printed receipt cannot be filed
    d) Because the manual process is kept and the datum does not flow into the system
9. In a dispatch process, the bottleneck is
    a) the activity with the most people assigned
    b) the activity that limits the capacity of the process as a whole
    c) the most expensive activity
    d) the first activity in the chain
10. Process mining differs from traditional process mapping because
    a) it uses structured interviews with the process owners
    b) it reconstructs the real process from the event logs of the systems
    c) it only applies to manufacturing
    d) it requires an ERP from the same vendor
11. For which of these tasks is robotic process automation most suitable?
    a) Negotiating terms with a new supplier
    b) Deciding which products to discontinue
    c) Copying data from a form into the accounting system every day
    d) Designing the seasonal campaign

12. The ripple effect in a supply chain describes

a) the amplification of demand variability upstream
b) the propagation of a disruption from one link to the others
c) the fall in price as volume grows
d) the loss of traceability when the carrier changes

CHAPTER 6.
CUSTOMERS, DIGITAL MARKETING AND ELECTRONIC COMMERCE

The relationship with the customer is the ground where digital transformation first becomes visible. Before redesigning its internal processes, an MSME discovers that its customers already search, compare and buy from their phones, and that they expect an answer at any hour. The customer experience is, in fact, one of the three fronts on which digitally leading companies concentrate their transformation, together with operational processes and the business model (Westerman et al., 2014).

This chapter studies that relationship from a management standpoint. It starts with the journey of the connected customer, reviews the tools of digital marketing and social media, and explains why integrating channels demands more than opening a new account. It then addresses electronic commerce, with its logistics, payment and trust conditions, and ends with the metrics that show whether the commercial effort creates value or merely generates activity.

Some neighboring topics are developed in other chapters: platforms, in chapter 3; data analytics, in chapter 4; customer management systems, in chapter 5, and the protection of personal data, in chapter 11. The thread that joins the sections is simple: the relationship with the customer is an asset, and the company is better off owning it than renting it.

By the end of this chapter, the reader will be able to:

1. Describe the journey of the connected customer, its stages and the types of touchpoints that take part in it.
2. Distinguish the tools of digital marketing and paid, owned and earned media according to their function in the customer journey.
3. Explain the differences between multichannel and omnichannel approaches, and the demands on data, inventory and organization that integrating channels implies.
4. Analyze the logistics, payment and trust conditions that support the electronic commerce of an MSME.
5. Calculate and interpret the conversion rate, the customer acquisition cost, the customer lifetime value and the return on advertising spend.

6.1. The connected customer and the customer journey

The connected customer comes to the purchase with information that only the seller used to have: they check prices, read the opinions of strangers and compare a company with its

competitor in minutes. A bakery in Manta or a repair shop in Ibarra used to live on neighborhood word of mouth, which traveled slowly and among acquaintances; today a review posted on a digital map reaches people who never set foot in the store, and the messaging app on the phone serves at once as counter, catalog and till.

Behind these scenes lies a shift of power toward the buyer. Rogers (2016) describes it as the move from a mass market that receives messages to dynamic networks of customers who communicate with one another, influence the reputation of brands and take part in the creation of value.

This reality is organized through the concept of the customer journey, the process a person follows before, during and after buying. Lemon and Verhoef (2016) define the customer experience as a multidimensional construct that brings together the customer's cognitive, emotional, behavioral, sensory and social responses to a company's offering along that journey, and they distinguish three stages: the prepurchase stage, with the recognition of the need and the search; the purchase, with the choice, the order and the payment, and the postpurchase stage, which covers use, service and possible repurchase.

The same authors group touchpoints according to who controls them. Brand-owned ones include the website, the catalog, advertising and the way the staff treats the customer; partner-owned ones are designed or managed together with third parties, such as the online marketplace, the delivery company or the payment gateway; customer-owned ones are the customer's own decisions, for example the payment method they choose, and social or external ones cover the opinions of other buyers and independent sources of information. Figure 6.1 places these four types in the three stages of the journey.

Of the four groups, the company fully governs only the first; the others require coordinating with partners, making the customer's decisions easier and listening to what is said outside its own channels. The journey also has a memory: someone who had a problem with a delivery arrives at their next purchase with less patience and more doubts.

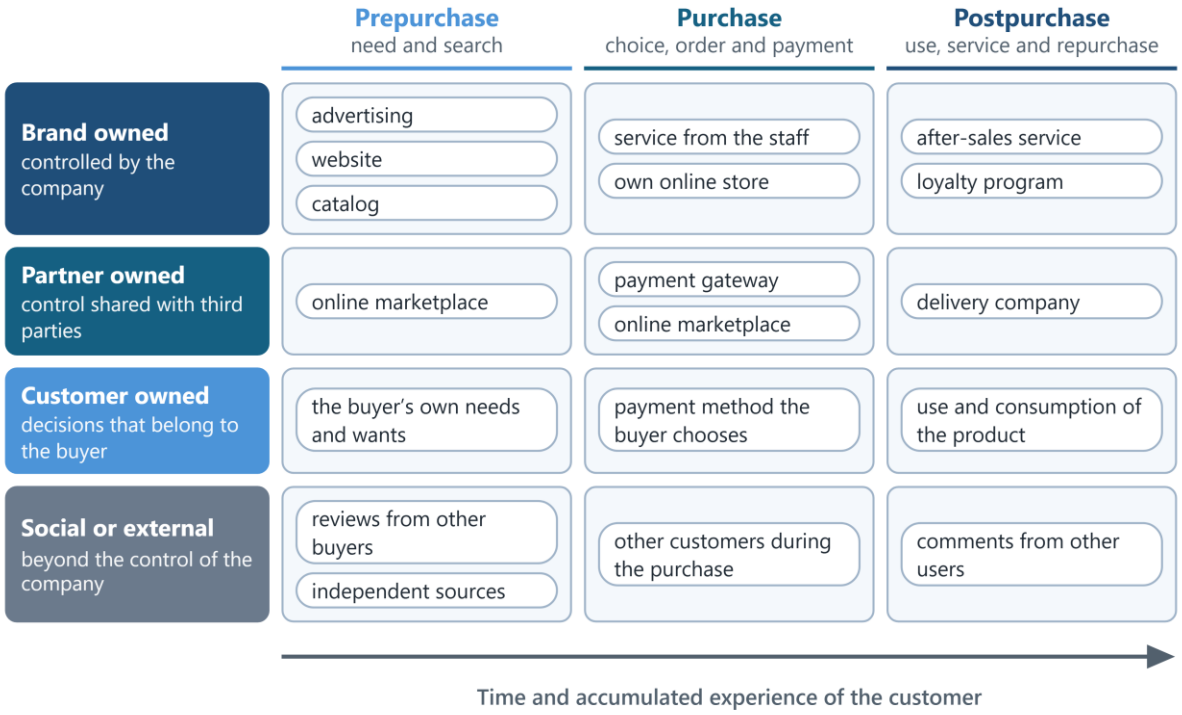
A description closer to commercial practice is the five A's path proposed by Kotler et al. (2017): becoming aware of the brand, feeling its appeal, asking and researching, acting through purchase and use, and advocating it. The last stage breaks the logic of the traditional funnel, which ended with the sale. A satisfied customer who posts a favorable opinion begins the journey of other people; a bad experience told in public produces the opposite effect.

The practical value of these models lies in diagnosis. When a hardware store in Cuenca draws, step by step, the journey of a real customer, it usually finds frictions that appeared in no report: the price query sent by message that nobody answers until the next day, the online

catalog that shows products out of stock or the invoice that arrives with errors. Correcting them usually costs less than a new campaign.

Figure 6.1

The customer journey: stages and touchpoints



Note. The authors' own work, based on Lemon and Verhoef (2016).

6.2. Digital marketing: framework and tools

In everyday conversation, digital marketing is usually reduced to posting on social media. The academic definition is broader: Kannan and Li (2017) describe it as an adaptive, technology-enabled process by which firms collaborate with customers and partners to create, communicate, deliver and sustain value for all stakeholders. It is adaptive because the data from each interaction help to correct the offering almost in real time, and collaborative because the customer takes part with their searches, their opinions and their own content.

For planning purposes it is useful to distinguish between paid, owned and earned media, a classification used by Chaffey and Ellis-Chadwick (2019). Paid media are bought: advertisements in search engines, on social networks or on third-party sites. Owned media belong to the company, such as its website, its mailing list or its catalog. Earned media come from third parties who talk about the brand without being paid, for example a review, a note in a local

outlet or a post shared by a customer. The underlying difference appears when the investment stops: paid media disappear with the last advertisement, while the other two keep their value. The tools of digital marketing can be grouped into five families, each with a different function within the customer journey:

- **Search.** It comprises search engine optimization (SEO) and the paid advertisements that appear next to the results; it captures demand at the moment the customer expresses an intention.
- **Content.** Guides, videos, recipes or articles that answer the customer's questions and build authority over time; generative artificial intelligence, described in chapter 2, makes their production cheaper, although it does not replace judgment about what to publish.
- **Email.** Messages to a list of people who agreed to receive them; it is an owned and inexpensive medium, suitable for repurchase and after-sales service.
- **Advertising.** Display, video or social advertising, targeted by location, interests or behavior; it generates new demand, but its effect stops when the budget runs out.
- **Social media.** Spaces for conversation and community, whose management is examined in section 6.3.

None of these tools covers the whole journey on its own. A specialty coffee roaster in Loja can spark interest with short videos about brewing methods, appear before whoever searches for "high-altitude coffee beans" thanks to search engine optimization, close the sale in its online store and, three weeks later, when the bag runs out, send an email that makes it easy to repeat the order. The commercial plan consists of articulating those pieces around a single message.

Personalization is the most attractive promise of digital marketing and also the most delicate. Data on browsing, purchases and responses serve to adapt messages and offers to each person, but that same intensive use of data breeds distrust when the customer does not know what is collected and for what purpose. In Ecuador, such processing is subject to legal obligations that section 6.5 summarizes and chapter 11 develops.

6.3. Social media and communities

Social media are the most visible face of digital marketing and the one most open to improvisation. In their work on social media, Kaplan and Haenlein (2010) define them as a group of internet-based applications, built on the ideological and technological foundations of web 2.0, that allow the creation and exchange of user-generated content. They distinguish six

types according to social presence and media richness, and according to what the user reveals about themselves: collaborative projects, blogs, content communities, social networking sites, virtual game worlds and virtual social worlds.

It follows from that definition that content is also produced by users. The brand posts, but its customers comment, tag, compare and reply, and what other buyers say weighs on the decision because it comes from peers. Managing social media therefore means listening and conversing as much as broadcasting messages. A complaint handled in public quickly and courteously, and then resolved through a private channel, can become proof of seriousness in the eyes of those watching.

It is worth separating audience from community. An audience is made up of followers who receive messages; a community appears when its members interact with one another around a shared interest, even if the brand does not take part in every conversation. According to Rogers (2016), networked customers seek easy access to content and services, engagement with experiences that interest them, personalization of the offering, connection with others and collaboration in common projects.

Creating a community does not require a large budget. An association of fine aroma cocoa growers in Esmeraldas can show the fermentation of the bean in short videos and introduce the families who grow it; a neighborhood gym in Guayaquil can propose monthly challenges in which members post their progress. In both cases, the content is largely contributed by the members, and the brand acts as host.

There is, however, a structural limitation. The account belongs to the platform, and the reach of each post depends on algorithms the company does not control; a change in those rules can cut overnight the visibility of a business that had built its clientele there. It is therefore advisable to treat social media as a meeting place and to lead interested followers toward owned media, always with their consent.

6.4. Omnichannel management

For years, companies that added channels managed them separately: the physical store with its targets, the website with its own and the call center with its own customer records. That scheme, called multichannel, clashes with the behavior of a customer who does not think in channels. Against it, Verhoef et al. (2015) define omnichannel management as the synergetic management of the numerous available channels and customer touchpoints, in such a way that the customer experience across channels and the performance of the whole are optimized at the same time.

The difference shows in everyday behavior. There are customers who research on the internet and buy in the store (*webrooming*) and others who examine the product in the store and buy it online, sometimes from a competitor (*showrooming*). An appliance distributor in Portoviejo that publishes its inventory online, sets a product aside through a message and hands it over in the store takes advantage of the first behavior instead of suffering the second.

Integrating channels demands four conditions that are rarely met by themselves. The first is a single view of the customer, bringing together in one record their purchases and queries through any route; customer relationship management (CRM) systems, studied in chapter 5, perform that function. The second is a shared inventory, visible in real time. The third, consistency of prices, promotions and exchange policies. The fourth, often forgotten, is incentives that do not pit the counter salesperson against the online store.

Full omnichannel management is expensive and not every MSME needs it. A gradual route starts with consistency, with the same catalog, the same prices and the same information in every channel; it continues with integration, which shares inventory and service history, and it culminates in orchestration, in which each interaction is adjusted to what the customer already did in another channel. Moving from one step to the next makes sense when the volume of customers and the frequency of purchase justify the investment.

6.5. Electronic commerce and online marketplaces

Electronic commerce comprises the buying and selling of goods and services through digital networks, even if payment or delivery takes place afterwards outside them. It covers business-to-consumer, business-to-business and consumer-to-consumer sales, as well as social commerce, which closes sales inside social networks and messaging apps. An MSME can sell in a store of its own, in online marketplaces, through social media and messaging, or combine those routes.

Online marketplaces are two-sided platforms, studied in chapter 3. In the definition of Parker et al. (2016), a platform is a business that creates value by facilitating interactions between external producers and consumers, and that sets the conditions of those interactions. For the small seller it solves traffic, trust and payment; in exchange, it charges commissions, exposes the seller to immediate price comparison and keeps much of the buyer’s data. Many companies therefore use the marketplace to make themselves known and their own store for repeat customers.

6.5.1. Logistics and the last mile

The promise of an online store is kept or broken in logistics: order picking, packing, dispatch and home delivery, the stretch known as the last mile, plus the reverse logistics that handles exchanges and returns. In Ecuador, the cost and the time of shipping vary greatly between a provincial capital and a rural parish. A handicraft store in Otavalo that sells low-value pieces soon discovers that freight can absorb the margin, and responds with a minimum amount for free shipping or with grouped dispatches.

6.5.2. Payment methods

Payment is another critical point: a missing option or a confusing form is enough for the customer to abandon the purchase. An MSME can offer bank transfer, cash on delivery, cards processed by a payment gateway, payment links or digital wallets. The gateway charges a commission, but it confirms the payment instantly; the transfer costs the seller nothing, although it forces them to reconcile receipts, and cash on delivery reaches customers without a card at the price of more orders rejected at the door.

6.5.3. Trust

In electronic commerce the customer usually pays before receiving and cannot examine the product, so trust comes before everything else. A small, unknown store makes up for that asymmetry with verifiable signals: clear shipping, exchange and return policies, visible contact details, reviews from real buyers, faithful photographs, a secure connection and quick replies. The adoption models of chapter 9 help to explain why a consumer decides, or does not decide, to buy online.

Customer data are part of that trust. In Ecuador, their processing is governed by the Ley Orgánica de Protección de Datos Personales (Asamblea Nacional del Ecuador, 2021), which requires a legitimate basis, such as the consent of the data subject, and grants rights over their information; chapter 11 develops these obligations together with those of cybersecurity.

6.6. Digital marketing metrics

Digital marketing leaves a trace of almost everything, from how many people saw an advertisement to what they bought afterwards. That abundance holds a risk, that of confusing activity with result: followers and reactions are vanity metrics as long as they are not connected with sales, margins or returning customers.

The first measure is the conversion rate, the proportion of visits that ends in the intended action, defined in advance: the purchase in an online store, the booking in an inn or the contact form in an accounting firm. Calculated for each step of the funnel, it locates the stretch where customers are lost; a sharp fall between the cart and the payment usually betrays unexpected shipping costs.

Two measures sum up the economics of the customer: the customer acquisition cost (CAC), which divides everything spent on acquiring new customers by the customers obtained, and the customer lifetime value (CLV), which estimates the margin a customer leaves over their whole relationship with the company. In examining the future of the discipline, Rust (2020) argues that the deepening of relationships makes it necessary to manage customers by that value, to project their flows into the future and to avoid short-term decisions.

Table 6.1 brings together these and other metrics with their formula, their interpretation and the most frequent mistake in using them. The formulas are deliberately simple, so that an MSME can apply them in a spreadsheet with its own data.

Table 6.1

Digital marketing metrics: formula, interpretation and frequent mistake

Metric	Formula	What it indicates	Frequent mistake
Conversion rate	Conversions / visits × 100	Proportion of visits that complete the intended action: purchase, booking or sign-up.	Comparing rates that define the conversion or count the visits in different ways.
Average order value	Sales revenue / number of orders	Average spending per order; an input for estimating the value of the customer.	Raising it with volume discounts that reduce the margin.
Customer acquisition cost (CAC)	Total acquisition investment / new customers	How much it costs, on average, to win a new customer.	Counting only the advertisements and leaving out content, commissions and staff hours.
Retention rate	Customers from the start who are still active / customers at the start × 100	Proportion of customers who keep buying from one period to the next.	Measuring it over periods shorter than the natural repurchase cycle.

Metric	Formula	What it indicates	Frequent mistake
Customer lifetime value (CLV)	Margin per purchase × purchases per year × years of the relationship	Total margin a customer leaves; a reasonable ceiling for the CAC.	Calculating it with revenue instead of margin or assuming longer relationships than those observed.
Return on advertising spend (ROAS)	Revenue attributed to advertisements / advertising investment	Revenue generated by every dollar invested in advertising.	Reading it as profitability: a ROAS greater than 1 can still leave losses.
Return on marketing investment (ROI)	(Attributed margin - investment) / investment × 100	Profit left by every dollar invested, after covering its cost.	Attributing to the campaign sales that would have happened without it.

Note. The authors' own work. The CLV appears in its simple version, without retention or discounting.

That simple version of the CLV overlooks the fact that not all customers keep buying and that a future dollar is worth less than a present one. If an annual margin per customer m, a retention rate r, which is the probability that an active customer stays active the following year, and a discount rate i are assumed constant, the present value of the margins that an already acquired customer will leave in the following years is:

$$CLV = m \times r / (1 + i - r)$$

With an annual margin of USD 40, a retention of 60% and a discount rate of 12%, that value comes to about USD 46, which is added to the margin of the first year; with a retention of 70%, it reaches about USD 67. The discounting follows the logic of net present value, which chapter 12 applies to digital investments.

The return on advertising spend (ROAS) divides the revenue attributed to the advertisements by the amount invested in them. It measures the efficiency of advertising, but not its profitability, because it does not deduct the cost of what was sold. A campaign with a ROAS of 2 looks successful; however, with a gross margin of 40%, the two dollars of sales brought by each dollar invested leave barely 80 cents to cover it. The threshold of profitability is the break-even ROAS:

$$\text{Break-even } ROAS = 1 / \text{Gross margin (as a proportion)}$$

For a margin of 40%, that threshold is 2.5; below it, every sale attributed to the campaign costs more than it leaves. If the sale generates other variable costs, such as shipping or

the payment commission, it is advisable to use the margin that remains after them. The threshold guides, but it does not decide on its own: a campaign that brings new customers may be justified if their later purchases offset the initial loss.

There remains the problem of attribution. A customer may watch a video on social media, search for the brand days later and buy from a link received by email; if the system assigns the whole sale to the last click, it overvalues the email and underestimates the content that sparked the interest. Asking the customer how they heard about the company, using different discount codes per channel and tagging the links of each campaign soften that bias without sophisticated models; chapter 4 shows how to bring those data together in a dashboard.

Illustrative case: a beach inn that recovers the relationship with its guests

The inn has been running for eleven years in a coastal community in the province of Santa Elena and has fourteen rooms. For a long time, three out of four bookings came through two online travel agencies that charged a commission of 18% on the value of the stay. The owning family did not know the email address of most of its guests, and its reputation depended on the ratings posted on those platforms.

The change began with a question from the owner's daughter: how much was the inn paying for each guest who came back? Many frequent customers booked again through the agency, and the commission was charged again. The family then built a channel of its own: a website with a booking engine and breakfast included for anyone booking directly, a business messaging account, a mailing list built with the guests' consent and short videos about the whale season.

Eighteen months later, slightly more than half of the bookings came through owned channels. The direct channel did not turn out to be free: the site, the search advertisements with the name of the inn and the hours spent answering at night had a cost that the family learned to compare with the commission. Nor did it drop the intermediaries, which still bring in foreign tourists and low-season bookings.

6.7. Chapter summary

The chapter followed the relationship with the customer from the first contact with the brand to repurchase and recommendation. The digital company manages a journey it only partly controls, and its advantage depends on integrating channels, taking care of trust and measuring the value of each customer.

- The customer journey runs through the prepurchase, purchase and postpurchase stages, with touchpoints that belong to the brand, to its partners, to the customer or to third parties.
- Digital marketing is an adaptive process of value creation with customers and partners; each tool serves a stage of the journey.
- Owned and earned media keep their value when the investment stops; paid media disappear with the last advertisement.
- Social media serve for conversing and forming community, but the account belongs to the platform: it is advisable to take the relationship to owned media with the customer's consent.
- Omnichannel management demands a single view of the customer, shared inventory, consistent prices and aligned incentives, and it can be reached in stages.
- Electronic commerce rests on logistics, payment methods and trust; online marketplaces bring traffic in exchange for commissions and data.
- The conversion rate, the CAC, the CLV and the ROAS are read together: a ROAS above 1 does not guarantee profitability if the margin is low.

Key terms: *customer journey, touchpoint, owned media, earned media, omnichannel management, online marketplace, last mile, payment gateway, conversion rate, customer acquisition cost, customer lifetime value, return on advertising spend.*

6.8. Exercises and activities

Comprehension questions

1. Which stages make up the customer journey, and why does the experience of one journey condition the next?
2. Explain the difference between paid, owned and earned media, and give an example of each one for a service MSME.
3. What distinguishes a community from an audience of followers? Why is it advisable to take part of the relationship with followers to owned media?
4. How does omnichannel management differ from a multichannel approach, and what conditions does integrating the channels demand?
5. What trust signals can a small online store offer to a buyer who does not know it?

Application exercises

1. A specialty coffee roaster in the province of Loja sells through its online store. In the last quarter it recorded 40,000 visits and 1,000 orders, with an average value of USD 25 per order; 400 of those orders came from new customers. It invested USD 4,500 in search and social advertising, and USD 1,500 in content production and staff hours devoted to acquiring customers. Its analytics tool attributes USD 13,500 of revenue to the advertisements. The gross margin is 40%, and a customer buys on average four times a year for a year and a half. Calculate: a) the conversion rate; b) the CAC; c) the simple CLV and the CLV/CAC ratio, and d) the ROAS and the break-even ROAS. With those results, interpret whether customer acquisition is sustainable. *Worked solution in Appendix B.*
2. An online sportswear store, with a gross margin of 30%, is appraising two campaigns from last month. Campaign A, in search engines, cost USD 2,000 and is credited with revenue of USD 7,000; campaign B, on social media, cost USD 1,500 and is credited with USD 4,200. a) Calculate the ROAS of each campaign and the break-even ROAS of the store. b) Determine the contribution of each campaign, understood as the gross margin of its sales minus its cost. c) State what additional information should be requested before suspending the campaign with the poorer result. *Worked solution in Appendix B.*
3. Choose a local MSME (a bakery, a hardware store, a medical practice or a workshop) and draw up its customer journey in the three stages. Identify at least two touchpoints of each type according to who controls them, point out three frictions and propose a specific improvement for each one.
4. A leather footwear workshop in Gualaceo wants to sell shoes online at an average price of USD 45. Compare three alternatives: its own store, an online marketplace and selling through social media and messaging. Use as criteria the cost, the control of customer data, the available traffic, the trust the buyer perceives and the shipping logistics, and recommend a justified combination.

Analysis of the case

1. Classify the touchpoints of a guest's journey at the inn, before and after the changes, according to whether they belong to the brand, to partners, to the customer or to third parties. What changed in the control of the journey?

2. Why is the mailing list built with consent worth more to the inn than its followers on social media? Relate the answer to owned, paid and earned media.
3. The family decided not to drop the intermediaries. Assess that decision with criteria of reach, seasonality, cost per booking and risk of dependence.
4. Propose four monthly indicators for following the inn's own channel, with their formula and the decision each one would help to make.

Collaborative activity

1. In teams of three or four people, design a staged omnichannel proposal (consistency, integration and orchestration) for a retail business in the city. Expected output: a two-page document with the inventory of channels, the information they must share, the actions of each stage and three follow-up indicators.
2. Each team goes through the buying process of three online stores of MSMEs in the region, from the search to the step before payment, and records the trust signals and the frictions it finds. Expected output: a ten-point checklist for an MSME that is starting to sell online, grounded in what was observed.

Self-assessment

1. According to the model of Lemon and Verhoef (2016), a review posted by another buyer on an independent site is a touchpoint that is:
   a) brand-owned.
   b) owned by a partner of the company.
   c) customer-owned.
   d) social or external.
2. Which of the following is an owned medium?
   a) A paid advertisement in a search engine.
   b) The mailing list of customers who agreed to receive messages.
   c) A spontaneous review on a travel portal.
   d) A note published by a local newspaper without any payment.

3. Omnichannel management differs from a multichannel approach because:
   a) it manages the channels in an integrated way so that the customer moves from one to another without starting over.
   b) it uses a larger number of digital channels.
   c) it replaces the physical store with the online store.
   d) it assigns independent sales targets to each channel.
4. An online store received 30,000 visits and 600 orders in a month. Its conversion rate is:
   a) 0.5%.
   b) 5%.
   c) 2%.
   d) 20%.
5. If the gross margin of a store is 25%, its break-even ROAS is:
   a) 0.25.
   b) 2.5.
   c) 1.25.
   d) 4.0.
6. The customer acquisition cost must include:
   a) everything spent on acquiring new customers: advertisements, content, commissions and staff hours.
   b) only the investment in paid advertisements.
   c) the cost of the products sold to the new customers.
   d) the spending devoted to retaining current customers.
7. In the five A's path proposed by Kotler et al. (2017), the stage in which the customer becomes a source of new customers is:
   a) aware.
   b) ask.
   c) advocate.
   d) act.

8. What does an online marketplace mainly offer to an MSME that is starting to sell over the internet?
    a) Full control of its buyers' data.
    b) Traffic and payment and trust mechanisms that are already established.
    c) The absence of commissions per sale.
    d) The freedom to set the rules of display.
9. A store receives 4,000 visits to its site and closes 80 sales. Its conversion rate is
    a) 0.2%
    b) 2%
    c) 5%
    d) 20%
10. The customer acquisition cost of a campaign is obtained by dividing
    a) revenue by the number of customers
    b) the campaign spend by the number of new customers it brought in
    c) the spend by the number of visits
    d) the margin by the number of orders
11. What characterizes an omnichannel strategy as opposed to a multichannel one?
    a) Being present on more social networks
    b) Having the channels share information so the customer can start in one and finish in another without repeating data
    c) Selling only online
    d) Using an online marketplace instead of an own website
12. A spontaneous review from a satisfied customer on a social network is an example of
    a) owned media
    b) paid media
    c) earned media
    d) an internal touchpoint

CHAPTER 7.
PEOPLE, CULTURE AND LEADERSHIP IN DIGITAL TRANSFORMATION

Two businesses in the same industry can use the same invoicing software and the same online store and still obtain very different results. In one, the data from the system are discussed at the weekly meeting and errors are corrected quickly; in the other, each area keeps its own files, failures are hidden and the software is used only halfway. The difference lies in the people, in the culture that guides their behavior and in the leadership that gives meaning to the change.

The previous chapters dealt with technologies, strategy, data, processes and customers; this one deals with those who make all of it work. It starts from a question (why technology is not enough to transform an organization) and then goes through digital skills, leadership, culture, change management, the automation of tasks and agile working.

The approach is practical. In many micro, small and medium-sized enterprises (MSMEs) of the region there are no specialists in organizational change, and it is the owner who decides, trains and corrects, often on the same day. That is why the concepts are illustrated with examples from cooperatives and small firms. Neighboring topics are referred to their own place: digital maturity, to chapter 8; the theories of adoption, to chapter 9, and project management, to chapter 12.

By the end of this chapter, the reader will be able to:

1. Explain why digital transformation depends on people, culture and leadership more than on the technology acquired.
2. Use the DigComp 2.2 framework to describe digital skills and diagnose the gaps of a work team.
3. Distinguish the practices of digital leadership and the cultural traits that favor learning, in particular psychological safety.
4. Apply the change models of Lewin and Kotter to a digital transformation project.
5. Analyze the effect of automation on the tasks of a job and assess agile ways of working as support for change.

7.1. The technology fallacy: people as the key

Faced with digital pressure, many managers look first for a technological solution, be it a new system or a fashionable application. Kane et al. (2019) call that reaction the technology

fallacy. On the basis of several years of surveys of professionals and interviews with executives, they argue that digital disruption is above all a matter of people and that concentrating only on choosing and installing the right technology hardly ever leads to success; effective transformation requires changing the dynamics of the organization and the way the work is done.

The fallacy is seductive because technology is visible: it has a price, a supplier and a delivery date, whereas changing habits is slow and often uncomfortable. A bakery with four outlets can install a point-of-sale system and discover, months later, that the cashiers still balance the till in a notebook because the owner does not trust the system's reports. The software works; the daily closing, by contrast, is done twice. Chapter 1 reviewed this kind of mistake; what matters here is its human root.

Studies of small and medium-sized enterprises (SMEs) point in the same direction. Koca and van Deursen (2026) interviewed managers, digital transformation officers, consultants and technology experts linked to Dutch SMEs. Their results show that the success of the transformation depends as much on technological investment as on the skills of employees, managerial capability and the infrastructure of each sector. For these authors, digitalizing an SME is a multidimensional and people-centered process.

Over time, the weight of the organizational side grows. In an analysis of listed Chinese SMEs, technological breakthroughs drove the initial stage of the transformation, but organizational change gained importance as the process matured (Yang et al., 2026). The following sections deal with that organizational change, seen from the standpoint of people.

7.2. Digital skills: the European DigComp framework

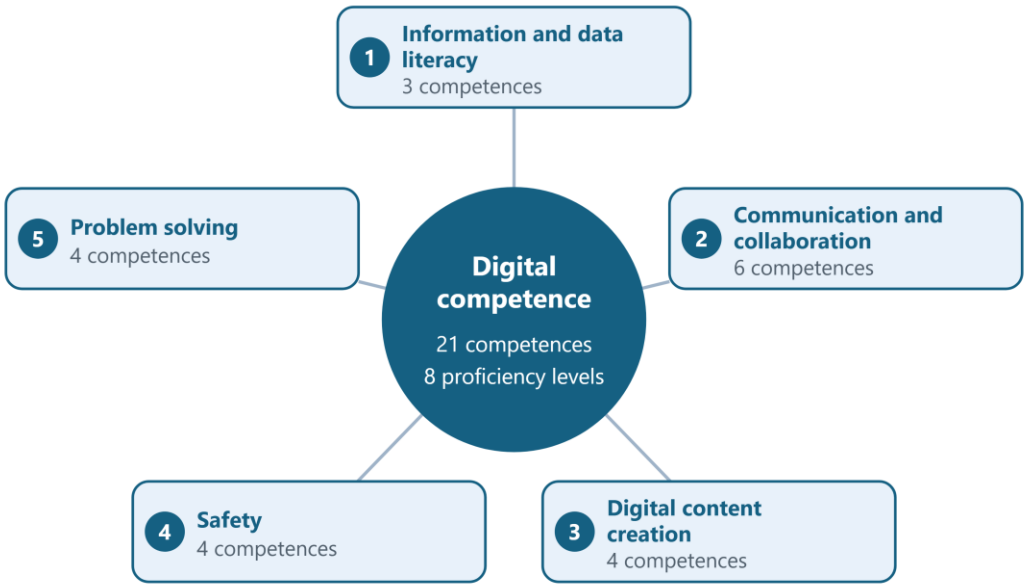
A competence combines knowledge, skills and attitudes that are brought to bear in real situations. In the European Union, digital competence means the use of digital technologies with confidence, a critical sense and responsibility in order to learn, work and take part in society. The Joint Research Centre of the European Commission described it in the Digital Competence Framework for Citizens, known as DigComp. Its version 2.2 keeps five areas and 21 competences and adds examples of knowledge, skills and attitudes, some of them about artificial intelligence and remote work (Vuorikari et al., 2022).

Figure 7.1 summarizes the five areas. The first, information and data literacy, covers searching for, evaluating and organizing data and content, as a purchasing assistant does when comparing the price lists of several suppliers. The second, communication and collaboration, comprises interacting and coordinating through digital means, respecting netiquette and taking

care of one's digital identity. The third, digital content creation, ranges from producing a catalog to respecting usage licenses and programming simple tasks.

Figure 7.1

Areas of digital competence according to DigComp 2.2



Note. The authors' own work, based on Vuorikari et al. (2022).

The other two areas are transversal, because they are involved in any digital activity (Vuorikari et al., 2022). Safety covers the protection of devices, personal data, health, well-being and the environment; problem solving ranges from overcoming a technical failure to identifying needs and recognizing one's own gaps. Neither can be fully delegated to the IT department: the salesperson who handles orders by messaging app deals with personal data and must be able to recognize a fraudulent link, a matter taken up in chapter 11.

To grade proficiency, version 2.1 of the framework defined eight levels grouped in four bands: foundation, intermediate, advanced and highly specialized (Carretero et al., 2017). Each level implies more complex tasks, greater autonomy and a more demanding cognitive domain: at level 3 simple problems are solved without help, at level 5 one already guides other people and at level 8 new ideas and processes are proposed for the field.

With that scale, an organization can set the level each job requires, compare it with the current proficiency of its staff and decide which training to offer first, as is done in the first application exercise. Investing in those skills has empirical support: in SMEs, Abdulaal (2026)

found that the digital capabilities of employees mediate the relationship between digital transformation and innovation performance.

The framework is revised periodically to keep up with technological change. Its version 3.0, published at the end of 2025, keeps the same structure, systematically integrates artificial intelligence competence across all the areas and adds a broad set of learning outcomes (Cosgrove & Cachia, 2025). This chapter works with version 2.2 because its examples and its scale of eight levels are the ones used in the exercises.

7.3. Digital leadership

Digital leadership can be defined as the capacity of managers to set a direction that takes advantage of what technology makes possible, to mobilize people toward it and to govern the resulting change. In MSMEs, that role usually falls to the owner. In studying entrepreneurs who took their SMEs into cross-border electronic commerce with scarce resources, Li et al. (2018) describe how they managed it through the renewal of their own way of understanding the business, the development of relationships, the building of teams and the construction of organizational capabilities.

Based on the study of large companies in traditional industries, Westerman et al. (2014) distinguish digital capabilities, which define what is transformed, from leadership capabilities, which define how the transformation is conducted. The latter are expressed in four practices: formulating a transformative digital vision, engaging the whole organization, governing the transformation with shared priorities and rules, and building technology leadership capabilities, starting with a close relationship between the business and the technology area. Chapter 8 combines both capabilities to distinguish four profiles of company.

In SMEs too, leadership seems to work through capabilities. In a sample of firms in Ghana, Gyamerah et al. (2025) found that digital transformational leadership was positively associated with digital transformation and that part of that effect was transmitted through digital capabilities in information technology and through those of employees; digital strategy, by contrast, showed a weaker mediating role.

In daily life, staff infer the leader's priorities from what the leader attends to, measures and rewards. Among the mechanisms by which leaders embed culture, Schein (2010) includes their sustained attention to certain matters, their reaction to critical incidents, the allocation of resources and rewards, and personal example. For instance, a manager who reviews the sales dashboard at every meeting signals, without saying so, that decisions must be based on data.

7.4. Organizational culture, learning and psychological safety

7.4.1. The three levels of culture

The culture of an organization can be understood as the set of shared assumptions that a group learned while solving its problems of external adaptation and internal integration. Since those assumptions worked, the group teaches them to new members as the correct way to perceive, think and feel (Schein, 2010). That culture shows itself at three levels. Artifacts are what is visible: the layout of the offices, the forms or the rituals. Espoused values express what the organization says it believes. Basic assumptions, the deepest level, are beliefs that are taken for granted and are no longer discussed.

This distinction helps to understand frequent failures. A company can launch an application and proclaim in its mission statement that it values innovation while keeping the assumption that information gives power to whoever withholds it, or that making a mistake is costly. With those assumptions untouched, data do not circulate and nobody risks trying. It is no surprise that research on SMEs considers culture, structure and leadership to be essential components for enabling digital transformation (Leso et al., 2023).

7.4.2. Learning and psychological safety

Transforming requires learning continuously. In Chinese construction SMEs, organizational learning was among the capabilities that drove the transformation, and the readiness of the organization, shaped among other factors by the disposition of leadership and of culture, acted as an enabler (Wang et al., 2026). Learning, however, means asking, admitting mistakes and putting forward incomplete ideas, behaviors that nobody adopts if they fear ridicule or punishment.

That fear is at the core of the concept of psychological safety. Edmondson (1999) defined it as the belief, shared by the members of a team, that the team is a safe space for interpersonal risk taking. In her study of teams in a manufacturing company, psychological safety was associated with learning behavior (asking for feedback, sharing information, discussing errors), and that behavior mediated its relationship with performance. Contextual support and coaching by the leader were among the antecedents of that belief.

None of this amounts to complacency: psychological safety can coexist with demanding standards. In a warehouse that is adopting an inventory system, it shows when the worker who finds a discrepancy between the record and the shelf reports it immediately, instead of correcting it by hand to avoid questions. Leaders build it with concrete gestures: they ask before

judging, they thank whoever reports a problem, they review incidents in order to improve the process and not to look for culprits, and they acknowledge their own mistakes.

7.5. Change management: the models of Lewin and Kotter

Every transformation disturbs routines and certainties, and that is why it arouses opposition. In his review of the literature, Vial (2019) identifies inertia and resistance as barriers to digital transformation. Resistance is best read as information: someone objects when they fear losing competence, status, income or control over their work, or when they do not understand what the change is for. The individual motives for acceptance and rejection are studied in chapter 9; this section deals with collective change.

7.5.1. Lewin's three-stage change

One of the most influential models comes from social psychology. Lewin (1947) described the behavior of a group as a quasi-stationary equilibrium, sustained by forces that push toward change and forces that hold it back, and he argued that lasting change goes through three moments: unfreezing the present level, moving to a new one and freezing the behavior again at that level. From that idea came force field analysis, which advises weakening the restraining forces rather than increasing pressure, because additional pressure usually raises the tension of the group.

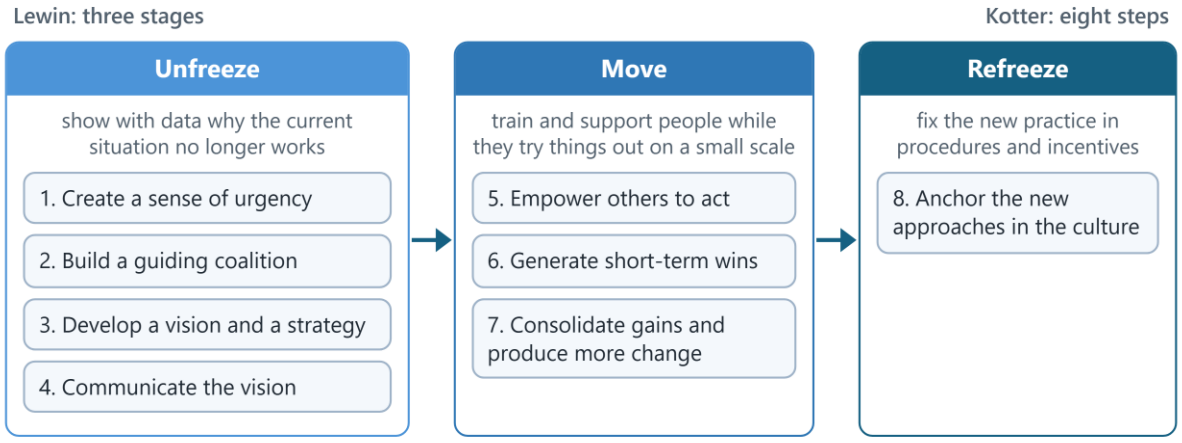
In a digital project, unfreezing means showing with data why the current situation no longer works; moving means training and supporting people while they try the tool out on a small scale; refreezing means fixing the new practice in procedures and incentives and withdrawing the old route. Figure 7.2 relates these stages to Kotter's eight steps, described next.

7.5.2. Kotter's eight steps

Half a century later, on the basis of the mistakes that kept recurring in business transformation efforts, Kotter (1996) proposed eight steps: create a sense of urgency, build a guiding coalition, develop a vision and a strategy, communicate the vision, empower others to act, generate short-term wins, consolidate gains to produce more change and anchor the new approaches in the culture. Table 7.1 applies them to a typical project: an online ordering system for a food distributor that supplies neighborhood stores.

Figure 7.2

From unfreezing to refreezing: three-stage change and Kotter's eight steps



Note. The authors' own work, based on Lewin (1947) and Kotter (1996).

Table 7.1

Kotter's eight steps applied to a digital transformation project

Step	Purpose	Application in the online ordering system	Typical mistake
1. Create a sense of urgency	Show that keeping the current situation is riskier than changing.	Present the orders lost to typing errors and the stores that already buy online from other suppliers.	Confusing urgency with alarm or with threats to the staff.
2. Build a guiding coalition	Bring together authority, knowledge and credibility.	Include sales, warehouse, collections, IT and a salesperson respected by colleagues.	Leaving the project solely in the hands of the IT department.
3. Develop a vision and a strategy	Define a desirable future and the path to reach it.	"Every shopkeeper orders from their phone and receives a confirmation with a delivery date".	Formulating the vision in technical terms that nobody remembers.
4. Communicate the vision	Make sure the vision is understood and repeated.	Explain it in route meetings, with demonstrations and answers to the salespeople's fears.	Announcing it once, by email, and taking it as understood.
5. Empower others to act	Remove obstacles of structure, skills, systems and supervisors.	Train the salespeople as channel advisors and adjust the commissions on online orders.	Keeping incentives that reward the paper order.

Step	Purpose	Application in the online ordering system	Typical mistake
6. Generate short-term wins	Show visible and credible results early.	Pilot it on one route and publicize the orders that arrived without errors in the first month.	Waiting for the final result to communicate progress.
7. Consolidate gains and produce more change	Use the credibility gained to extend the change.	Extend the system to every route and integrate it with inventory and electronic invoicing.	Declaring victory too soon.
8. Anchor the new approaches in the culture	Turn the new practice into the usual way of working.	Include the channel in onboarding, in performance indicators and in promotion criteria.	Depending on the enthusiasm of a single person.

Note. The authors' own work, based on Kotter (1996).

Read through Lewin, the first four steps unfreeze the situation, the next three install the new practices and the last one refreezes them. Both models, however, conceive change as an episode with a beginning and an end, and digital transformation looks more like a continuous process of strategic renewal (Warner & Wäger, 2019). In an MSME, moreover, the steps are compressed: the coalition may be the owner with two trusted employees; the first win, the first order without errors, and refreezing, a few weeks of stable practice before the next adjustment.

7.6. Automation, employment and new tasks

The fear of losing one's job is a common source of resistance, and it is not groundless. Two routes have been followed to measure workers' exposure to automation. The first examines whole occupations: Frey and Osborne (2017) estimated the probability of automation of hundreds of occupations according to the bottlenecks that still limit machines, such as fine perception and manipulation, creative intelligence and social intelligence. They also observed that this probability falls as wages and educational attainment rise.

The second route looks at the tasks that make up each occupation. The economist David Autor (2015) explains that automation easily substitutes for routine tasks, which follow explicit and codifiable procedures, and complements those that require solving problems, adapting and creating; by raising productivity, it can also increase the demand for labor. From this standpoint, a job is a bundle of tasks that technology recomposes: some disappear, others expand and new ones arise. He also warns that commentators tend to exaggerate substitution and forget those complementarities.

Consider a small accounting services firm. With electronic invoicing, the automatic import of receipts replaced much of the data entry; what remained were the review of doubtful cases, the support of clients with tax problems and the preparation of information for decision making. If the firm reorients its jobs toward analysis and advisory work and trains its staff, it gains valuable time; if it does not, the change is experienced as a threat.

With generative artificial intelligence a nuance appears, because the technology can also transfer knowledge. In studying a conversational assistant in the customer support of a company, Brynjolfsson et al. (2025) observed that agents with less experience and skill improved the speed and the quality of their work, whereas the most expert ones barely gained speed and lost some quality; they also found signs that the assistant facilitated learning. The evidence on productivity belongs to chapter 4; here the finding matters because it suggests a way of shortening the learning curve of newcomers.

From that division of labor between people and machines, new tasks arise: formulating instructions for the systems, verifying their results, explaining to customers decisions supported by algorithms and taking care of the data that feed them. To organize that collaboration in SMEs, Ortolano and Gallegos (2026) propose a maturity model that stresses the empowerment of staff, the ethical oversight of artificial intelligence and a culture able to adapt. It falls to management to take stock of the tasks of each job, decide which ones to automate, which ones to support with technology and which ones to keep, and to plan reskilling.

7.7. Agile ways of working

Agile methods were born in *software* development, in response to projects that failed because everything was planned at the start and what the user needed was discovered too late. They propose working in short cycles, delivering something usable frequently and adjusting course according to what is learned. The Project Management Institute (2021) distinguishes predictive, adaptive and hybrid development approaches, and advises choosing according to factors such as the certainty of the requirements and the stability of the scope. Chapter 12 applies those approaches to project management; here what matters is agility as a way of working.

Day to day, agility rests on small, cross-functional teams that decide how to meet an objective. Progress is shown on a board of tasks that are pending, in progress and finished, and the work is organized with short routines: a daily coordination meeting, a review with the user at the close of each cycle and a retrospective on the team's own way of working. These practices depend on the conditions seen earlier, especially psychological safety, without which the retrospective becomes a formality, and on leaders willing to delegate.

Beyond projects, Kane et al. (2019) argue that the best response to digital disruption is a culture that is more agile, more tolerant of risk and more experimental. In an MSME, getting started requires no certifications or new positions: a board, two-week cycles and a frank retrospective may be enough. The risks are also well known: ceremonies without real autonomy, overloading the team or abandoning the documentation that regulated processes require. The case that follows brings together several topics of the chapter.

Illustrative case: the mobile banking of a savings and credit cooperative

A savings and credit cooperative with five branches in cantons of the central highlands serves mainly traders, farmers and pensioners. To ease the queues at the counters on payday, the board of directors approved the purchase of a mobile banking application. The IT department installed it in four months and management announced the launch with posters. Six months later, most transactions were still being carried out at the counter.

Internal interviews revealed why. The tellers did not recommend the application because they feared that fewer transactions would mean fewer jobs, and several of them could not explain the initial registration. Many older members distrusted the channel after a fraudulent link imitating the cooperative's brand circulated through a messaging app. Nobody measured usage by branch, and the project was still solely in the hands of the IT department.

The general manager then took over the leadership. She formed a team with the head of operations, two branch managers, a teller respected by her colleagues and the systems analyst. She showed with internal data how long members waited in line and set a watchword: "routine matters, on the phone; advice, at the branch". She committed in writing not to dismiss anyone and offered the tellers training as digital services advisors, with an emphasis on security and problem solving.

Each branch appointed a digital ambassador who helped members with their first login, and a mixed team reviewed complaints about the registration every two weeks in order to simplify it. Reported errors were analyzed without looking for culprits, and the first branch to meet its usage target received public recognition. A year later, the onboarding of new staff included the application, and use of the channel was part of the indicators of every branch.

7.8. Chapter summary

This chapter argued that digital transformation is decided in the daily behavior of people and offered tools for acting on it: a framework for measuring skills, leadership practices, criteria for reading culture, two models of change, an analysis of tasks in the face of automation and ways of working that make learning a routine. Its central ideas are the following.

- The technology fallacy consists of looking for a technological fix to challenges that are, above all, about people and organization.
- DigComp 2.2 organizes digital competence into five areas and 21 competences, with the eight proficiency levels introduced in version 2.1; that scale makes it possible to set requirements per job and to measure gaps.
- Digital leadership combines vision, engagement of the organization, governance of the change and a close relationship between business and technology, and it works above all through people's capabilities.
- Culture operates at three levels; basic assumptions, barely visible, decide whether a new tool changes behavior or not.
- Psychological safety allows teams to ask, report errors and learn, a condition of any sustained transformation.
- Lewin and Kotter offer complementary sequences for unfreezing, moving and consolidating change, which in an MSME are compressed and repeated.
- Automation recomposes the tasks of each job; managing it requires redesigning jobs, training staff and organizing the work in agile cycles.

Key terms: *technology fallacy, digital competence, DigComp 2.2, proficiency levels, digital leadership, organizational culture, basic assumptions, psychological safety, change management, guiding coalition, routine tasks, agile team.*

7.9. Exercises and activities

The data in table 7.2 correspond to the first application exercise. They gather the self-assessment of four branch advisors of a cooperative on the eight-level DigComp scale, together with the level their job requires and the weight of each area.

Table 7.2

Self-assessment of four branch advisors in the DigComp areas

Area of competence	Advisor A	Advisor B	Advisor C	Advisor D	Required level	Weight (%)
Information and data literacy	3	4	2	3	4	10
Communication and collaboration	5	4	4	5	5	25
Digital content creation	2	3	2	3	3	10
Safety	2	2	3	1	5	35
Problem solving	3	3	4	2	5	20

Note. The authors' own work with fictitious data for teaching purposes. The levels follow the DigComp scale of 1 to 8.

Comprehension questions

1. What does the technology fallacy consist of, and why is it attractive to those who run an MSME?
2. Why does DigComp 2.2 consider the areas of safety and problem solving to be transversal? Propose a workplace example of each one.
3. Which leadership practices do Westerman and his co-authors distinguish, and what do studies of SMEs suggest about the route through which leadership influences digital transformation?
4. What relationship did Edmondson find between psychological safety, learning behavior and the performance of teams? What can leaders do to favor it?
5. How does the analysis of automation by whole occupations differ from the analysis by tasks, and what consequences does each one have for people management?

Application exercises

1. With the data of table 7.2: a) calculate the average level of the team in each area and the gap with respect to the required level; b) obtain the simple average gap and the weighted gap, with the weights expressed as proportions; c) rank the areas by training priority (gap × weight) and compare that order with the one resulting from the simple gap; d) identify the advisor with the largest average individual gap and the area in which they are furthest from the requirement. *Worked solution in Appendix B.*

2. Choose an organization you know (a family business, a public body or your own university) and identify two artifacts, two espoused values and two basic assumptions related to the use of data and technology. Explain which of those assumptions would facilitate and which would hold back a digital transformation project.
3. A municipality on the Ecuadorian coast decided that building permits should be processed online only. The technical staff fear losing control over inspections and many users distrust the digital procedure. Draw up a force field analysis with at least four driving forces and four restraining forces, and propose a specific action for each of Kotter's eight steps.
4. An administrative assistant in a distributor of agricultural supplies works 40 hours a week: typing invoices and delivery notes, 12 h; reconciling collections with bank statements, 8 h; preparing the weekly sales report, 5 h; handling complaints and negotiating terms with customers, 9 h, and coordinating deliveries with carriers when something unexpected happens, 6 h. The company will install tools that will absorb 80% of the hours of typing and reconciliation and 50% of those of the report. a) Classify the tasks as routine and non-routine; b) calculate the hours freed up per week and the percentage of the working week they represent; c) propose new or expanded tasks for that time and state which DigComp areas they would demand. *Worked solution in Appendix B.*

Analysis of the case

1. Which driving and restraining forces were at work in the cooperative before the manager took over the leadership of the project? Classify them according to whether they came from the members, from the staff or from the organization itself.
2. Which steps of Kotter's model were left out in the first launch of the application, and what consequence did each omission have?
3. Why did the commitment not to dismiss anyone and the training of tellers as advisors reduce resistance? Relate the answer to the task approach and to the DigComp areas that the new job requires.
4. What evidence shows that the new way of serving members began to take root in the culture of the cooperative, and which additional indicator would be worth following?

Collaborative activity

1. In teams of four or five students, interview the owner or manager of a local MSME that has introduced a digital tool in the last two years (electronic invoicing, online inventory, virtual store). Reconstruct the process with Lewin's stages and Kotter's steps, identify

the weakest step and propose an improvement. Expected output: a three- to four-page report with the force field analysis, a timeline of the change and a prioritized recommendation.

2. Prepare the presentation of the previous report in two agile cycles of one week, with a visible board of pending, in-progress and finished tasks, and a retrospective at the close of each cycle. Expected output: an image of the board at the end of each cycle and a short record of the two retrospectives with the improvements agreed.

Self-assessment

1. What is meant by the technology fallacy in digital transformation?
   a) The idea that digital technologies do not improve the productivity of MSMEs.
   b) The belief that the challenges posed by technology are solved, above all, by acquiring technology.
   c) The mistake of adopting a technology before the competition does.
   d) The tendency to overestimate the cost of cloud services.
2. In DigComp 2.2, which areas are transversal because they are involved in any digital activity?
   a) Communication and collaboration, together with digital content creation.
   b) Information and data literacy, together with communication and collaboration.
   c) Digital content creation, together with safety.
   d) Safety, together with problem solving.
3. What do studies of SMEs suggest about the effect of digital transformational leadership?
   a) That it influences digital transformation partly through digital capabilities in information technology and in employees.
   b) That its effect disappears when the company formulates a written digital strategy.
   c) That it only has an effect in companies with an IT department of their own.
   d) That it removes the need to train employees in digital skills.

4. According to Schein, which level of organizational culture is the hardest to observe and to change?
   a) Artifacts, such as the layout of the offices or the forms.
   b) The values espoused in the mission statement and in the rules.
   c) The basic assumptions that the group takes for granted.
   d) The digital tools that the staff uses.
5. How did Edmondson define the psychological safety of a team?
   a) As the guarantee of job stability during a change project.
   b) As the shared belief that the team is a safe space for interpersonal risk taking.
   c) As the absence of conflict and disagreement among its members.
   d) As the protection of employees' personal data.
6. A company gets its new ordering system to work, but when the manager changes the staff goes back to the paper order. Which of Kotter's steps was neglected?
   a) Create a sense of urgency.
   b) Build a guiding coalition.
   c) Generate short-term wins.
   d) Anchor the new approaches in the culture.
7. According to the task approach, which kind of activity does automation substitute for most easily?
   a) Those that demand creativity and the solving of new problems.
   b) Interpersonal ones, such as negotiating or handling complaints.
   c) Routine ones, which follow explicit and codifiable procedures.
   d) Whole occupations, without altering the composition of their tasks.
8. In an agile team, what is the purpose of the retrospective?
   a) To review how the team worked during the cycle and agree on improvements for the next one.
   b) To present the finished product of the project to the client.
   c) To determine who was responsible for the errors of the cycle.
   d) To plan in detail every task up to the close of the project.

9. In the DigComp 2.2 framework, a person's proficiency level is defined by
    a) years of experience with computers
    b) the complexity of the task they solve and how autonomously they solve it
    c) the number of tools they can use
    d) the certificate they hold
10. What does psychological safety in a team describe?
    a) That the work is free of physical risk
    b) That the team's data is protected
    c) That people can raise an error or a doubt without fearing a penalty
    d) That employment is stable
11. In Kotter's model, the guiding coalition serves to
    a) replace the management committee
    b) bring together people with real influence from different areas to push the change
    c) document the affected processes
    d) measure the return on investment
12. The evidence on automation and employment presented in the chapter suggests that, in most cases, technology
    a) eliminates whole occupations within a few years
    b) replaces tasks within occupations and shifts work toward other tasks
    c) does not affect the composition of employment
    d) always creates more jobs than it destroys in the same firm

CHAPTER 8.
DIGITAL MATURITY: MODELS, MEASUREMENT AND DIAGNOSIS

When the manager of a micro, small or medium-sized enterprise (MSME) asks how digital the business is, the answer usually takes the form of a list of purchases: a website, electronic invoicing, a cloud accounting system and several social media accounts. That list says little about what the company does with those tools and about whether anyone decides with the data they produce.

This chapter proposes a more rigorous way of answering the question. It starts from the concept of digital maturity, goes through the models that measure it, with their dimensions and levels, and explains how to build a methodologically defensible index from 0 to 100. It then describes the diagnosis step by step, with the case of a wholesale hardware business, and closes with the uses and the limits of these models.

To do so it draws on the definitions of chapter 1 and on the human dimension of chapter 7, and it prepares what follows: the theories of adoption of chapter 9 help to explain why an organization stalls at one level, and the road map of chapter 12 turns the diagnosis into a plan of action.

By the end of this chapter, the reader will be able to:

1. Explain what digital maturity is and tell it apart from the adoption of technologies and from digital readiness.
2. Compare stage models and maturity models according to their approach, their dimensions, their levels and their recommended use.
3. Build a digital maturity index from 0 to 100 that distinguishes formative from reflective indicators and justifies its weighting.
4. Apply a digital maturity diagnosis in an MSME, from the design of the instrument to the feedback of results.
5. Assess critically the uses and the limits of maturity models in the management of digital transformation.

8.1. What digital maturity is and what measuring it is for

In ordinary usage, maturity designates the degree of development reached by a living being. In organizations it indicates how far the capabilities demanded by a management domain, such as quality or projects, have been developed. In the digital domain, Kane et al. (2019)

understand it as the capacity to take advantage of the opportunities opened up by new technologies, and they argue that it depends more on talent, culture and leadership than on technology itself.

Three traits define the concept. Maturity is multidimensional: a company may be advanced in its relationship with customers and behind in the handling of its data. It is relative, because it is judged against a model and against what the environment demands. And it is dynamic, since what looks advanced today will be basic in a few years.

Nor should maturity be confused with the adoption of technologies, which only records whether a tool is used, or with digital readiness. In studying small and medium-sized enterprises (SMEs) in emerging markets, Pingali et al. (2023) define readiness as the firm-wide interpretation of technological disruptions, the agile response to them and the deployment of emerging technologies to manage them, and they describe it as a process that expresses willingness and ability to act. Readiness indicates whether the organization can undertake the change; maturity, how far it has advanced in it.

An example helps to fix the difference. Two car repair shops in Cuenca contract the same work-order management software. In the first one, each order records the parts used, the customer receives a message when their vehicle is ready and the owner reviews every month which services leave the greatest margin; in the second one, the orders are printed and filed. Adoption is identical, but the first shop is more mature, because the technology changed its way of working and of deciding.

Measuring maturity serves, above all, to set a baseline against which to compare progress. It also makes it possible to detect imbalances, such as investing in social media advertising without being able to serve the orders it generates, and to direct scarce resources toward the gaps that constrain the most. In addition, it offers a common language to the owner, to middle managers and to those who finance the company, something valuable in an MSME, where much of the decision making rests on the owner's intuition.

8.2. From stage models to maturity models

8.2.1. The stage hypothesis

One of the classic antecedents is the stage hypothesis of Nolan (1973), formulated from the study of data processing expenditure. According to it, the planning, organization and control of the computing resource change in character over time and follow patterns associated

with four stages of the computing budget: the acquisition of the computer, intense systems development, the proliferation of controls and the orientation toward the user and the service.

The proposal left a lasting lesson: each phase in the use of technology raises different management problems. Its weakness is to assume a single sequence, with one axis and a fixed order, which many MSMEs do not follow: some sell through social media before systematizing their accounting.

8.2.2. Maturity models

Maturity models became popular in software development, with five-level scales for assessing its processes, and they later spread to the management of information technology (IT). In the formulation of Becker et al. (2009), a maturity model is a sequence of levels for a class of objects, usually organizations or processes, that represents an anticipated, desired or typical evolution path in discrete stages: the lowest level corresponds to an initial state with few capabilities and the highest one, to full maturity.

Compared with stage models, maturity models assess several dimensions separately, include an instrument with observable criteria for each level and have a prescriptive intent: they indicate what must be achieved in order to move up a step. The same authors warn that the development of these models has barely been documented and propose a procedure that includes comparing them with existing ones, advancing through iterations and evaluating the result before disseminating it.

Figure 8.1 represents the reference model that will be used in the rest of the chapter: five steps in which each level is defined by what the organization does with the digital, rather than by the tools it owns.

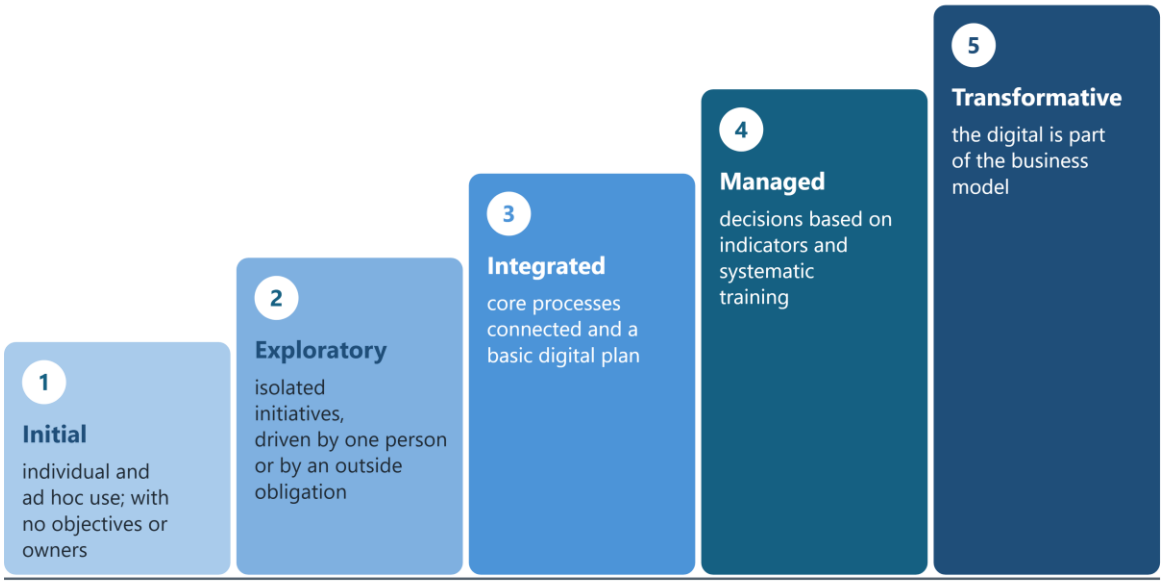
The five levels are described as follows:

- **Initial:** the use of digital tools is individual and ad hoc; there are no objectives or owners, and information lives in notebooks, personal spreadsheets and chats.
- **Exploratory:** isolated initiatives appear, such as a social media page or electronic invoicing, driven by one enthusiastic person or by an external obligation.
- **Integrated:** the core processes are digitalized and connected, there is a basic digital plan and sales and inventory data are consolidated in a single system.
- **Managed:** decisions are supported by indicators reviewed regularly, digital channels are coordinated with operations and training is systematic.
- **Transformative:** the digital is part of the business model; the company experiments continuously, creates value with its data and collaborates with partners in its ecosystem.

The staircase metaphor is useful for teaching, but it suggests that the whole company climbs at once, when the usual situation is to have one foot on the second step and another on the fourth. That is why maturity models score each dimension separately, and some replace the staircase with a map.

Figure 8.1

Levels of digital maturity: a staircase of five steps



Note. The authors' own work.

8.2.3. Beyond the staircase: capability profiles

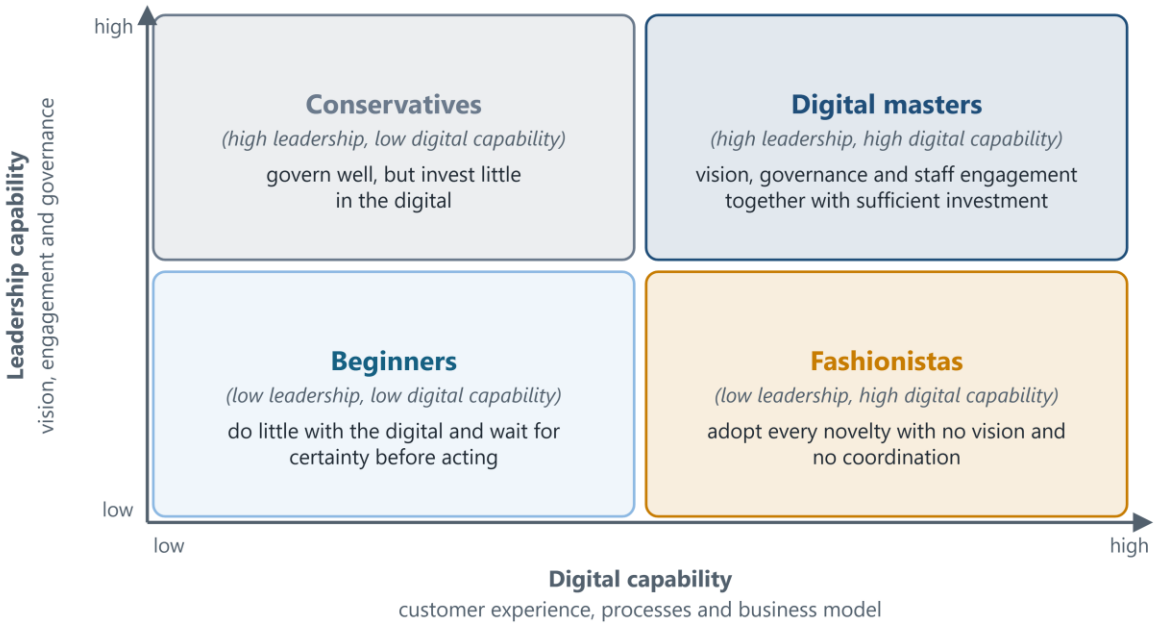
Among the most widespread maps is the matrix of Westerman et al. (2014), which crosses two capabilities. Digital capability answers what is transformed: the customer experience, operational processes and the business model. Leadership capability answers how the change is conducted: with a transformative vision, with the engagement of people and with governance mechanisms that coordinate the initiatives. From their combination arise the four company profiles shown in figure 8.2: beginners, fashionistas, conservatives and digital masters.

Beginners do little with the digital and wait for certainty before acting. Fashionistas adopt every novelty with enthusiasm, but without vision or coordination, and they pile up initiatives that do not change the core of the business, such as the store that opens accounts on every platform without anyone attending to them. Conservatives put prudence before

innovation: they govern well, but they invest little. Digital masters combine vision, governance and staff engagement with sufficient investment, and they turn that combination into a repeatable process.

Figure 8.2

Digital capability and leadership capability: four company profiles



Note. The authors' own work, based on Westerman et al. (2014).

The matrix teaches something the staircase hides: technology without leadership does not produce maturity, and leadership without digital capabilities does not either. Knowing which quadrant an MSME is moving toward helps to decide whether what is urgent is investing in tools or strengthening the conduct of change, a subject chapter 7 dealt with when studying digital leadership.

8.3. Typical dimensions and levels

Which dimensions should a maturity model observe? In his systematic review of digital maturity models, Teichert (2019) found that the dimensions vary greatly from one model to another, that few consider transformation capabilities in addition to digital ones and that organizational culture appears as a dimension of its own only in some of them. He concluded that most of them offer an incomplete picture of digital maturity and that models for service firms are poorly represented.

To widen the technological focus that dominated the models of their time, Schumacher et al. (2016) designed one that assesses the maturity of manufacturing companies with respect to Industry 4.0. Its nine dimensions combine basic enablers (products, customers, operations and technology) with organizational aspects (strategy, leadership, governance, culture and people); each one is assessed with several items, and the whole was tested as a practical tool in companies.

In a Delphi panel with specialists from Morocco, strategy, leadership, technological infrastructure and customer orientation emerged as central components of maturity (Touijer & Elabjani, 2025), and similar dimensions recur in the literature. The reference model of this chapter retains six dimensions, each one associated with a diagnostic question:

- **Strategy:** is there an explicit digital vision, backed by management, with goals, owners and a budget?
- **Customers:** how does the company relate to its customers in digital channels, and what does it know about them?
- **Processes:** what part of the operation is digitalized and integrated, with no manual rework?
- **Technology:** are the infrastructure and the applications adequate, secure and compatible with one another?
- **People and culture:** does the staff have the skills and the disposition to work with digital tools and to keep learning?
- **Data:** are the data reliable and accessible, and are they used to decide?

Each dimension refers back to a chapter of the book: technology to chapter 2, strategy to 3, data to 4, processes to 5, customers to 6 and people to 7. Within each one, the maturity levels take shape in observable descriptors: in data, the initial level corresponds to records scattered in notebooks; the integrated one, to sales and inventories consolidated in a single system, and the transformative one, to models that anticipate demand.

Simpler models have been proposed for small companies. Quenum et al. (2025) observed that the available models fit SMEs poorly because of their particularities of type, sector and location, and they designed a simplified framework with six levels and a self-assessment tool. In the SMEs they studied, in a sparsely urbanized region of Quebec, the beginner level prevailed: small initiatives, with no clear strategy and with processes digitalized only in part. Table 8.1 compares this model with five others.

Table 8.1

Comparison of digital maturity models

Model	Approach	Dimensions	Levels	Recommended use
Nolan's stage hypothesis	Management of the computing resource according to the evolution of the budget	One axis, the computing budget, with planning, organization and control tasks	Four stages	Explaining how an organization learns to manage technology
Matrix of Westerman and colleagues	Digital capability and leadership capability	Two axes: what is transformed and how it is conducted	Four profiles, with no compulsory order	Management conversation and quick positioning of the company
Model of Schumacher and colleagues	Maturity for Industry 4.0 in discrete manufacturing	Nine, technical and organizational	Maturity calculated by dimension from items	Industrial plants planning their digitalization
Model of Quenum and colleagues	Simplified and holistic self-assessment of SMEs	Six, among them technology, culture and strategic planning	Six progressive levels	SMEs in regions with few resources
Road map of Mick and colleagues	Maturity aligned with strategy and sustainability	Six, among them culture, governance and sustainability	Process assessment based on the ISO/IEC 33000 family	Planning a gradual transformation
Reference model of this chapter	Comprehensive diagnosis of MSMEs	Six: strategy, customers, processes, technology, people and data	Five, from initial to transformative	Self-diagnosis, annual follow-up and the basis of the road map

Note. The authors' own work, from the models analyzed in this chapter.

The comparison shows that no model is superior in the abstract: the leadership matrix opens the conversation in the management team, the industrial model fits plants and simplified ones let a small company assess itself without consultants. What is decisive is to choose the model before measuring and to keep it in later measurements. Along those lines, Silva et al. (2023) proposed a standardized set of categories and subcategories that any future model could use to assess the digital transformation of SMEs.

8.4. Building a maturity index

Like every composite index, the digital maturity index (DMI) summarizes in a single figure the position of the organization within the model. Building it requires deciding how the indicators relate to the concept, how much each dimension weighs and on what scale the result is expressed.

8.4.1. Reflective and formative indicators

Maturity is inferred from indicators, and its relationship with them can follow two logics. In the reflective one, the concept causes the indicators: the staff's attitude toward data shows in statements such as "I consult the reports before deciding" or "I trust the figures from the system", which should move together. In the formative one, the indicators make up the concept: digital selling is formed by the online store, the catalog and electronic payments, practices that can occur separately.

The distinction has consequences that Diamantopoulos and Winklhofer (2001) explained clearly. Reflective indicators are interchangeable and removing one does not alter the concept; leaving out a formative indicator, by contrast, amounts to leaving out a part of the concept, and internal consistency tests lose their meaning. To build formative indices, these authors propose specifying the content of the concept, covering it completely with the indicators, watching collinearity among them and checking the external validity of the index.

In reflective scales, internal consistency is indeed a requirement, and it is usually estimated with the alpha coefficient (Cronbach, 1951). A maturity index for management combines both logics: within a dimension, the items may be reflective, if they capture one and the same attitude, or formative, if they list different practices; between dimensions, the logic is formative, because a good score in technology says nothing about the quality of the data and no dimension replaces another.

8.4.2. A scale from 0 to 100, weighting and levels

Items are usually answered on a scale from 1 to 5, with an observable descriptor for each point. The average of the items of a dimension, Mj, is taken to the scale from 0 to 100 through a linear transformation that assigns 0 to the lowest possible value and 100 to the highest one:

$$Pj = (Mj - 1) / 4 \times 100$$

Thus, an average of 3.4 is equivalent to 60 points. The overall index is the weighted mean of the scores of the dimensions, with weights *wj* that add up to 1:

$$DMI = \Sigma\ (wj \times Pj)$$

Equal weights provide transparency; those of a panel of experts, knowledge of the sector, and strategic ones, the priorities of the company: a trading firm may give more weight to customers and a plant, to processes. In any case, the weights are set and declared before applying the instrument and not after the results are known.

Each level of the reference model occupies a band of twenty points: initial, from 0 to under 20; exploratory, from 20 to under 40; integrated, from 40 to under 60; managed, from 60 to under 80, and transformative, from 80 to 100. The cut-offs are a convention, and that is why it is advisable to report the score together with the level: a 41 and a 59 fall in the same band and describe different companies.

The weighted mean also has a known defect: it allows a strong dimension to offset a weak one, and a company with excellent technology and chaotic data can obtain an acceptable index. There are two simple remedies: presenting the index together with the complete maturity profile, for example in a radar chart, and applying the weakest-link rule, according to which the overall level cannot exceed by more than one step that of the lowest dimension. Recalculating with equal weights shows whether the classification is fragile.

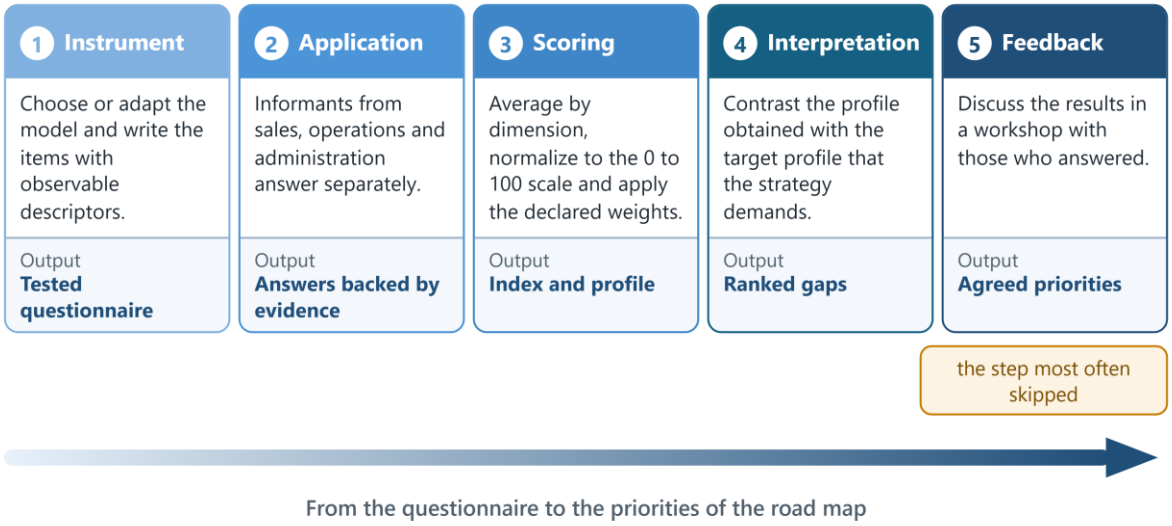
8.5. The diagnosis step by step

A well-conducted maturity diagnosis follows five linked steps, each one with a verifiable output, summarized in figure 8.3:

1. **Instrument:** the model is chosen or adapted, items with observable descriptors are written and the questionnaire is tested with two or three people.
2. **Application:** informants from different areas answer separately and provide evidence of what they state.
3. **Scoring:** the averages per dimension are calculated, normalized, and the index is obtained with the declared weights.
4. **Interpretation:** the profile obtained is contrasted with the target profile that the strategy demands and the gaps that constrain the most are identified.
5. **Feedback:** the results are presented to those who took part and priorities for the road map are agreed.

Figure 8.3

From the questionnaire to the maturity profile: the five steps of the diagnosis



Note. The authors' own work. Every step delivers a verifiable output, so that the next one works on something that can be checked and not on an impression.

The instrument accounts for much of the quality of the diagnosis. A question such as "are data used well in the company?" invites complacent answers; an item that forces a choice between descriptions such as "sales are written down in a notebook" or "a forecasting model guides purchasing" anchors the answer in facts. It is also advisable to avoid items that ask about two aspects at once and to request evidence supporting each answer.

In an MSME, the usual temptation is for the owner alone to answer; the owner knows the business well, but tends to judge it by what was bought rather than by what is used. It is better for people from sales, operations and administration to answer separately and then agree on each score with evidence. The distance between the owner's scores and those of the team is, in itself, a finding, as the case in this section shows.

Interpreting does not consist of celebrating or lamenting a figure. The index is read together with the profile, and both are contrasted with a target profile derived from the strategy: a company that competes on the quality of its service needs more maturity in customers than in automation. The gaps, ordered by their effect on the business, are the raw material of priorities, and a large gap in a secondary dimension can wait.

Feedback closes the cycle and is the step most often skipped. A report sent by email rarely changes anything; a workshop in which participants discuss the results and agree on three to five priorities generates commitment. Mick et al. (2024) place that connection between

diagnosis and plan at the center of their proposal, which integrates the assessment of digital maturity with strategic alignment in order to draw a gradual road map in SMEs, the subject of chapter 12.

Illustrative case: a wholesale hardware business that assesses itself

A wholesale hardware business in Manabí, with two warehouses and around forty employees, supplies small hardware stores across the province. It had already bought an enterprise resource planning system, adopted electronic invoicing and opened social media accounts. When a competitor began receiving orders through an app, the manager, the founder's son, decided to measure the digital maturity of the company with the reference model of this chapter, with equal weights.

He answered alone and obtained 71.7 points, at the managed level. A lecturer from the outreach program of a nearby university suggested repeating the exercise with the warehouse supervisor, two salespeople and the accountant, who answered separately and provided evidence before agreeing on a score per dimension. The new index was 35.8 points, at the exploratory level. The normalized scores were the following:

- Strategy: 70 according to the manager and 25 according to the team.
- Customers: 75 and 45.
- Processes: 65 and 30.
- Technology: 85 and 65.
- People: 65 and 35.
- Data: 70 and 15.

The largest gaps appeared in data, strategy and processes: the salespeople retyped into the system the orders received by phone, the recorded inventory did not match the stock on hand and nobody had digital goals in writing. In the feedback workshop, the manager admitted that he had measured technology purchases and not their use, and the team agreed on three priorities for six months: a single order channel connected to the system, cycle counts of the inventory with barcode readers and a monthly indicators meeting.

8.6. Uses and limits of maturity models

Used well, maturity models serve purposes in three areas. In the company, they organize the conversation about priorities and make it possible to follow progress from one year to the next. With banks or corporate customers, they document the state of the organization. In public

policy, they help to offer support suited to the maturity level of each company, a matter taken up in chapter 10. For SMEs, Pinto and Gonçalves (2026) also propose a self-diagnosis that generates specific recommendations, because the existing models tend to be too generic.

The first limit is the illusion of a point of arrival. The staircase suggests that the task ends on the last step, but what defines the transformative level today will be common practice tomorrow. For Warner and Wäger (2019), digital transformation is a continuous process of strategic renewal in which agility makes it possible to review the business model, collaboration and culture again and again; maturity models must be reviewed with the same regularity.

Another limit arises from self-reporting. When one and the same person answers every question at a single moment, their answers may share biases unrelated to the reality being assessed, such as the wish to give a good impression. Podsakoff et al. (2003) reviewed these sources of common method bias and recommended procedural remedies, such as obtaining the measures from different sources, protecting the anonymity of respondents and taking care with the wording of items; multiple informants and evidence follow that advice.

There is also the risk of false precision. An index with decimals suggests an exactness that the instrument does not have: the difference between 47.3 and 48.1 points falls within the normal variation of a questionnaire. When the score becomes a target, for example by linking it to bonuses, people learn to answer so as to raise the figure instead of improving the practices, and the diagnosis loses its value.

Finally, every model reflects the concerns of its time: the first ones concentrated on infrastructure and current ones incorporate culture, data and, increasingly, sustainability. Tiron-Tudor and Deliu (2025) propose, for example, a maturity model for SMEs that integrates digitalization and sustainability, validated with focus groups. Digital maturity is thus worth as much as it serves the economic, social and environmental objectives of the organization, the subject of chapter 11.

8.7. Chapter summary

Digital maturity describes how far an organization has developed the capabilities that allow it to take advantage of digital technologies in its different dimensions. Measuring it requires an explicit model, an instrument with observable descriptors, an index built with judgment and feedback that turns the result into priorities. None of those elements is neutral, and that is why they must be declared. Chapter 9 will examine why organizations adopt or reject technologies.

- Digital maturity is multidimensional, relative to a model and dynamic; it is not measured by the amount of technology acquired.
- Stage models describe sequences; maturity models add dimensions, instruments and prescriptive intent.
- The matrix of digital capability and leadership capability shows that technology without the conduct of change does not produce maturity.
- In a maturity index, the dimensions work as formative indicators: none replaces another.
- The scale from 0 to 100, the weights and the level cut-offs are set and declared before applying the instrument.
- Multiple informants, evidence and participatory feedback give validity to the diagnosis.
- The results must be read with caution in view of self-reporting, false precision and changes in the environment.

Key terms: *digital maturity, digital readiness, stage model, maturity model, maturity level, maturity profile, composite index, formative indicator, reflective indicator, weighting, weakest-link rule, feedback of results.*

8.8. Exercises and activities

Comprehension questions

1. How do the adoption of a technology, digital readiness and digital maturity differ? Illustrate the answer with a local MSME.
2. What did the stage hypothesis contribute to the study of technology management, and what are its main limitations?
3. Explain three differences between a stage model and a maturity model.
4. Why is it inappropriate to calculate the alpha coefficient on a set of formative indicators?
5. Describe the four profiles of the matrix of digital capability and leadership capability, and state what a conservative company needs in order to become a digital master.

Application exercises

1. A distributor of agricultural supplies in the province of Los Ríos applied an instrument with five dimensions, with items from 1 to 5, and obtained these averages and weights: strategy, 2.2 (weight 0.25); customers, 3.4 (0.20); processes, 2.6 (0.20); technology, 3.8 (0.15), and people, 1.6 (0.20). a) Normalize each average to the scale from 0 to 100. b) Calculate the weighted index and classify the level with the cut-offs of section 8.4. c)

Recalculate the index with equal weights and apply the weakest-link rule. d) Compare the effect on the index of raising the average of people or that of technology by 0.8 points. *Worked solution in Appendix B.*

2. Write three items for the data dimension, each one with five observable descriptors, and explain why the question "are data used well in the company?" is a poor item.
3. Classify each set of indicators as reflective or formative and justify which quality test applies in each case: a) "every order is recorded in the system", "there is an online store" and "electronic payments are accepted"; b) "I trust the reports from the system", "I consult the data before deciding" and "I prefer to decide with figures rather than with intuition".
4. Choose one of the models of table 8.1 for a medium-sized shrimp farm in the province of El Oro and another one for a savings and credit cooperative, and justify each choice according to the purpose of the diagnosis.

Analysis of the case

1. Why did the manager's score exceed that of the team by more than thirty points? Relate the answer to the biases of self-reporting.
2. In which quadrant of figure 8.2 would the hardware business be placed before the diagnosis? Justify with the data of the case.
3. Apply the weakest-link rule to the team's scores. Does the classification of the company change?
4. Do the three agreed priorities respond to the largest gaps? Propose a follow-up indicator for each one.

Collaborative activity

1. In teams of three or four students, adapt the reference model to a local MSME: write two items with descriptors per dimension, apply the instrument to three informants from the company and calculate the index. Expected output: a two-page feedback report with the profile by dimension, the index, the level and three justified priorities.
2. Debate as a group whether a public support program for MSMEs should allocate its funds according to the maturity level of the companies. Expected output: a one-page record with the arguments for and against and a reasoned recommendation.

Self-assessment

1. What best describes the digital maturity of an organization?
   a) The number of technologies it has acquired in recent years.
   b) The degree to which it has developed capabilities to take advantage of the digital in its different dimensions.
   c) The share of its sales made through online channels.
   d) The willingness of its staff to use email.
2. In Nolan's hypothesis, the stages of the management of the computing resource are associated with the evolution of:
   a) the market share of the company.
   b) the number of employees in the IT department.
   c) the satisfaction of internal users.
   d) the computing budget.
3. In the matrix of digital capability and leadership capability, a company with numerous digital initiatives but no vision or governance to coordinate them corresponds to the profile of:
   a) fashionistas.
   b) beginners.
   c) conservatives.
   d) digital masters.
4. If one of the formative indicators of an index is removed:
   a) the concept does not change, because the indicators are interchangeable.
   b) the internal consistency of the index increases.
   c) a part of the concept to be measured is left out.
   d) it becomes possible to calculate the alpha coefficient.
5. If the average of a dimension is 2.8 on a scale from 1 to 5, its normalized score from 0 to 100 is:
   a) 56.
   b) 45.
   c) 70.
   d) 28.

6. What problem does the weighted mean present as a rule for aggregating a maturity index?
   a) It allows a strong dimension to offset a weak one.
   b) It forces equal weights to be used for every dimension.
   c) It prevents the result from being expressed on a scale from 0 to 100.
   d) It requires every indicator to be reflective.
7. What is the most appropriate practice in the application step of a diagnosis in an MSME?
   a) That only the owner answers, because they know the whole company.
   b) That an external consultant completes the questionnaire without consulting the staff.
   c) That a single employee chosen at random answers.
   d) That informants from several areas answer separately and then agree on scores with evidence.
8. What function does the feedback of results perform?
   a) Publishing a ranking of the staff according to their answers.
   b) Repeating the survey until the index goes up.
   c) Discussing the results with the participants and agreeing on priorities for the road map.
   d) Sending the final report by email so it can be filed.
9. What distinguishes a maturity model from a classic stage model?
   a) The maturity model describes several dimensions and allows uneven profiles
   b) The stage model is more recent
   c) The maturity model only applies to large firms
   d) The stage model uses formative indicators
10. In a composite index built with formative indicators, removing one dimension
   a) does not affect the meaning of the index
   b) changes the concept the index measures
   c) always improves reliability
   d) requires recomputing Cronbach's alpha

11. Applied to a maturity diagnosis, the weakest-link rule recommends
    a) investing first where the firm is already strong
    b) averaging the dimensions and acting on the average
    c) addressing the most lagging dimension first, because it holds the rest back
    d) discarding the dimensions with low scores

12. What is the main risk of reporting the result of a diagnosis as a single number?
    a) That the firm will not understand the scale
    b) That the information about which dimension to improve is lost
    c) That the calculation is wrong
    d) That the number cannot be compared with other firms

CHAPTER 9.
TECHNOLOGY ADOPTION: THEORIES AND FACTORS

A bakery in Portoviejo installed a point-of-sale system with cloud inventory in order to control waste and product turnover. Six months later, the owner discovered that the cashiers were still writing sales down in a notebook and that the system served, in practice, only to print receipts. The subscription was paid every month, but the business worked just as before. Scenes like this raise the question that organizes this chapter: why a technology is adopted, used only halfway or abandoned, and why its use does not always translate into better results.

The previous chapters defined digital transformation (chapter 1), described the technologies that support it (chapter 2) and proposed ways of measuring digital maturity (chapter 8). This chapter brings together the theories that explain adoption at three levels (the person, the social group and the organization) and adds a fourth question: which resources and capabilities make it possible to turn use into performance.

For whoever runs a company, these theories have a concrete use, because they separate problems that look alike on the surface. The complaint that "the staff does not want to use the system" may hide a tool that is hard to handle, a benefit that nobody has seen, an unstable connection or a badly designed incentive, and each cause calls for a different response. The chapter closes with the case of a dental clinic appraising an online appointment system and with exercises on an acceptance survey and a diffusion curve.

By the end of this chapter, the reader will be able to:

1. Distinguish between the adoption, the use, the assimilation and the value of a technology, and explain why it may be abandoned after being adopted.
2. Apply the technology acceptance model (TAM) and the unified theory of acceptance and use of technology (UTAUT) to the diagnosis of users' disposition toward a system.
3. Analyze the diffusion of an innovation from its perceived attributes, from the decision process and from the adoption curve.
4. Assess with the technology, organization and environment (TOE) framework the factors that favor or hinder adoption in an organization.
5. Relate the resource-based view and dynamic capabilities to the conversion of technology use into performance.

9.1. Why a technology is adopted or abandoned

It is worth distinguishing four moments that everyday speech confuses. *Adoption* is the decision to bring in a technology; *use*, its effective employment in the tasks; *assimilation*, the point at which that use becomes routine and no longer depends on reminders; *value*, the improvement of the processes or of the results. An association of cocoa growers that hands tablets to its technicians adopts on the day of the purchase, uses when every visit is recorded, assimilates when the reports for the buyer come out of those records without being retyped, and obtains value if the rejected lots decrease.

Abandonment is the other side of adoption. For Rogers (2003), discontinuance is the rejection of an innovation that has already been adopted, and it occurs by replacement, when it is replaced by a better alternative, or by disenchantment, when its performance disappoints. A transport company that swaps its desktop accounting software for a cloud service abandons by replacement; another one that removes satellite tracking from its trucks because the drivers kept disconnecting it abandons by disenchantment. The first case usually reflects learning; the second, a problem of fit or of support that nobody addressed in time.

Not every adoption springs from a free choice. When a tax rule requires electronic receipts to be issued or a supermarket chain requires its suppliers to use its ordering portal, the decision comes from outside and the relevant question becomes how deep the use will be. In micro, small and medium-sized enterprises (MSMEs), whoever decides on the purchase is usually also one of the main users, and their perceptions count twice. A failed adoption, moreover, costs them proportionally more, because it consumes scarce money and the team's willingness to try again.

These distinctions explain why the label "resistance to change" is of little use as a diagnosis. It names the symptom and hides the cause, which may lie in the person, in the technology, in the organization or in its environment. In Brazilian micro and small firms, Machado Becker et al. (2026) identified technical, social, organizational and environmental factors that work as barriers or as enablers, and they observed that firms improving in several of those dimensions at once are more likely to sustain the transformation.

9.2. Individual level: the technology acceptance model (TAM) and UTAUT

9.2.1. The technology acceptance model

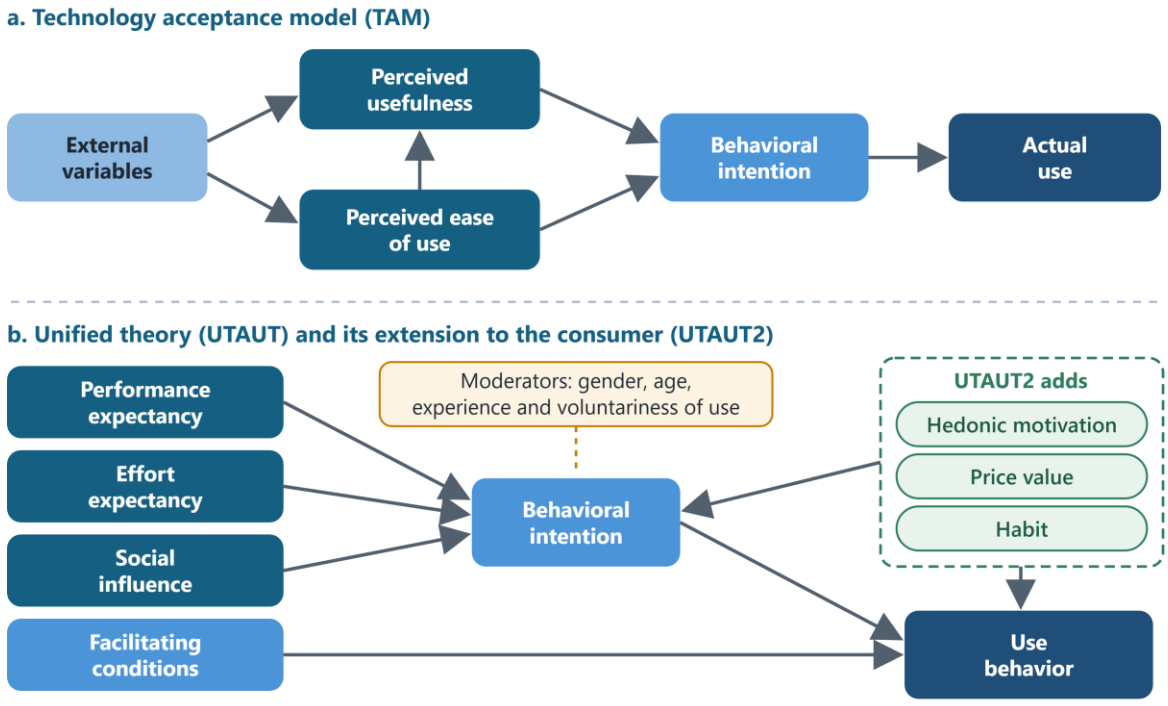
The individual approach starts from a simple question: why a person accepts or rejects a system. Davis (1989) proposed answering it with two beliefs of the user. Perceived usefulness

is the degree to which someone believes that using a system will improve their job performance; perceived ease of use, the degree to which they believe that using it will be free of effort. On them the technology acceptance model (TAM) was built.

Both beliefs are related to each other and to behavior. External variables, such as training, the design of the screens or technical support, influence them; ease of use raises perceived usefulness, because a simple system yields more for the same effort, and the two beliefs lead to the intention to use, the antechamber of actual use. In the original work, Davis (1989) found that usefulness was associated with use more strongly than ease, and that the latter seemed to act above all through the former. Figure 9.1 gathers the model and the extensions of subsection 9.2.2.

Figure 9.1

The technology acceptance model and its extensions



Note. The authors' own work, based on Davis (1989), Venkatesh et al. (2003) and Venkatesh et al. (2012).

For management, the model offers a quick diagnosis. If a group perceives usefulness and still finds the system difficult, it is worth investing in training, initial support and simpler screens; if the group finds it easy but of little use, the problem lies in the process or in the way the benefit is shown, and more training will not solve it. Its limits are also well known: it

measures perceptions at a given moment, with self-reported questionnaires; it assumes that use is voluntary; it says little about what to change in the system, and it takes for granted that the stated intention translates into use.

9.2.2. The unified theory and its extension to the consumer

Extensions of the model multiplied until Venkatesh et al. (2003) compared eight theories, among them TAM and the diffusion of innovations, and integrated them into the unified theory of acceptance and use of technology (UTAUT). In it, performance expectancy, effort expectancy and social influence determine intention, and facilitating conditions act directly on use. Gender, age, experience and voluntariness of use moderate those relationships; social influence, for example, weighs more when use is mandatory.

That facilitating conditions act on use without going through intention means that a convinced employee will not be able to use the system if the connection goes down, if they have no equipment or if nobody answers their questions. For the consumer context, Venkatesh et al. (2012) extended the model (UTAUT2) with hedonic motivation, that is, the enjoyment of using the technology; price value, which compares benefits and monetary cost; and habit. Those factors help to explain why one patient books from their phone and another prefers to call.

9.3. Diffusion of innovations

While acceptance models look at the person, diffusion theory looks at the group. Rogers (2003) defines diffusion as the process by which an innovation is communicated, through certain channels and over time, among the members of a social system. An innovation is any idea, practice or object that the adopter perceives as new. Novelty is therefore relative, and cloud inventory can be an innovation for a spare parts store in a small canton even if it is commonplace in large cities.

According to this theory, the speed with which an innovation is adopted depends largely on five attributes perceived by potential adopters:

- *Relative advantage*: the degree to which the innovation is perceived as better than the practice it replaces, whether in cost, time, convenience or reputation.
- *Compatibility*: consistency with the values, previous experiences and needs of potential adopters; a payment system that does not allow buying on credit clashes with the practice of many neighborhood stores.
- *Complexity*: the perceived difficulty of understanding and using it.

- *Trialability*: the option of experimenting with it on a small scale, such as a free month or a pilot in a single branch.
- *Observability*: the degree to which its results are visible to others; payments with quick response (QR) codes spread among neighboring stores because everyone sees how they work.

Two of these attributes overlap with the constructs of the previous section. Relative advantage resembles perceived usefulness, and complexity is the opposite of ease of use; UTAUT, in fact, placed the former among the roots of performance expectancy and the latter among those of effort expectancy (Venkatesh et al., 2003). What diffusion adds are three attributes on which the manager can act: compatibility, by adapting the technology to local practices; trialability, with pilots; and observability, by showing concrete results.

Each adopter goes through a decision process in five stages: knowledge, persuasion, decision, implementation and confirmation. During implementation, reinvention usually appears, which consists of adapting the innovation to unforeseen purposes, as the restaurant does when it sends the menu of the day from its booking system. In confirmation, the person looks for arguments supporting what was decided and may reverse it; that is where the abandonment described in section 9.1 arises. In organizations, the process begins by matching a problem with an innovation and continues with a mutual adjustment between the innovation and the structure, until the novelty becomes routine (Rogers, 2003).

If the moment when each member of a system adopts is recorded, cumulative adoption draws an S-shaped curve: a slow start, an acceleration when opinion leaders adopt, those whom others consult, and a final saturation. According to how soon they take up the innovation, adopters are classified as innovators, early adopters, early majority, late majority and laggards. Rogers (2003) himself warns, however, against the pro-innovation bias, the assumption that every innovation should spread. The shopkeeper who does not take QR payments because sales are low and customers pay in cash may be deciding wisely.

9.4. Organizational level: the technology, organization and environment (TOE) framework

In an organization, adoption happens in two moments: someone with authority decides to invest and, afterwards, each person accepts, adapts or avoids the technology. The previous models explain above all the second moment. For the first one, the technology-organization-environment (TOE) framework of Tornatzky and Fleischer (1990) proposes that the decision to adopt an innovation depends on three contexts that interact. The framework does not set in

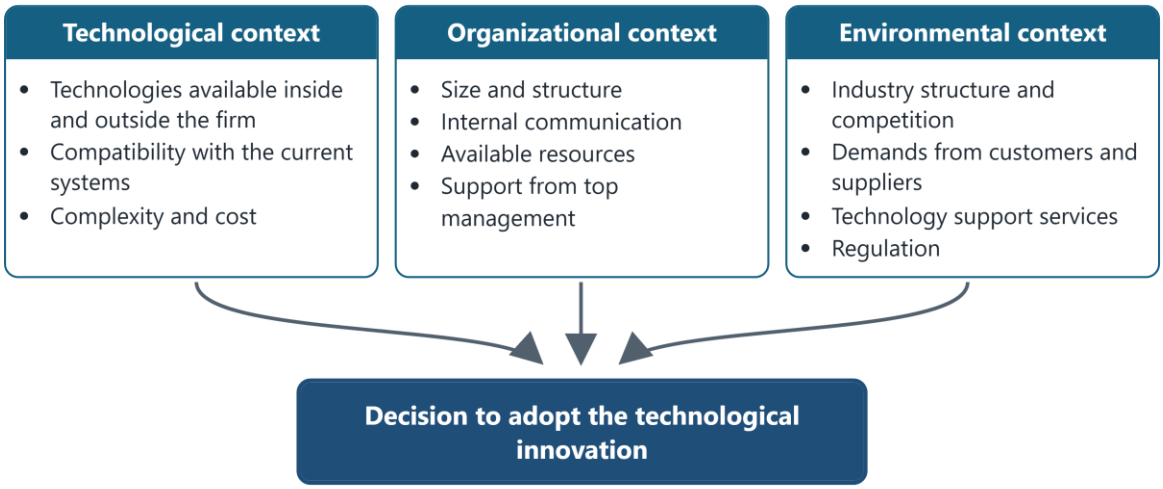
advance which variables to include, and that openness has made it possible to apply it to technologies as different as electronic data interchange and cloud computing.

Figure 9.2 arranges the three contexts and the factors usually examined in each one:

- *Technological context*: the technologies available inside and outside the firm and their characteristics, such as compatibility with the current systems, complexity and cost.
- *Organizational context*: size, structure, internal communication mechanisms, available resources and support from top management.
- *Environmental context*: industry structure and competition, the demands of customers and suppliers, the supply of technology support services and regulation.

Figure 9.2

The technology, organization and environment (TOE) framework



Note. The authors' own work, based on Tornatzky and Fleischer (1990).

For small organizations, Iacovou et al. (1995) proposed, on the basis of electronic data interchange, a model with three factors: perceived benefits; organizational readiness, understood as the availability of financial and technological resources; and external pressure from competitors and trading partners. That pressure weighs more on the small firm because of its weak position in the market, and benefits tend to remain limited because the technology is little used and is not integrated with the other systems. The supermarket supplier of section 9.1 runs into that ceiling if it retypes the orders from the portal.

Recent evidence supports the idea that the three contexts act together. In Vietnamese small and medium-sized enterprises, Hoang (2024) found that the adoption of digital transformation depends on technological factors, such as cybersecurity and the ability to integrate

systems; organizational ones, such as top management support and corporate governance; and environmental ones, such as the relationship with customers and partners. In the cocoa association of section 9.1, the buyer demands traceability and the board drives the change, but the lack of mobile coverage on the farms may stall the whole project.

The flexibility of the framework has a cost. Since it does not specify relationships between factors, each study fills it with different variables and its results are hard to compare. After reviewing systematic mappings on small and medium-sized enterprises in developing countries, Díaz-Arancibia et al. (2025) conclude that TAM and TOE are only partially effective and that they often fail to capture the sociocultural complexities of resource-scarce settings. Traits that are frequent in the region, such as informality, trust in personal networks or family ownership, tend to be left out of those models; chapter 10 takes them up when studying the barriers facing the MSME.

9.5. Resources and capabilities: the resource-based view and dynamic capabilities

9.5.1. The resource-based view

The previous theories explain why a technology is adopted; the resource-based view asks why some firms get more out of it than others. For Barney (1991), a sustained competitive advantage requires resources that are valuable, rare, hard to imitate and without equivalent substitutes. Imitation is made difficult by the unique history of the resource, by ambiguity about what makes it work or by its social complexity. According to the author himself, computing equipment bought on the market is imitable, whereas a system interwoven with the way a company decides is far less so.

Research in information systems later developed that idea. Wade and Hulland (2004) distinguished outside-in resources, such as the management of external relationships and market responsiveness; spanning resources, such as the partnership between the IT department and the business; and inside-out resources, such as infrastructure and technical skills. They also insisted that these resources rarely act alone and that their effect on performance depends on their combination with others.

9.5.2. Dynamic capabilities

The resources that give an advantage today may lose value tomorrow, and the question then shifts to the capacity to renew them. With that concern, Teece et al. (1997) defined dynamic capabilities as the firm’s ability to integrate, build and reconfigure internal and external

competences in the face of rapidly changing environments. According to them, the possibilities of a firm depend on its coordination processes, on the position of its assets and on its path. A cooperative that for decades served customers only at the counter, for example, does not develop the capability to design digital services overnight.

A decade later, Teece (2007) broke those capabilities down into three groups of activities: sensing opportunities and threats, seizing them by mobilizing resources and reconfiguring tangible and intangible assets to sustain competitiveness. In a neighborhood pastry shop, sensing may mean noticing that customers order more often through messaging; seizing, deciding on a modest investment in an ordering system and reviewing the prices of home delivery; reconfiguring, reassigning duties so that someone handles the online orders and arranging deliveries with couriers.

A reading closer to practice is that of Eisenhardt and Martin (2000), for whom dynamic capabilities are identifiable processes, such as product development or alliance formation, that share features across firms, in the manner of best practices. The advantage therefore lies less in the capability itself than in the resource configurations built with it. An MSME can cultivate those capabilities with explicit habits, such as reviewing customer data every month or evaluating each pilot before extending it.

9.6. From use to value: technology and firm performance

That a technology is used daily does not guarantee that it improves results. Chapter 1 explained that technology pays off when it is combined with organizational change and that its benefits take time; what matters here are the mechanisms. Brynjolfsson and Hitt (2000) argue that the greatest benefits of information technology (IT) appear when the investment is accompanied by complementary changes in processes, work practices and organization, and that a good part of them consists of intangible improvements in convenience, timeliness, quality or variety. Since those improvements escape conventional measurements, an evaluation that counts only visible savings may underestimate a project that is on the right track.

The integrative model of Melville et al. (2004), which chapter 1 presented as a chain of resources, processes and performance, also serves to locate where value gets stuck. If IT resources are not combined with complementary organizational resources, such as structure, work practices or culture, processes barely change; if processes improve while trading partners remain unintegrated or the conditions of the country prevent it, the improvement may not carry over to the performance of the organization. It is therefore advisable to measure first in the processes: in a clinic, no-shows or waiting time; afterwards, profitability.

From the resource-based view, Bharadwaj (2000) understood IT capability as the ability to mobilize and combine technological infrastructure, IT human resources and intangible assets that technology makes possible, such as customer orientation or accumulated knowledge. In her study, firms with high capability outperformed a comparison group in profitability and cost indicators. For an MSME, the implication is that a modest infrastructure can pay off handsomely if it is handled by people who know the customers and can read the data.

In Latin America, the environment that the integrative model places on the periphery often weighs as much as internal resources. In a study of MSMEs in a vulnerable district of Cali, Londoño-Cardozo et al. (2025) found that innovation was the most developed dynamic capability, while integration and reconfiguration lagged behind. The highest levels were associated with formalization, the age of the business, the age of the entrepreneur and access to credit. Turning use into value therefore requires resources that the company does not always control; chapter 10 examines the external support that can make up for some of them.

Seen as a whole, the theories of the chapter answer complementary questions and can be used in sequence within a single project. The TOE framework helps to decide whether the conditions for adopting exist; diffusion guides the rollout with pilots and opinion leaders; TAM and UTAUT make it possible to monitor the acceptance of each group; the resource-based view and dynamic capabilities indicate which complements to build; and the integrative model points out where to measure. Table 9.1 compares these approaches, and the illustrative case that follows makes it possible to apply them to a concrete decision.

Table 9.1

Comparison of the theories on the adoption and the value of technology

Theory	Level	Key variables	Question it answers	Limitations
Technology acceptance model (TAM)	Individual	Perceived usefulness, perceived ease of use, intention to use	Why does a person accept or reject a system?	It measures perceptions at a given moment; it assumes voluntary use; it gives little guidance for redesign
UTAUT and UTAUT2	Individual: employee or consumer	Performance and effort expectancy, social influence, facilitating conditions; in UTAUT2, hedonic motivation, price and habit	What explains intention and use, and on whom does each factor weigh most?	Many variables and moderators; it demands large samples; it remains centered on the individual
Diffusion of innovations	Individual and social system	Relative advantage, compatibility, complexity, trialability, observability	How and at what pace does an innovation spread in a group?	Pro-innovation bias; it describes voluntary adoption better than imposed adoption
TOE framework	Organization	Technological, organizational and environmental contexts	Which conditions lead a company to adopt a technology?	It does not define relationships between factors; results are hard to compare across studies
Resource-based view	Firm	Resources that are valuable, rare, hard to imitate and without substitutes	Which resources sustain a competitive advantage?	A static approach; it does not explain how resources are created or renewed
Dynamic capabilities	Firm in changing environments	Sensing, seizing and reconfiguring	How does a firm renew its resources when the environment changes?	Hard to measure; risk of circular explanations

Theory	Level	Key variables	Question it answers	Limitations
Integrative model of IT business value	Processes and firm	IT resources, complementary resources, business processes, environment	How and where is the use of technology turned into performance?	It requires process data; the effects take time to appear

Note. The authors' own work.

Illustrative case: a dental clinic appraising an online appointment system

A dental clinic in La Libertad, in the province of Santa Elena, operates in two locations with eight dentists and four people at the front desk. Appointments are written down in notebooks and confirmed by phone; no-shows and double bookings irritate patients and leave chairs empty. The owner, who also treats patients, is appraising an online appointment system paid for by monthly subscription, which allows booking from a phone and sends automatic reminders.

The provider offered three weeks of free trial at the main location. The front desk staff acknowledged that the system avoided clashes of schedules, but they complained about cluttered screens and about having to register twice those who called by phone. Several dentists found the tool simple, although they did not see what they gained from it: they feared losing control of their schedule and preferred to keep fitting in trusted patients on their own. Younger patients booked at night without difficulty; older ones kept calling.

At the second location, the internet connection goes down frequently. Two clinics in the area already offer online booking, and the personal data protection law demands special care with health information. The owner finds the subscription reasonable if no-shows fall, but she does not want to pay for a system that the staff avoids. Before deciding whether to adopt it in both locations, only in the main one or later on, she asked for a short acceptance questionnaire to be given to those who took part in the pilot.

9.7. Chapter summary

Adopting a technology is the beginning of a journey that passes through use, assimilation into routines and, if conditions allow, the improvement of results. Each theory in the chapter sheds light on one stretch of that journey, and none is enough on its own. These are the key ideas of the chapter:

- Adoption is only the initial decision: use, assimilation and value are different stages, and an adopted technology may be abandoned by replacement or by disenchantment.
- At the individual level, perceived usefulness and ease of use explain much of the intention; UTAUT adds social influence and facilitating conditions, and UTAUT2, hedonic motivation, price value and habit.
- Diffusion depends on relative advantage, compatibility, complexity, trialability and observability, and it advances along an S-curve through networks and opinion leaders.
- In the organization, the TOE framework organizes the technological, organizational and environmental factors; in the small firm, internal readiness and pressure from customers and partners weigh heavily.
- Technology bought on the market is imitable; lasting advantage comes from combinations that are hard to copy and from the capacity to sense, seize and reconfigure.
- Value appears first in the processes and depends on complementary resources and on the environment; its financial appraisal is addressed in chapter 12.

Key terms: *technology adoption, assimilation, discontinuance, perceived usefulness, perceived ease of use, facilitating conditions, diffusion of innovations, adoption curve, TOE framework, resource-based view, dynamic capabilities, IT business value.*

9.8. Exercises and activities

Comprehension questions

1. How do the adoption, the use, the assimilation and the value of a technology differ, and what example from an MSME illustrates each moment?
2. What relationship does the technology acceptance model propose between perceived ease of use, perceived usefulness and intention to use?
3. Why, in UTAUT, do facilitating conditions influence use directly, and what does this imply for a company with poor connectivity?
4. Which are the five attributes of an innovation that, according to diffusion theory, explain its speed of adoption, and on which of them can the manager act?
5. Why, according to the resource-based view, does technology bought on the market hardly sustain a competitive advantage, and what makes a resource hard to imitate?

Application exercises

1. At the close of the pilot in the illustrative case, the clinic applied a TAM questionnaire with a scale from 1 (strongly disagree) to 5 (strongly agree). The means were: front

desk (n = 4), usefulness 4.4, ease 2.7 and intention 3.0; dentists (n = 8), usefulness 3.2, ease 3.8 and intention 3.1; patients (n = 88), usefulness 4.1, ease 3.6 and intention 3.9. The clinic considers a mean of 3.5 or more acceptable. Calculate the weighted means of each construct and the gap of each group with respect to the threshold, explain why the overall average may hide the problem and propose a priority action for each group. *Worked solution in Appendix B.*

2. An association of shopkeepers in a coastal canton recorded the year in which each of its 200 affiliated stores began taking payments with a QR code (hypothetical data): 2018, 4 stores; 2019, 10; 2020, 26; 2021, 44; 2022, 52; 2023, 34; 2024, 20; 2025, 10. Calculate cumulative adoption and its percentage in each year, identify the year with the most new adoptions and the one in which more than half of the stores was passed, and explain the shape of the curve with diffusion theory. *Worked solution in Appendix B.*
3. Choose an MSME from the student's province and a technology it is considering, such as electronic invoicing, an online store or cloud inventory. Build a TOE matrix with two enablers and two barriers per context, and conclude whether it is advisable to adopt now, to start with a pilot or to postpone the decision.
4. A distributor of agricultural supplies has three resources: the license of a cloud management system, a database of customers and crops built over ten years and a team of salespeople who interpret those data to recommend products. Apply to each resource the criteria of value, rarity, difficulty of imitation and absence of substitutes, and state which one could sustain a competitive advantage and why.

Analysis of the case

1. With the technology acceptance model, which belief limits acceptance in each group of the pilot (front desk, dentists and patients), and which facts of the case show it?
2. Which facts of the case correspond to the technological, organizational and environmental contexts of the TOE framework, and which of them weighs most in the decision about the second location?
3. Which attributes of the innovation did the pilot take advantage of, which one should be strengthened in order to convince the dentists and with what concrete action?
4. From the resource-based view, can the appointment system give the clinic a lasting advantage over the two competing clinics? Which complementary resources would it have to develop for the use to translate into better results?

Collaborative activity

1. In groups of three or four students, choose a technology that a local MSME has brought in over the last two years, interview the person in charge and two users, and reconstruct the move from adoption to use, assimilation and value. Expected output: a two-page report identifying at which moment the problems appeared and which theory of the chapter explains them best.
2. With the same technology, adapt a questionnaire of eight to ten items on perceived usefulness, perceived ease of use and intention to use, apply it with informed consent to at least ten users and calculate the mean of each construct. Expected output: the instrument, a table of results and a prioritized proposal of actions.

Self-assessment

1. A flower shop stops using its online store because orders arrived with errors and customers complained. According to diffusion theory, this is:
   a) A mandatory adoption
   b) Discontinuance by replacement
   c) Discontinuance by disenchantment
   d) A reinvention of the innovation
2. In the technology acceptance model, perceived usefulness is:
   a) The degree to which a person believes that using a system will improve their job performance
   b) The degree to which a person believes that using a system will be free of effort
   c) The frequency with which a person uses a system during the working day
   d) The opinion of colleagues about how advisable it is to use a system
3. In UTAUT, which determinant acts directly on use, without going through intention?
   a) Performance expectancy
   b) Effort expectancy
   c) Social influence
   d) Facilitating conditions

4. A provider of accounting software offers a free month so that MSMEs can try the system before paying. Which attribute of the innovation does it take advantage of?
   a) Observability
   b) Trialability
   c) Compatibility
   d) Relative advantage
5. In the TOE framework, the demand of a large customer to work with its ordering portal corresponds to the context that is:
   a) Technological, because it involves using a new system
   b) Environmental, because the pressure comes from a trading partner
   c) Organizational, because it forces internal processes to change
   d) Individual, because each employee decides whether to use the portal
6. According to the resource-based view, which of these resources is most likely to sustain a competitive advantage?
   a) State-of-the-art computing equipment
   b) A subscription to cloud accounting software
   c) A high-speed internet connection
   d) The way the staff combines customer data with its knowledge of the business
7. A distributor notices that its customers are beginning to place orders through messaging apps and decides to study that change. In terms of dynamic capabilities, that activity corresponds to:
   a) Sensing opportunities and threats
   b) Seizing opportunities through investment
   c) Reconfiguring assets and structures
   d) Protecting valuable resources against imitation
8. According to the integrative model of IT business value, where is it advisable to measure the effect of a new technology first?
   a) In the annual profitability of the company
   b) In the market value of the company
   c) In the performance of the business processes that the technology modifies
   d) In the number of licenses acquired

9. In the technology acceptance model, the two central determinants of the intention to use are
    a) price and brand
    b) perceived usefulness and perceived ease of use
    c) competitive pressure and government support
    d) infrastructure and firm size
10. The TOE framework differs from TAM mainly because
    a) it came first
    b) it explains adoption in the organization, also considering the context and the environment
    c) it only applies to hardware
    d) it cannot be tested empirically
11. A firm buys a management system and uses it only for invoicing, without changing the rest of its processes. In the terms of the chapter, there is adoption but not
    a) intention to use
    b) assimilation
    c) discontinuance
    d) diffusion
12. From the resource-based view, a technology available on the market to anyone
    a) generates sustainable competitive advantage on its own
    b) does not generate sustainable advantage unless combined with resources that are hard to imitate
    c) always reduces performance
    d) replaces dynamic capabilities

CHAPTER 10.
DIGITAL TRANSFORMATION IN MSMES AND IN EMERGING ECONOMIES

Much of the models reviewed in the previous chapters was built by observing large companies in advanced economies, with their own IT departments and technology budgets. The typical firm in Ecuador and in Latin America is, by contrast, a micro or small enterprise, often family owned, whose owner serves the customers and keeps the accounts. The Organisation for Economic Co-operation and Development (OECD) warns that SMEs lag behind in digital transformation and that this distance widens the inequalities between people, territories and firms (OECD, 2021).

This chapter argues that digitalizing an MSME demands a logic of its own, which is not a miniature version of the corporate one. In the small firm the starting point, the resources and the way of deciding are different; in emerging economies, moreover, the shortcomings in connectivity, financing and institutions fall more heavily on those who cannot offset them. That is why low digitalization tends to perpetuate itself when nobody intervenes, and effective responses are usually gradual, frugal and shared with other actors.

The route starts with the traits of the MSME (10.1) and with the digital divide in three levels (10.2). The Latin American and Ecuadorian context follows (10.3), then the barriers, their vicious circle and frugal solutions (10.4), the staged routes (10.5) and the support ecosystem (10.6), which closes with the case of an association of craftswomen. Basic definitions refer back to chapter 1; the theories of adoption, to chapter 9; digital maturity, to chapter 8, and financial appraisal, to chapter 12.

By the end of this chapter, the reader will be able to:

1. Characterize the traits of the MSME that condition the scope and the pace of its digitalization.
2. Distinguish the three levels of the digital divide (access, use and outcomes) and apply them to the diagnosis of a company.
3. Analyze the traits of the Latin American and Ecuadorian context that favor or hinder the digital transformation of smaller firms.
4. Explain the vicious circle of low digitalization and propose frugal solutions for breaking it.
5. Design a staged digitalization route that takes advantage of the support of the State, universities, trade associations and intermediaries.

10.1. Traits of the MSME that condition its digitalization

In Ecuador, the size of a company is defined by the number of people employed and by annual sales, according to the stratification adopted in the Andean Community; this is how the microenterprise, the small firm and the medium-sized firm are distinguished, grouped under the acronym MSME. Under it coexist a neighborhood store that barely covers household expenses and a medium-sized agricultural exporter with an accountant and customers in other countries; it is therefore more useful to speak of frequent traits than of a single profile.

Above all, digitalization goes through the owner: it depends on what the owner knows, on what they fear and on the time left once the store closes, and there is rarely an IT department to put initiatives forward. In studying entrepreneurs of SMEs with limited resources who turned to cross-border electronic commerce, Li et al. (2018) describe how the entrepreneur renews their way of understanding the business, widens their relationships, builds a team and develops organizational capabilities with the backing of the platform provider.

A second trait is the lack of slack. Every dollar devoted to technology competes with inventory, payroll or the loan installment, and a wrong purchase can compromise several months of cash flow. Money, even so, does not exhaust the question: in a survey of SMEs, Eller et al. (2020) found that information technology infrastructure, the skills of employees and digital strategy are positively related to digitalization, and that digitalization is associated with financial performance.

The third trait is dependence on the environment. According to the OECD, SMEs find it harder than large companies to hire and retain qualified staff and depend more on external sources of knowledge, even though they are less well integrated into the networks that generate it (OECD, 2019). Read through the technology, organization and environment (TOE) framework of chapter 9, these traits show that in the MSME the organizational side is concentrated in one person and the external side weighs more than in a large company. In exchange, the MSME has in its favor closeness to the customer and speed in deciding.

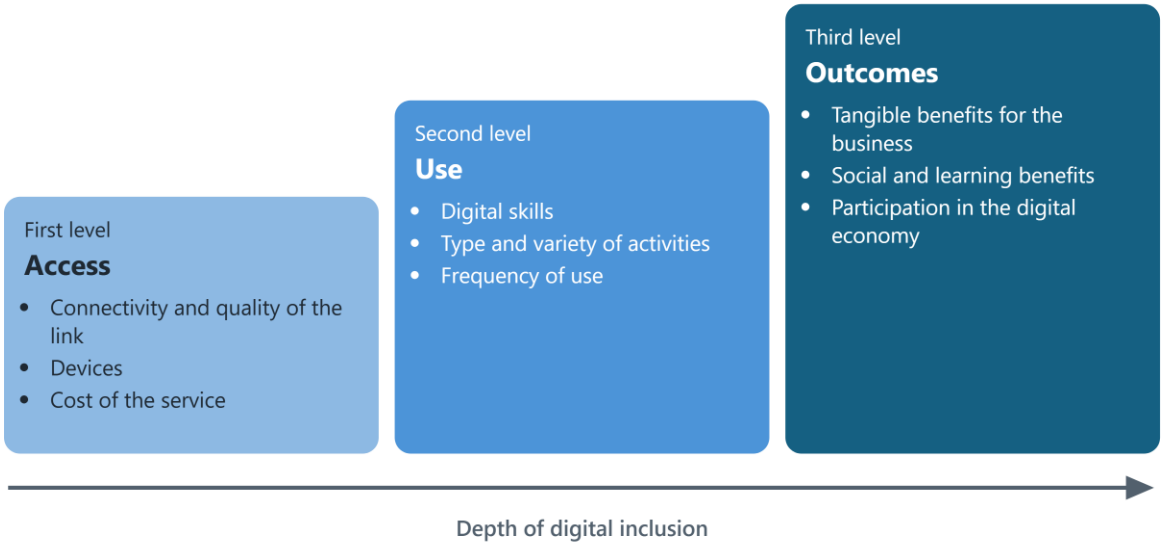
10.2. The digital divide: access, use and outcomes

The expression digital divide was born to separate those who had access to the internet from those who did not, a binary reading that soon fell short. After asking internet users to search for different contents, Hargittai (2002) found considerable differences in their ability to find them and in the time they took, and called those differences of skill among people who already had a connection a second-level divide.

Later research organized the problem as a sequence. For van Dijk (2020), full access to digital media is built in stages (motivation, material access, skills and use), and its unequal outcomes tend to reinforce prior social inequalities. From that sequence follow the three levels of figure 10.1: access, which covers connectivity, devices and cost; use, which depends on skills and on the type of activities, and outcomes, measured by the tangible benefits obtained.

Figure 10.1

Three levels of the digital divide



Note. The authors' own work, based on van Dijk (2020).

Applied to the firm, the distinction sharpens the diagnosis. Two carpentry workshops in Riobamba may have the same phone and the same data plan; one uses messaging to greet its customers and the other receives orders, collects deposits by transfer and schedules the week's jobs: what separates them is use. The first level, however, still weighs outside the cities, because the place of residence marks differences of access between urban and rural households (Comisión Económica para América Latina & el Caribe, 2022), and in the countryside the business usually depends on the owner's personal phone.

A further nuance affects emerging economies head-on. According to Hilbert (2016), structural shortcomings in infrastructure, resources and institutions aggravate in those countries the problems of privacy and talent scarcity associated with large volumes of data, and the result is a new divide: that of using data-based knowledge to decide. An MSME may sell online every day without knowing which products leave it a margin, because its data remain scattered between chats and notebooks.

The outcomes divide explains why extending coverage is not enough. The World Bank showed that digital dividends fell short of expectations wherever analog complements were missing: rules that allow competition, skills for taking advantage of technology and institutions that are accountable (World Bank, 2016). In an MSME those complements are concrete: an orderly process before automating it, a bank account for receiving payments or a passable road for delivering what was sold online.

10.3. Latin America and Ecuador: traits of the context

The most persistent trait of the region is structural heterogeneity, studied for decades by the Economic Commission for Latin America and the Caribbean (ECLAC): alongside firms close to the international productive frontier survives a multitude of small units with low productivity. Digitalization follows that pattern, with a long tail of lagging firms made up above all of MSMEs and traditional, vulnerable businesses, with lower productivity and greater informality (Comisión Económica para América Latina & el Caribe, 2021).

The COVID-19 pandemic worked as a stress test. Digital technologies sustained part of the activity, but access gaps limited the reach of the responses, and it became plain that many firms connected to the internet, above all SMEs, had not brought technology into their purchasing or their sales channels (Comisión Económica para América Latina & el Caribe, 2020). Many microenterprises began to sell through messaging apps more out of necessity than out of strategy; it remains to be seen how many turned that urgency into a lasting change.

The emerging context imposes limits and, at the same time, changes the return of certain investments. With data from firm surveys in numerous countries, Heredia et al. (2022) found that digital capabilities improve performance only through technological capabilities, and that the indirect effect of digital skills is greater in economies with lower human development. Investing in skills would thus pay off more in less developed contexts, provided that it translates into capabilities to produce and sell better.

Ecuador shares these traits and adds others of its own. The Constitution recognizes the popular and solidarity economy, and for many associations and cooperatives digitalization is, of necessity, a collective project. In regulatory terms, the Ley Orgánica de Emprendimiento e Innovación created a framework of support with new corporate forms, such as the simplified joint-stock company, and financing mechanisms such as crowdfunding platforms (Asamblea Nacional del Ecuador, 2020).

It is also worth acknowledging a limit of the available knowledge. In reviewing the statistics on the use of digital technologies in Ecuadorian firms, Dini et al. (2021) warned that

the official survey analyzed covered only medium-sized and large companies, so its results do not extend to micro and small ones. That gap advises caution when generalizing and gives value to the local diagnoses of chapter 8, especially when they are carried out by universities and trade associations in their own territory.

10.4. Barriers and the vicious circle of low digitalization; frugal solutions

10.4.1. The most frequent barriers

The barriers facing MSMEs recur in the literature. With an assessment based on fuzzy logic, Restrepo-Morales et al. (2024) identified as the main obstacles of SMEs the lack of financial resources, high investment costs, resistance from workers, the shortage of qualified staff, unfamiliarity with technology providers, information security requirements and the absence of a culture oriented to digital transformation. They can be grouped into families that table 10.1 takes up later: knowledge, skills, finance, infrastructure, rules, trust and organizational culture.

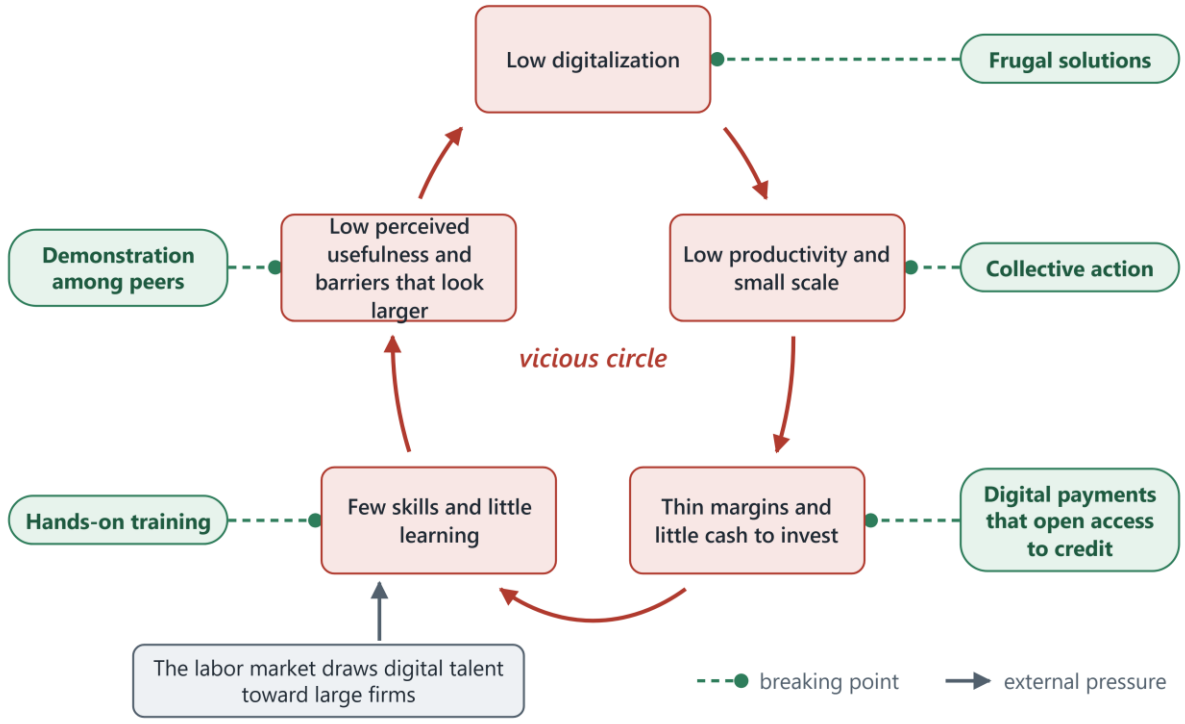
Not all firms perceive those barriers with the same intensity. In MSMEs of the cultural and creative industries of the Basque Country, Eguia et al. (2025) found that the least digitalized ones feel more strongly the lack of information about appropriate technologies, the shortage of qualified staff and the low priority of the subject, while collaboration with other entities and public assistance are associated with greater digitalization and with a lower perception of the obstacles. The craft work of the final case belongs to that creative field.

10.4.2. A circle that feeds itself

The barriers are linked in the vicious circle of figure 10.2. Low digitalization translates into low productivity and small scale, and from that follow thin margins and little cash to invest. Without that investment there are few skills and little learning about technology; perceived usefulness stays low, barriers look larger and the firm returns to the low digitalization of the start. The labor market aggravates the link of skills, since it pays better those with greater digital capabilities and draws them toward large companies (Comisión Económica para América Latina & el Caribe, 2021).

Figure 10.2

The vicious circle of low digitalization and how to break it



Note. The authors' own work.

Breaking the circle requires acting at several points at once. In micro and small firms of southern Brazil, Machado Becker et al. (2026) observed that those improving simultaneously in the technical, social, organizational and environmental dimensions were more likely to sustain their transformation. Figure 10.2 places a breaking point at each link: frugal solutions act on low digitalization; collective action, on small scale, because it brings several firms together; digital payments that open access to credit, on the lack of cash; hands-on training, on skills, and demonstration among peers, on perceived usefulness.

10.4.3. Frugal solutions

Frugal innovation designs solutions with scarce resources: it concentrates on the essential function, costs little, is easy to use and adapts to the existing way of working. For SMEs in emerging countries, Rossit and Bidanda (2026) propose a step-by-step frugal methodology that, unlike maturity models demanding full integration and high costs, prioritizes critical processes, uses technologies the staff already knows and is implemented in modules; with it, an Argentine SME quickly improved the management of its inventory.

Frugal does not mean improvised. A spreadsheet shared in the cloud, with defined columns and someone responsible for updating it, solves the inventory of a grocery store better than an expensive system that nobody feeds. Digital payments show the reach of these solutions: in informal firms of Asia and Africa, Khan (2025) found that mobile money facilitates the move toward financial inclusion based on deposits and credit. The record of collections, moreover, helps to prove ability to pay before a cooperative.

10.5. Staged digitalization routes

If the barriers reinforce one another, the answer will hardly be a single leap. For Dini et al. (2021), digitalization does not follow predefined patterns and has no optimal path: the changes are gradual, can be analyzed in stages and depend on the sector, the firm, the technology and the environment. A staged route is, then, a reasoned sequence of steps adjusted to each case; the maturity diagnosis of chapter 8 locates the starting point and the route organizes what follows.

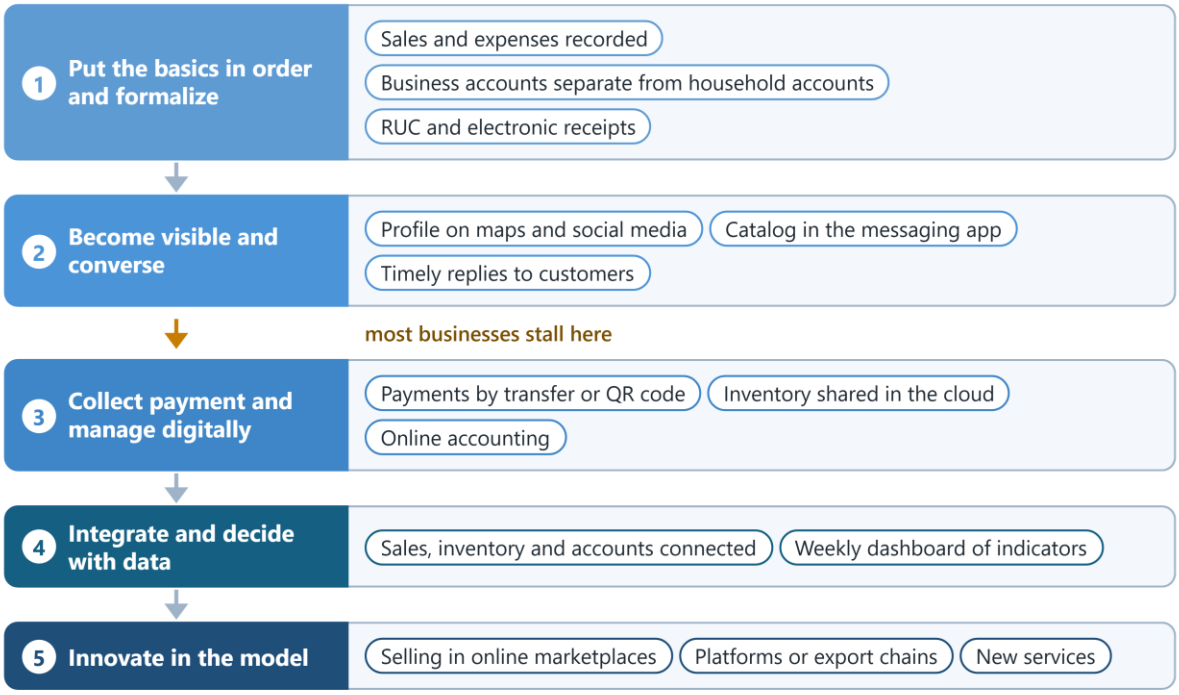
A useful reference comes from a project supporting manufacturing SMEs in southern Italy, a region of low digital maturity. On that basis, Garzoni et al. (2020) propose four levels of engagement with digital technologies: digital awareness, when the firm recognizes what technology can do for it; digital enquiry, when it looks for information and appraises tools; digital collaboration, when it works with other actors in order to bring them in, and digital transformation, when it integrates them into its processes and its business model.

On those foundations, a typical route for an MSME in the region has five stages, ordered in figure 10.3:

1. Put the basics in order and formalize: record sales and expenses, separate the accounts of the business from those of the household, obtain the Registro Único de Contribuyentes (RUC) and issue electronic receipts (chapter 5).
2. Become visible and converse: a profile on maps and social media, messaging with a catalog and timely replies to customers.
3. Collect payment and manage digitally: payments by transfer or QR code, inventory shared in the cloud and online accounting.
4. Integrate and decide with data: connect sales, inventory and accounts, and review a simple dashboard of indicators every week (chapter 4).
5. Innovate in the model: sell in online marketplaces, join platforms or export chains and offer new services (chapters 3 and 6).

Figure 10.3

A stage-based digitalization route for an MSME



Note. The authors' own work. The sequence is not rigid and every company enters where its diagnosis places it; the move from the second to the third stage is the one most businesses leave pending.

The sequence is not rigid. An association may sell in an online marketplace before digitalizing its accounting, but the lack of a base will show up in lost orders or inventories that do not add up; that is why the first stage deals with order before technology. The synthesis of Díaz-Arancibia et al. (2025) on SMEs in developing countries is consistent with that gradual approach: social media and the cloud bring immediate value, while advanced technologies unfold their potential in the supply chain and in data-based processes.

The most common risk is getting stuck at the second stage, because posting on social media is easy and visible, while collecting, recording and integrating demand discipline. Support must therefore change with the stage: a talk is enough to get started, but not to integrate data. ECLAC formulates it as a progression of enablers that runs from knowledge and consideration to access and adoption, then to application and use and, at the end, to transformation at scale (Comisión Económica para América Latina & el Caribe, 2021).

10.6. The support ecosystem: government, universities and intermediaries

No MSME digitalizes on its own, even if it looks that way from behind the counter. With a participatory concept mapping, Pelletier and Cloutier (2019) showed that entrepreneurs, information technology professionals and socioeconomic support professionals perceive differently the problems of adopting off-the-shelf applications in very small firms, applications that may be free but are not free of complications. The authors stress relational capital and the need for a shared understanding among those actors.

10.6.1. The State and local governments

States have tried out numerous support programs. According to the review by Ramdani et al. (2022), these facilitate the digital transformation of SMEs through financing, training, infrastructure, a favorable regulatory framework and knowledge networks, but they tend to be short-lived and to lack follow-up, so that their results remain unknown; that review, moreover, found no documented programs in Latin America and the Caribbean. The authors call for programs oriented to quality rather than to subsidies, stable in the face of changes in technology or in authorities, and monitored.

The design of that support runs into the heterogeneity of MSMEs. As Dini et al. (2021) warn, measures that are the same for every firm are not neutral, since they favor the firms, sectors and territories that already have better capabilities; the sensible course is to differentiate the instruments and bring them closer to the territory. In Ecuador, the decentralized autonomous governments (GAD), in particular the provincial and the rural parish ones, have competences in productive development and usually know which village lacks a signal or which association needs to sell online.

10.6.2. Universities, trade associations and intermediaries

Universities contribute diagnosis, training and applied research, and in Ecuador they reach MSMEs through community outreach and pre-professional internships. Their risk is that the projects end with the semester. Among the experiences reviewed by Casalet (2018), the German Industry 4.0 platform brought together the public sector, large and small firms, trade unions, universities and research centers in interinstitutional working groups that produced studies, guides and support instruments.

Between the firm and the rest of the ecosystem operate the intermediaries: trade associations, cooperatives, technology centers and digital innovation hubs. For winegrowing in northern Chile, in the Atacama Desert, Kalverkamp et al. (2024) propose a hub of this kind as

a neutral point of contact with respect to providers, one that informs, raises awareness and trains SMEs while taking cultural traits such as uncertainty avoidance into account. Neutrality counts: whoever sells a piece of software rarely advises against buying it.

What distinguishes an effective intermediary are its capabilities. In a region of Finland, Hafeez et al. (2025) identified three: sensing opportunities to create digital solutions for problems of the ecosystem which, along the way, digitalize SMEs; designing business models together with the customers, suppliers and even competitors of those firms, and renewing the ecosystem with bridges to others and with international good practices. In Ecuador, those functions could be taken on by provincial chambers, cooperatives or university transfer centers with stable staff and a clear mandate.

Table 10.1 crosses the barriers of section 10.4 with the responses each actor can offer. Read by rows, it shows that no barrier is resolved from a single cell; read by columns, that every actor has something to contribute. In the same direction, the OECD examines how the integration of SMEs into networks of production, of knowledge and innovation and of skills development allows them to benefit from the transformations under way (OECD, 2023).

Table 10.1

Typical barriers to the digitalization of MSMEs and possible responses by actor

Barrier	Firm	Trade association	University	State and local governments
Unfamiliarity with tools and benefits	Visiting peer businesses that already use them	Fairs and demonstrations among members	Diagnoses and awareness workshops	Guidance portals and one-stop shops
Insufficient digital skills	Appointing and training a digital owner	Shared training and peer mentoring	Internships and outreach projects	Certified technical training
Initial cost and access to credit	Starting with pay-per-use services	Joint purchases of equipment and licenses	Support for appraising the investment	Co-financing and development credit
Poor or expensive connectivity	Tools that work offline	Negotiation of collective tariffs	Coverage maps and community networks	Infrastructure in underserved areas
Informality and administrative procedures	Step-by-step formalization: RUC and electronic receipts	Support with procedures	Accounting and legal clinics	Simple online procedures

Barrier	Firm	Trade association	University	State and local governments
Distrust and security risks	Basic cybersecurity practices (chapter 11)	Fraud alerts and verified providers	Simple guides and drills	Data and consumer protection
Low priority and scarce time of the owner	A short road map with priorities	Technical assistance on the premises	Support from students	Technology extension programs

Note. The authors' own work.

Illustrative case: an association of toquilla straw weavers that sells online

In a rural community on the Ecuadorian coast, an association of twenty-three weavers produces hats, bags and fans of paja toquilla (toquilla straw), a craft whose traditional weaving UNESCO recognizes as intangible cultural heritage. For years it sold almost everything to a middleman who set the prices and paid late. During the pandemic, the daughter of one member opened a social media account with photographs of the pieces; orders arrived from Quito and from abroad, but there was no way to collect payment or pack them, the inventory was kept from memory and messages waited for days.

With an outreach project of a university and the backing of the parish government, the association drew a staged route. First it put the basics in order: prices calculated from weaving hours, an inventory shared in the cloud and the RUC for issuing electronic receipts. It then opened a messaging account with a catalog and QR code payments linked to its account in a savings and credit cooperative. A year later it listed its best pieces in an online handicraft marketplace with international payments; it dropped, by contrast, a custom-built online store whose monthly fee it could not sustain.

Two years later, direct sales grew and the price per piece improved, although the middleman kept buying the simpler pieces. Tensions arose: the older weavers felt that the young digital manager concentrated information and power, the signal reached only the community hall and returns from abroad over sizing problems caused losses. The board is now discussing whether to pay the manager a fixed salary or a commission per sale.

10.7. Chapter summary

The digital transformation of an MSME obeys a logic of its own, marked by the centrality of the owner, the lack of slack and dependence on the environment. In emerging economies such as the Ecuadorian one, that logic collides with gaps in access, use and outcomes that overlap with productive heterogeneity and tend to form a vicious circle. The key ideas of the chapter are the following:

- The MSME is not a large company in miniature: its digitalization depends on the owner, on resources with no slack and on external networks of knowledge and talent.
- The digital divide has three levels; closing the access divide does not guarantee use or, even less, outcomes, which require analog complements.
- In Latin America, the digital divide among firms follows the pattern of productive heterogeneity, and in Ecuador data on micro and small firms are missing.
- The barriers are linked in a vicious circle that is only broken by acting at several points at once.
- Frugal solutions, centered on the essential function and on familiar technologies, make it possible to start small and obtain early results.
- Digitalization advances through reasoned stages and needs a coordinated ecosystem of the State, local governments, universities, trade associations and intermediaries.

Key terms: *MSME, digital divide, access divide, second-level divide, outcomes divide, analog complements, structural heterogeneity, vicious circle of low digitalization, frugal innovation, staged digitalization route, innovation intermediary, digital innovation hub.*

10.8. Exercises and activities

Comprehension questions

1. Explain why the centrality of the owner can speed up or hold back the digitalization of an MSME, with an example of each situation.
2. Distinguish the three levels of the digital divide and propose, for each one, an indicator that can be observed in a small company.
3. What does it mean to say that the digital divide among Latin American firms follows the pattern of productive heterogeneity?
4. Describe the links of the vicious circle of figure 10.2 and explain why it is advisable to act on several of them at once.

5. How does a frugal solution differ from a merely cheap one? Illustrate the difference with an inventory or a payment process.

Application exercises

1. A trade association of small shops in a canton of the highlands brought thirty members together in a diagnostic workshop. Each barrier received an average score for frequency (*F*: 1 = almost no firm faces it; 5 = almost all do) and another for impact (*I*: 1 = minor nuisance; 5 = prevents progress): insufficient digital skills (*F* = 4.4; *I* = 4.0); lack of time of the owner (*F* = 4.1; *I* = 3.4); unstable connectivity (*F* = 3.6; *I* = 3.5); initial cost of equipment and software (*F* = 2.5; *I* = 4.2); distrust of online payments (*F* = 3.5; *I* = 2.3); tax informality (*F* = 1.8; *I* = 4.6), and customers' rejection of the digital channel (*F* = 1.9; *I* = 2.1). a) Calculate the priority $P = F \times I$ of each barrier and rank them from highest to lowest. b) Place each barrier in a four-quadrant matrix with 3.0 as the cut-off on both axes. c) Compare the ranking by *P* with the reading by quadrants and propose which actor from table 10.1 should lead the response to the two priority barriers. *Worked solution in Appendix B.*
2. A weaver of the association in the case sells a standard woven hat to the middleman for USD 22. In an online marketplace, the same hat sells for USD 48; the platform charges a commission of 15% on the price, packaging costs USD 2.50 per unit and the association retains a contribution of 5% of the price to finance digital management; shipping is paid by the buyer. a) Calculate the net income per hat in each channel and the percentage difference. b) Calculate how many hats a month must be sold online to match the income of selling ten hats a month to the middleman. c) Point out two costs or risks that the calculation does not include. *Worked solution in Appendix B.*
3. Diagnose, through a thirty-minute interview with the owner of a nearby MSME, their situation at the three levels of the digital divide. Prepare a guide of eight questions, record concrete evidence (equipment, tools, uses and results) and hand in a one-page report with two frugal recommendations.
4. Design a five-stage route for a neighborhood artisanal ice cream shop that today sells only over the counter and writes down event orders in a notebook. For each stage, state the objective, a frugal tool, an indicator of progress and the ecosystem actor that could support it.

Analysis of the case

1. Identify in the case the manifestations of the three levels of the digital divide and justify which one most limited the use made of the online channel.
2. Which barriers from table 10.1 did the association face, and which actor responded to each one? Point out the barriers that went unanswered.
3. Assess the decision to drop the custom-built online store from the logic of frugal solutions, and analyze the risks of depending on an online marketplace owned by others (see chapter 3).
4. Propose the next stage of the association's route, with two follow-up indicators, and a way of paying the digital manager that does not concentrate information or power.

Collaborative activity

1. In teams of four people, draw up a map of the ecosystem supporting the digitalization of MSMEs in the canton or the province: public bodies, local governments, universities, trade associations, cooperatives, technology providers and intermediaries. Contrast the map with table 10.1, identify two gaps and propose a joint initiative to cover them. Expected output: a map of actors on one sheet and a two-page proposal with owners, resources and outcome indicators.
2. Organize a two-hour digital clinic with three MSMEs from the area: each team serves one company, applies the three-level diagnosis and delivers a frugal recommendation with its estimated cost. Expected output: three service records and a one-page group reflection on what was learned.

Self-assessment

1. Which of the following situations illustrates the second-level digital divide?
   a) A store in a village with no mobile phone coverage.
   b) A workshop with a good connection whose owner only uses messaging to chat.
   c) A company that sells online but does not improve its margin.
   d) A business that cannot afford a data plan.

2. According to section 10.1, what explains why the decision to digitalize depends so much on a single person in the MSME?
   a) The obligation to issue electronic receipts.
   b) The heterogeneity of the sector the company belongs to.
   c) The pressure of foreign competitors.
   d) The centrality of the owner in decisions.
3. In the vicious circle of low digitalization, what happens to the perceived usefulness of technology when there is no investment in training?
   a) It stays low, because no skills are built and nothing is learned about what technology contributes.
   b) It increases, because the company saves resources it can devote to other purposes.
   c) It stops influencing the decision to adopt new tools.
   d) It depends solely on the price of the equipment.
4. Which trait best defines a frugal solution?
   a) It is the cheapest option on the market, even if it does not solve the main problem.
   b) It requires integrating every process of the company before starting.
   c) It concentrates on the essential function, costs little and adapts to the existing way of working.
   d) It can only be developed by a specialized technology provider.
5. According to section 10.6, why are support measures that are the same for every MSME not neutral?
   a) Because they are more expensive to administer than differentiated measures.
   b) Because they favor the firms and territories that already have better capabilities.
   c) Because they only reach organizations of the popular and solidarity economy.
   d) Because they are designed exclusively by local governments.
6. In the four levels of engagement described in section 10.5, which one corresponds to a firm that looks for information and appraises tools for its needs?
   a) Digital awareness.
   b) Digital collaboration.
   c) Digital transformation.
   d) Digital enquiry.

7. What function does a digital innovation hub perform for SMEs?
   a) Guiding SMEs as a neutral point of contact with respect to providers.
   b) Selling software at a discount to its members.
   c) Granting unsecured loans so that SMEs can buy equipment.
   d) Replacing the trade association in representing firms before the State.
8. Which frequent weakness of public programs supporting the digitalization of SMEs does the review cited in section 10.6 highlight?
   a) They last too long and turn out to be rigid for small firms.
   b) They are concentrated above all in the countries of Latin America and the Caribbean.
   c) They are short-lived and lack follow-up, so their results remain unknown.
   d) They finance only advanced and expensive technologies.
9. The second-level digital divide refers to
   a) the lack of network coverage
   b) differences in skills and in uses among those who already have access
   c) the price of devices
   d) the absence of regulation
10. The vicious circle of low digitalization describes that
   a) the firm invests and gets no return
   b) low productivity limits investment, and the lack of investment keeps productivity low
   c) suppliers charge small firms more
   d) competition prevents raising prices
11. A staged digitalization path for a micro firm should start with
   a) implementing a full ERP
   b) putting the sales and inventory record and electronic invoicing in order
   c) contracting predictive analytics
   d) opening its own online store

12. What role does an innovation intermediary play in the support ecosystem?
    a) Financing equipment purchases
    b) Translating the firm's need into an available solution and accompanying its incorporation
    c) Regulating the market of providers
    d) Certifying software quality

CHAPTER 11.
GOVERNANCE, ETHICS, CYBERSECURITY AND THE REGULATORY FRAMEWORK

The previous chapters showed how digital technologies create value. Those same technologies also create new exposures: a store that sells online holds the names, phone numbers and addresses of its customers; a cooperative that uses an algorithm to pre-approve loans decides about specific people; a company that moves its accounting to the cloud depends on providers it does not control. If nobody defines who decides, who protects and who answers, those exposures pile up until they surface as incidents, penalties or lost customers.

That less visible side was already on the academic agenda: in reviewing the literature, Vial (2019) describes digital transformation as a process whose outcomes may be positive or negative, and proposes addressing ethical questions as an important line of future research. The chapter takes up that warning from a management standpoint and deals with the governance of technology, cybersecurity according to the framework of the National Institute of Standards and Technology of the United States (NIST), the protection of personal data, the ethics of artificial intelligence (AI), trust and sustainability.

The approach is managerial. Without replacing legal advice or the work of a security specialist, the text offers whoever runs an MSME, or an area of a larger organization, criteria for asking the right questions, assigning responsibilities and prioritizing controls.

By the end of this chapter, the reader will be able to:

1. Explain the governance of technology as a system of decision rights and responsibilities that guides digital transformation.
2. Describe the usual threats and the six functions of the NIST Cybersecurity Framework 2.0, and prioritize risks from their likelihood and their impact.
3. Identify the principles, the rights and the obligations that the Ley Orgánica de Protección de Datos Personales establishes for whoever processes personal data in Ecuador.
4. Apply ethical principles of artificial intelligence through control questions in business decisions.
5. Assess trust, privacy and environmental sustainability as conditions for digital transformation to generate lasting value.

11.1. Governance of technology and of the transformation

Governing technology and managing it are different tasks. In the classic definition of Weill and Ross (2004), the governance of information technology (IT) specifies the decision rights and the accountability framework that encourage desirable behavior in the use of technology. Management, by contrast, resolves every day which equipment is bought, which provider is hired or which failure is fixed first. Governance does not take those decisions for the managers; it determines who takes them, with what criteria and to whom they are accountable for the results.

The same authors distinguish five decision domains (the principles that set what technology is used for, architecture, infrastructure, business application needs and investment with its prioritization) and six archetypes for distributing power over them. In the business monarchy the executives decide and in the IT monarchy, the technology managers; in the feudal model, each unit decides on its own; the federal one combines the center with the units; the duopoly joins IT with another group, and in anarchy each user acts freely.

The archetypes are easy to recognize in an MSME. When the owner decides alone, in a miniature business monarchy, purchases are usually coherent, although they depend on the owner's time and knowledge. When each area contracts its own application, the model becomes feudal: sales ends up with one system, accounting with another and the warehouse with a spreadsheet that nobody reconciles, while passwords circulate through messaging apps. That disorder is rarely deliberate; it appears when it has not been defined whose job it is to decide.

Digital transformation takes these decisions beyond the IT department. An online sales channel or a dashboard of indicators cuts across several areas, and someone must answer for each digital product, maintain the shared components and prevent every initiative from building its own island. To that end, Ross et al. (2019) propose an accountability framework that assigns accountability for digital offerings and components, so that teams gain autonomy without losing coherence with the whole.

In practice, an MSME can start governing its technology by answering four questions in writing:

- Who approves the purchase or the contracting of a technology, and with what criteria?
- Who answers for each system and for the data it contains?
- How are investments prioritized when the budget does not cover all of them?
- How often and with which indicators are the results and the risks reviewed?

Those answers are supported by simple mechanisms: a monthly committee made up of the owner and, if there is one, an external advisor; a register of systems, providers and owners, and an acceptable use policy known to all the staff. On these agreements rest the data governance dealt with in chapter 4 and cybersecurity.

11.2. Cybersecurity: threats and the NIST 2.0 framework

11.2.1. What is protected and against what threats

Chapter 2 presented cybersecurity as a baseline condition; here it is addressed as a matter of risk management. Its object is to preserve three properties of information: confidentiality, which reserves access to those who are authorized; integrity, which prevents improper alterations, and availability, which guarantees access when it is needed. The Ley Orgánica para la Transformación Digital y Audiovisual defines digital security as a state of confidence in the digital environment, resulting from the application of proactive and reactive measures against risks (Asamblea Nacional del Ecuador, 2023).

The threats an MSME faces are usually familiar: identity spoofing by email or messaging (phishing) to steal credentials, ransomware that encrypts the files and demands a ransom, the exploitation of unpatched software, password theft, the loss of unencrypted devices, internal mistakes and incidents that arrive through a provider. Assuming that a small company is of no interest to anyone is a mistake: automated attacks scan the network looking for any vulnerable system, regardless of its size.

Three concepts organize this picture. A threat is an event capable of causing damage; a vulnerability, the weakness that allows that damage to occur, such as an unpatched add-on or a reused password; risk combines the likelihood that the threat exploits the vulnerability with the impact it would have. In MSMEs, assessing that risk runs into a familiar obstacle: the resources and the experience to assess cyber risks and apply preventive measures are often missing, while digitalization raises exposure by increasing connectivity and dependence on software (OECD, 2021).

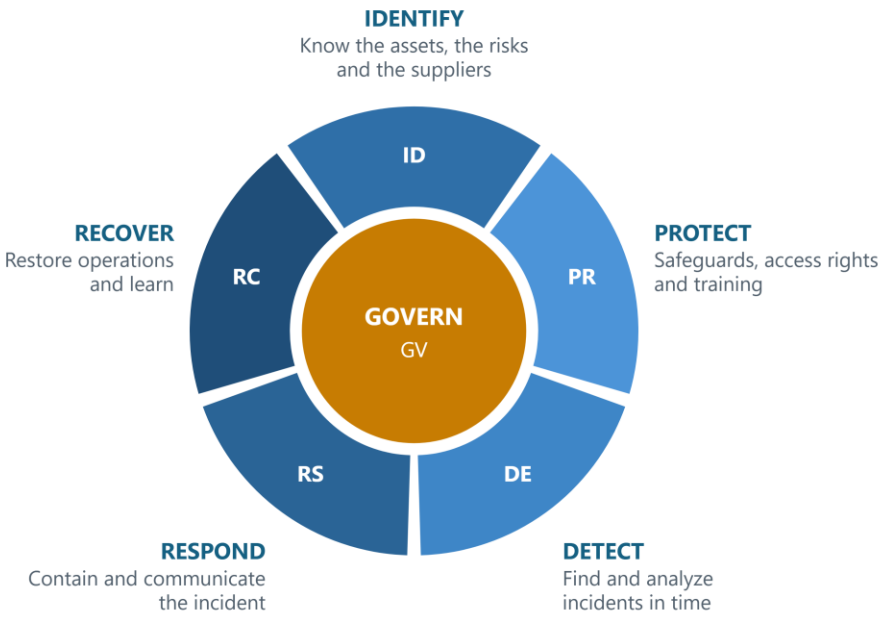
11.2.2. The six functions of the NIST 2.0 framework

To organize the response, the NIST Cybersecurity Framework offers a common language. Its version 2.0, published in 2024, is addressed to organizations of every size and sector, whatever the technical maturity of their security programs (National Institute of Standards and Technology, 2024). It does not prescribe technologies; it describes outcomes organized in

functions, categories and subcategories. Its main novelty is the Govern function, placed at the center because it guides the way the other five are applied. Figure 11.1 presents the six functions.

Figure 11.1

Functions of the NIST 2.0 Cybersecurity Framework



Note. The authors' own work, based on National Institute of Standards and Technology (2024).

In an MSME, each function translates into concrete tasks:

- **Govern.** Establish, communicate and oversee the strategy, the expectations and the policy on cyber risk, with defined roles and attention to the risk contributed by providers.
- **Identify.** Understand current risks from an inventory of data, equipment, software, services, people and providers.
- **Protect.** Apply safeguards such as identity and access control, training, encryption, backups and the updating of platforms.
- **Detect.** Find and analyze in time the anomalies that announce a possible attack, such as unusual logins or unauthorized changes.
- **Respond.** Contain, analyze, mitigate and communicate an incident once it has been detected.

- **Recover.** Restore the affected assets and operations, after verifying the integrity of the backups that will be used.

The functions do not form a sequence that is run through once: governing, identifying, protecting and detecting are continuous activities, and responding and recovering must be ready at all times. The framework suggests comparing a current profile, which describes the outcomes achieved today, with a target profile; the gap between the two becomes an action plan. Its implementation tiers, from partial to adaptive, describe the move from improvised responses to practices that learn from every incident, in a logic close to the maturity models of chapter 8.

11.2.3. From risk to priority

No organization can protect every asset with the same intensity, and that is why prioritizing is part of the work. Within the Identify function, the framework calls for using threats, vulnerabilities, likelihoods and impacts in order to understand risk and order the responses. A simple way consists of rating likelihood and impact on a scale from 1 to 5 and multiplying them:

$$Risk = Likelihood \times Impact$$

Likelihood runs from 1 (rare) to 5 (almost certain), and impact, from 1 (insignificant) to 5 (severe, such as a halted operation or the exposure of sensitive data). An employee who uses the same password on several services might receive a likelihood of 4 and an impact of 3, for a risk of 12 out of a maximum of 25. Controls act on one factor or the other: multi-factor authentication reduces the likelihood that a stolen password will be of use to an attacker, and an offline backup that has been tested does not prevent a ransomware attack, but it limits its impact.

The value that remains after the controls is the residual risk, which management can accept, reduce, transfer through insurance or avoid. Since the scales are ordinal, the product ranks priorities, but it does not measure losses in dollars; that monetary valuation belongs to chapter 12.

11.3. Protection of personal data: principles and the Ecuadorian law

In Ecuador, the processing of personal data is governed by the Ley Orgánica de Protección de Datos Personales (LOPDP), enacted in 2021, whose penalty regime has been in force since 2023 (Asamblea Nacional del Ecuador, 2021). The law understands personal data as data that identify or make identifiable a natural person, directly or indirectly, and considers

sensitive, among others, health data, biometric data, genetic data and data revealing ethnicity, religion or sexual orientation, because their improper processing may give rise to discrimination.

The rule distributes precise roles. The data subject is the person the data refer to; the controller decides on the purpose and the processing; the processor handles the data in the name and on behalf of the controller, as a web hosting provider does, and the Personal Data Protection Authority oversees compliance. Contracting a cloud service does not transfer responsibility: a store that hosts its customer database on an external server still answers for those data, and a contract must prevent the processor from using them for other purposes.

The principles of the law guide every decision about data. The principle of purpose requires using them only for the purposes communicated to the data subject; the principle of relevance and minimization limits collection to what is strictly necessary; the principle of retention prevents keeping them longer than their purpose requires, and the principle of proactive and demonstrated accountability requires being able to prove compliance.

Consent is only one of the bases that legitimize processing; the law allows others, such as the performance of a contract or compliance with a legal obligation. A store may use the customer’s address to deliver their order, because the purchase contract requires it; if it uses their data for direct marketing, the customer may object at any time. Data subjects also have rights of access, rectification, erasure, portability and suspension of processing, and the right not to be subject to decisions based solely or partly on automated assessments, which section 11.4 takes up.

The law also requires security measures proportionate to the risk, data protection by design and by default, and an impact assessment when processing may entail a high risk for the rights of the data subject. Cybersecurity and data protection converge here, because the LOPDP defines a security breach as an incident that affects the confidentiality, the integrity or the availability of personal data. When one occurs, the controller must, as a general rule, notify the authority within a few days and warn the data subjects if their rights are at risk.

For an MSME, complying with the law starts with five concrete steps:

1. Take stock of the personal data it processes, with their purpose, their legal basis, their retention period and the people who have access to them.
2. Publish a privacy notice in plain language.
3. Sign contracts with the processors, such as the hosting provider or the accounting firm.
4. Set up a channel for handling the requests of data subjects.
5. Prepare a response procedure for security breaches.

11.4. Ethics of artificial intelligence

The capabilities of AI and its technical limits were described in chapters 2 and 4. Its ethical dimension arises because these systems learn from historical data and take part in decisions about people: who receives a loan, which candidate moves on to an interview or which complaint is handled first. Among the risks are biases that reproduce past discrimination, the opacity of the models, threats to privacy and the temptation to attribute responsibility to the machine, challenges that the multidisciplinary literature documents alongside the opportunities of AI in management and in the public sector (Dwivedi et al., 2021).

In response to those risks, declarations of principles multiplied. After mapping the guidelines published by companies, research centers and public bodies, Jobin et al. (2019) found a global convergence around five principles (transparency, justice and fairness, non-maleficence, responsibility and privacy), together with substantive divergences about how to interpret and apply them. Signing up to a list of principles therefore does not ensure ethical behavior if they are not translated into verifiable procedures.

A synthesis that is useful for management is that of the AI4People project, presented by Floridi et al. (2018). It takes four principles from bioethics (beneficence, non-maleficence, autonomy and justice) and adds explicability, which brings together intelligibility, that is, how the system works, and accountability, that is, who answers for its operation. Autonomy is understood as the human power to choose which decisions are delegated to the machine, with the possibility of reversing that delegation. Table 11.1 turns these principles into control questions for a company.

Table 11.1

Ethical principles of artificial intelligence and control questions for a company

Principle	What it requires	Control question	Expected evidence
Beneficence	Promoting the well-being and the dignity of people and the care of the planet	What problem does the system solve and whom does it benefit?	An approved use case, with the expected benefits
Non-maleficence	Avoiding harm and misuse, and protecting privacy and security	What harm would an error or a misuse cause?	A risk assessment and an impact assessment on personal data
Autonomy	That people decide what is delegated to the machine and can reverse it	Who can review and overturn a decision of the system?	A documented human review procedure

Principle	What it requires	Control question	Expected evidence
Justice	Avoiding unfair discrimination and sharing the benefits equitably	Does the system treat customers with comparable profiles differently?	Bias tests by sex, age or territory
Explicability	Understanding how the system works and knowing who answers for it	Can a decision be explained to the person affected?	A model card and a designated owner

Note. The authors' own work, based on Floridi et al. (2018).

An example helps to make this concrete. A savings and credit cooperative testing a model to pre-approve microloans may perpetuate past exclusions if the history it was trained on favored certain neighborhoods, even if the neighborhood does not appear as a variable. The LOPDP recognizes the right not to be subject to automated decisions with legal effects, to ask for a reasoned explanation and to challenge them, but it provides for exceptions, such as decisions necessary to enter into a contract. Where the law leaves that margin, ethical principles still call for human review and understandable explanations.

Not every use demands the same rigor: human oversight must grow with the impact on people's rights. Generative AI adds an immediate rule, which is to define what information is never entered into external tools, such as customer data, and who reviews the texts before they are published.

11.5. Trust, privacy and the data economy

Data are a peculiar asset: they gain value when combined and reused, and the platforms that accumulate them, as seen in chapter 3, enjoy network effects that are hard to replicate. That logic has a flip side. Zuboff (2019) calls surveillance capitalism the economic order that claims human experience as free raw material, turns it into behavioral data and uses the surplus to manufacture predictions that are sold in markets of future behavior.

On the other side of that tension stands trust. Customers usually share their data when they expect fair treatment and a clear benefit, and they withdraw their preference when they discover hidden uses or suffer a leak. For the MSME it also has commercial value: small firms able to demonstrate solid security and privacy practices can gain an advantage when forming alliances with larger corporations (OECD, 2021).

Privacy is also decided in the design. A form that asks only for what is necessary and a configuration that by default does not share information with third parties reduce both the risk

and the cost of compliance, because data that are not collected cannot be leaked and require no custody.

In developing countries, the data economy presents a further nuance. Hilbert (2016) warns that concerns about privacy and the scarcity of talent are aggravated there by structural shortcomings in infrastructure, resources and institutions, and that the result is a new divide between those who use data-based knowledge to decide and those who cannot. For Latin American MSMEs, the risk is ending up as mere suppliers of data for platforms owned by others, a risk linked to the digital divide and to the support ecosystem analyzed in chapter 10.

11.6. Sustainability and digital transformation

The relationship between the digital and the environment has two sides. Sensors, data and automation make it possible to measure consumption, reduce waste and optimize routes; at the same time, digital infrastructure leaves a footprint of its own, because data centers consume energy and water, equipment is renewed quickly and ends up as electronic waste, and efficiency gains can stimulate greater consumption, the so-called rebound effect.

In their systematic review, Feroz et al. (2021) organize the contributions of digital transformation to environmental sustainability into four areas: pollution control, waste management, sustainable production and urban sustainability. Applied to the Ecuadorian coast, those areas translate into sensors that monitor water quality in a shrimp pond, delivery routes that save fuel, platforms that connect waste pickers with the companies that generate waste or electronic invoicing that does away with paper and travel.

From the standpoint of entrepreneurship, George et al. (2021) call digital sustainability the activities with which entrepreneurial organizations use digital technologies to tackle grand challenges, such as climate change. A grower who digitally records the origin and the practices of their harvest, for example, can reach buyers who demand traceability, provided that the information is verifiable and not an advertising ornament.

Measuring is the step that is usually missing. In reviewing how the performance of SMEs undergoing digital transformation is assessed, Costa Melo et al. (2023) found that sustainability is treated as a separate topic and that social and environmental aspects are the most neglected. It is therefore advisable for the scorecard of chapter 12 to include indicators such as the energy consumption of the equipment or the certified disposal of electronic waste.

Security, data protection, ethics and sustainability answer the same question of governance: who decides and who answers for the consequences of using technology. The case that follows shows what happens when that question goes unanswered.

Illustrative case: the online clothing store that lost its customers' data

A women's and children's clothing store in Manta, with eleven employees, moved in three years from a shop downtown to selling mainly through its website and its social media. A freelance programmer built the site on a content manager with an electronic commerce add-on. An external gateway processed card payments, but the database stored the names, identity card numbers, phone numbers, addresses and purchase history of several thousand customers. The administration password was shared by the owner, the social media manager and the programmer, and updates were put off "so as not to break the store".

One Monday, several customers called to ask about messages that, in the name of the store and quoting their latest order, asked them to pay a surcharge to release a package held at customs. The programmer discovered that, weeks earlier, someone had exploited a vulnerability of the add-on to copy the customer table. There was no data inventory and no response plan, and the owner hesitated for two days over whether to shut the site down and whether the law obliged her to notify anyone.

She finally closed the online store for four days, hired a consultant, changed the passwords, activated multi-factor authentication and updated the components. With legal advice she notified the breach to the authority and wrote to the affected customers to explain which data had been exposed and how to recognize the fraudulent messages. Some thanked her for the transparency; others did not come back. Months later, before a trade association of merchants, the owner summed it up by saying that the technical repair had cost less than the trust that was lost.

11.7. Chapter summary

Throughout the chapter the rules that allow digital transformation to create value without accumulating hidden risks were examined. Governance assigns decision rights; cybersecurity and data protection look after information and the rights of its subjects; ethics guides the use of AI, and sustainability brings the environment into technological decisions. These are the key ideas:

- Governing technology consists of defining who decides, with what criteria and who is accountable; management carries out those decisions.
- The NIST 2.0 framework organizes cybersecurity into six functions and places Govern at the center of Identify, Protect, Detect, Respond and Recover.

- Risk combines likelihood and impact: their product ranks priorities, and controls act on one factor or the other.
- The LOPDP assigns roles to the data subject, the controller and the processor, and requires principles such as purpose, minimization and proactive, demonstrated accountability.
- The ethical principles of AI protect people when they are translated into control questions, human review and designated owners.
- Trust is an economic asset, and digital transformation can improve or worsen environmental performance depending on how it is governed.

Key terms: *IT governance, decision rights, cybersecurity, NIST 2.0 framework, residual risk, personal data, sensitive data, data controller, data processor, explicability, surveillance capitalism, digital sustainability.*

11.8. Exercises and activities

Comprehension questions

1. How do the governance and the management of technology differ? Illustrate the difference with an example from an MSME.
2. Why does version 2.0 of the NIST framework place the Govern function at the center of the other five?
3. What distinguishes the controller from the processor of personal data? Propose an example of each one in an online store.
4. What does explicability add to the four principles taken from bioethics in the AI4People synthesis?
5. Why can digital transformation improve the environmental performance of an organization and, at the same time, increase its footprint?

Application exercises

1. An optician’s shop with three locations in Santa Elena and online sales rated five threats on scales from 1 to 5. T1, identity spoofing by email that steals credentials: likelihood 4, impact 4. T2, ransomware on the invoicing server: likelihood 3, impact 5. T3, interruption of the provider that hosts the online store: likelihood 2, impact 4. T4, loss of an unencrypted laptop: likelihood 3, impact 3. T5, mistaken sending of a sheet with the optical prescriptions and contact details of customers: likelihood 2, impact 5. a) Calculate the risk of each threat, classify it as low (1 to 4), medium (5 to 9), high (10 to 14)

or critical (15 to 25) and rank the priorities. b) The shop activates multi-factor authentication and trains the staff, with which the likelihood of T1 falls to 2; it also implements offline backups that are tested, which reduce the impact of T2 to 3. Calculate the residual risks, the percentage reduction of the total risk and the new priority. *Worked solution in Appendix B.*

2. Classify each practice according to the function of the NIST 2.0 framework it belongs to and justify the choice: a) approving a security policy and appointing its owner; b) keeping an inventory of equipment, software and cloud services; c) activating multi-factor authentication on email; d) reviewing alerts of logins from unusual places; e) notifying the customers affected by an incident; f) restoring invoicing from a verified backup; g) assessing the security of a provider before hiring it.
3. Draw up the inventory of personal data of a neighborhood gym that registers its members, charges monthly fees, controls entry with a fingerprint, records with cameras and sends promotions by messaging app. For each processing activity, state the purpose, the basis that legitimizes it, a reasonable retention period and a security measure, and point out which data are sensitive according to the LOPDP.
4. A savings and credit cooperative is appraising a model that pre-approves microloans using the applicant's payment history, age, neighborhood of residence and social media activity. Apply the control questions of table 11.1, identify the variables that could introduce bias and propose three conditions for authorizing its use.

Analysis of the case

1. Which functions of the NIST 2.0 framework failed in the store before the incident, and which ones during the response? Justify each one with facts from the case.
2. Which obligations of the LOPDP were triggered by the leak? Assess whether the owner's actions met them and at what moment.
3. Which governance decisions, such as assigning owners or a policy on updates, would have reduced the likelihood or the impact of the incident?
4. Write the message the store should have sent to the affected customers and propose two visible measures for recovering their trust.

Collaborative activity

1. In teams of three or four students, choose a local MSME, interview the person in charge and build its current profile and its target profile in the six functions of the NIST 2.0

framework. Expected output: a one-page matrix with the gaps prioritized by risk and a ninety-day action plan.

2. Write as a team a policy on the use of generative AI tools for a service MSME. Expected output: a two-page document with permitted and prohibited uses, data that must never be entered, review owners and the consequences of non-compliance.

Self-assessment

1. In the classic definition adopted in the chapter, IT governance consists of:
   a) deciding every day which equipment and software to buy
   b) specifying the decision rights and the accountability framework for the use of technology
   c) drawing up the annual budget of the IT department
   d) selecting the providers of cloud services
2. Which function was introduced in version 2.0 of the NIST framework and sits at the center of the others?
   a) Identify
   b) Protect
   c) Govern
   d) Recover
3. A company restores its invoicing system from a backup whose integrity it verified before using it. Which function does that activity belong to?
   a) Detect
   b) Identify
   c) Respond
   d) Recover
4. A threat has a likelihood of 3 and an impact of 4 on scales from 1 to 5. What is its level of risk?
   a) 12
   b) 7
   c) 1
   d) 0.75

5. According to the LOPDP, whoever processes personal data in the name and on behalf of another is:
   a) the data subject
   b) the data controller
   c) the data processor
   d) the supervisory authority
6. What name is given to the economic order that turns human experience into behavioral data in order to sell predictions about behavior?
   a) Surveillance capitalism
   b) Circular economy
   c) Sharing economy
   d) Attention economy
7. In the AI4People synthesis, explicability brings together:
   a) beneficence and justice
   b) intelligibility and accountability
   c) privacy and security
   d) autonomy and solidarity
8. Together with pollution control, waste management and sustainable production, which area completes the four in which digital transformation contributes to environmental sustainability, according to the review cited in the chapter?
   a) The conservation of biodiversity
   b) The efficiency of air transport
   c) Environmental education
   d) Urban sustainability
9. Technology governance is concerned, above all, with
   a) choosing providers
   b) defining who decides what, with what information and to whom they are accountable
   c) administering the servers
   d) drafting the password policy

10. Under Ecuador's Organic Law on the Protection of Personal Data, the controller is
    a) the person whose data is processed
    b) whoever decides on the purpose and the processing of the data
    c) whoever processes the data on behalf of another party
    d) the supervisory authority
11. The five functions of the NIST 2.0 framework used in the chapter as a working guide are
    a) prevent, detect, report, penalize and audit
    b) identify, protect, detect, respond and recover
    c) plan, do, check, act and document
    d) classify, encrypt, back up, test and restore
12. Requiring explainability from an artificial intelligence system means
    a) publishing its source code
    b) being able to give understandable reasons for a decision that affects a person
    c) guaranteeing that it never makes mistakes
    d) documenting the cost of the model

CHAPTER 12.
THE ROAD MAP: FROM STRATEGY TO EXECUTION AND THE MEASUREMENT OF VALUE

Many organizations reach this stage with a maturity diagnosis in hand, an approved digital strategy and a long list of ideas. What is usually missing is the intermediate step: deciding what is done first, with what money, who answers for each result and how it will be known whether the effort was worthwhile. Without that step, the strategy dissolves into scattered purchases of equipment and applications, and into projects that are abandoned as soon as the next urgent matter of the business appears.

That gap also appears in the international literature. In reviewing studies of SMEs, Mick et al. (2024) note that many operate without clear plans or strategies and that road maps integrating sustainability into their digital transformation are lacking. In an MSME the problem weighs more heavily, because the manager decides almost everything and the margin for error is narrow.

This chapter, the last of the book, deals with the move from strategy to execution. Its central instrument is the digital transformation road map, which arranges the initiatives over time, prioritizes them with explicit criteria and accompanies each one with a business case and a few indicators. It takes up the diagnosis of chapter 8 and the strategy of chapter 3, and it favors tools within the reach of an MSME: a prioritization matrix, a net present value calculation and a short scorecard.

By the end of this chapter, the reader will be able to:

1. Explain how the maturity diagnosis and the digital strategy are turned into a road map with phases, owners, resources and milestones.
2. Prioritize a portfolio of digital initiatives according to their impact, their effort, their risk and their dependencies.
3. Select the management approach, predictive, agile or hybrid, that best fits the uncertainty of each project.
4. Calculate and interpret the return on investment, the net present value, the internal rate of return and the payback period of a digital investment.
5. Design a scorecard that makes it possible to follow the transformation and to decide when to scale an initiative.

12.1. From the diagnosis to the road map

A digital transformation road map is a plan that arranges over time the initiatives with which an organization moves from its current situation to the one its strategy defines as desirable. Each initiative appears with an objective, an owner, an approximate budget, milestones and indicators. A technology purchasing plan lists equipment and licenses; the road map, by contrast, explains what business problem each step solves and why it comes before or after the others.

The starting point is the diagnosis of chapter 8, and, more than the overall score, what matters are the gaps by dimension: the distance between the current level and the one the strategy demands. A spare parts distributor that is active on social media but keeps its inventory in out-of-date spreadsheets has its main gap in processes and data. Measuring, however, is not the same as planning, and Pinto and Gonçalves (2026) warn that the available maturity models tend to be too generic or fail to offer actionable guidance for SMEs.

To bridge the distance between measuring and acting, Mick et al. (2024) propose a road map for SMEs that assesses digital maturity and facilitates a gradual implementation, aligned with strategic objectives, at three levels of planning: strategic, tactical and operational. In an MSME, the strategic level sets where the company wants to be in three years; the tactical one, which initiatives will be carried out this year and with what budget, and the operational one, who does what in each project, week by week.

The road map of a small company fits in a few pages. The available transformation models fit SMEs poorly, which is why Sirinanda and Balota (2024) propose a practical, simple and flexible framework that each company adapts to its business model and to its operating context. Three horizons are enough: one of six to twelve months, in detail, and two later ones sketched in blocks.

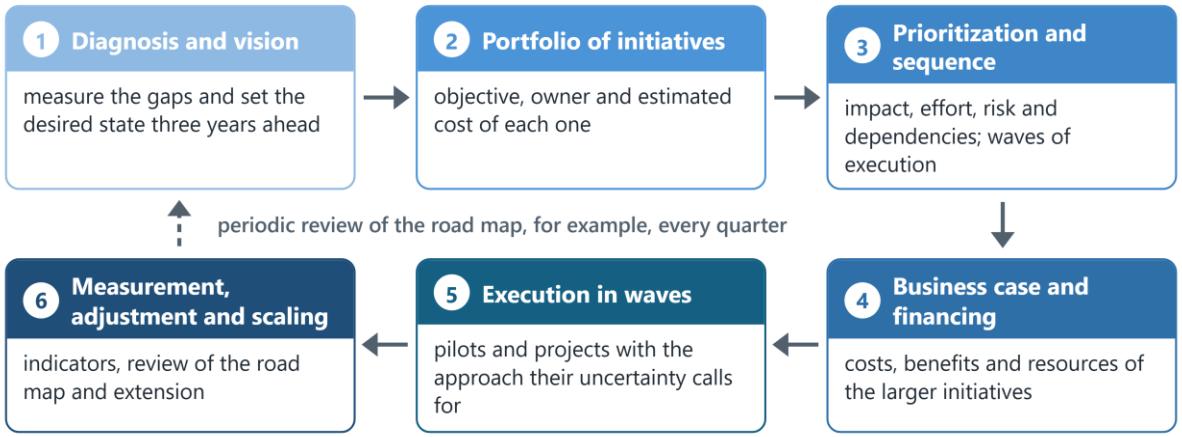
Figure 12.1 summarizes the phases of a road map, which in practice overlap and are repeated in each review cycle:

1. **Diagnosis and vision.** Measure maturity, identify the gaps and set the desired state three years ahead.
2. **Portfolio of initiatives.** Turn the gaps and the ideas into initiatives with an objective, an owner and an estimated cost.
3. **Prioritization and sequence.** Order the initiatives by impact, effort, risk and dependencies, and group them into waves of execution.

4. **Business case and financing.** Appraise the costs and benefits of the larger initiatives and secure the resources.
5. **Execution in waves.** Manage pilots and projects with the approach that matches their uncertainty.
6. **Measurement, adjustment and scaling.** Follow the indicators, review the road map and extend what works.

Figure 12.1

Phases of a digital transformation road map



Note. The authors' own work.

Each phase feeds the next one, and the last one returns information to the first. It is therefore advisable to review the road map every quarter in a small committee, with management, the owners of the areas involved and someone who knows the technology, following the governance rules of chapter 11.

12.2. Prioritizing initiatives: impact, effort, risk and dependencies

No MSME can take on at once all the initiatives that come out of the diagnosis. Money is limited, and the team's attention even more so, because those who install a new system still serve customers, dispatches and collections. Without explicit criteria, priority is set by whoever insists the most or by the provider with the most attractive offer. Prioritizing means deciding transparently what is done now, what comes later and what will not be done.

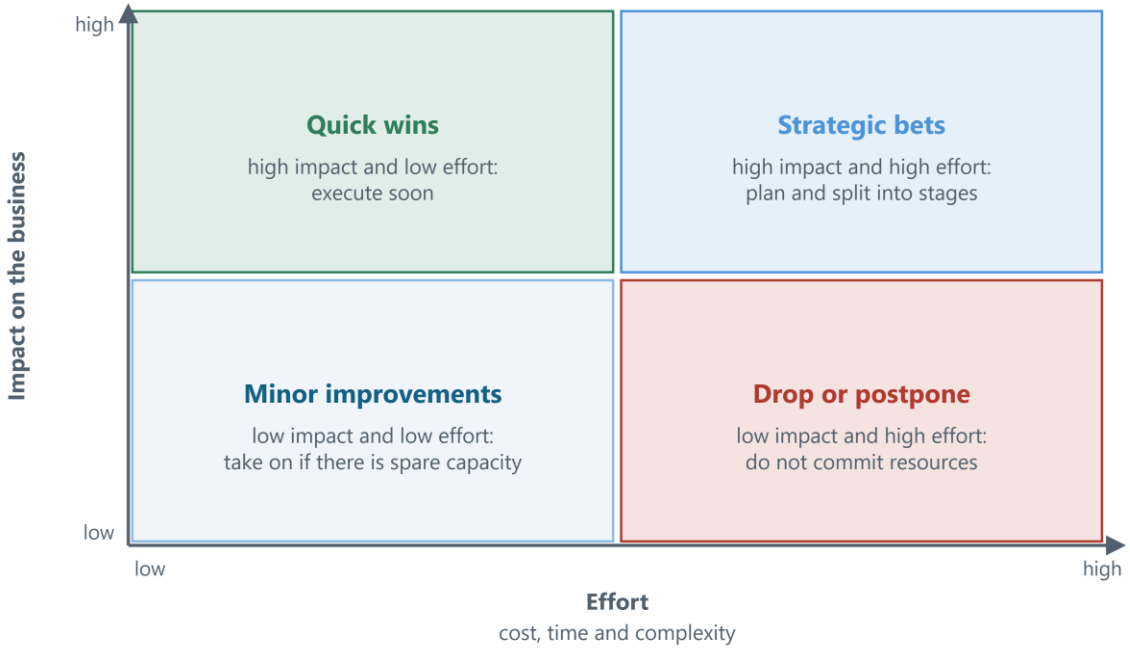
Four criteria cover most situations. Impact measures the expected contribution to the objectives: more revenue, lower costs, a better customer experience or compliance with a legal obligation. Effort adds up money, time, people and technical and organizational complexity.

Risk expresses the possibility of failure for technical reasons, because of rejection by users or because of dependence on a provider, and it can be estimated as the product of likelihood and impact (chapter 11). Dependencies, finally, indicate what must exist beforehand for the initiative to work.

Figure 12.2 crosses the first two criteria in a four-quadrant matrix. Initiatives of high impact and low effort are quick wins, which are carried out first because they deliver visible results and credibility for the program. Those of high impact and high effort, the strategic bets, demand planning, financing and, almost always, division into stages. Minor improvements, of low impact and low effort, are taken on when there is spare capacity. In the remaining quadrant, low impact with high effort, someone's pet projects usually hide; the prudent course is to drop or postpone them.

Figure 12.2

Prioritization matrix by impact and effort



Note. The authors' own work.

When there are many initiatives or several decision makers, the matrix is complemented with a weighted score. With scales from 1 to 5, a simple version is the following:

$$Priority = 0.5 \times \text{Impact} + 0.3 \times (6 - \text{Effort}) + 0.2 \times (6 - \text{Risk})$$

The weights express the strategy and are set by the committee before scoring; subtracting from 6 inverts the effort and risk scales, so that what is simple and safe adds more. An initiative with impact 5, effort 2 and risk 3 obtains $0.5 \times 5 + 0.3 \times (6 - 2) + 0.2 \times (6 - 3) = 4.3$. With many criteria or divergent judgments a formal multicriteria method is justified; Bayat et al. (2025) combine a Delphi panel with the best-worst method in order to rank the enablers of agile digital transformation in SMEs.

The score, however, says nothing about the order. A portal for customers to check their orders does not work if the company does not yet record them in a system, however high its priority may be. That base is part of what Ross et al. (2019) call the operational backbone: the coherent set of systems, data and processes that supports core operations. That is why initiatives are grouped into waves; the first one combines foundations and quick wins, and the following ones build on it.

12.3. Managing digital projects: predictive, agile and hybrid approaches

Once approved, each initiative is carried out as a project, that is, as a temporary effort with a defined objective, budget and closing. How to manage it depends above all on how much is known at the start. The guide of the Project Management Institute (2021), presented in chapter 7, places development approaches on a continuum running from predictive to adaptive, with hybrids in between, and recommends choosing according to the stability of the requirements and the degree of innovation.

The predictive approach sets scope, schedule and cost at the start and advances through successive phases: requirements, design, construction, testing and go-live. It works well when the requirements are stable and a late change is expensive, as when moving a server to the cloud or installing telemetry equipment in a fleet. Its main risk is discovering at the end, with the budget spent, that the system delivered does not match what the users needed.

In the agile or adaptive approach, the work advances in short iterations, of one to four weeks; after each one a working part of the product is delivered and the users' observations are collected. It is suitable when the solution is uncertain, as in an online sales channel or an application for customers. One useful practice is the minimum viable product (MVP): the simplest version that makes it possible to check with real users whether the idea works before financing the complete one.

Between the two extremes, the hybrid approach is usually the most practical for an MSME. When implementing an enterprise resource planning (ERP) system, for example, the contract with the provider, the data migration and the accounting configuration can follow a

predictive plan, while the reports and dashboards are built in iterations with the users. Prices and deadlines can thus be agreed without giving up learning during use, which is when the company discovers much of what it needs.

Whatever the approach, three decisions weigh more than the methodology. It is advisable to appoint as owner someone from the business, and not the provider, because that person will live with the result; to free up real time from the team, since an implementation handled in spare moments drags on for months; and to consider the project finished when people use the system and the indicators move, not on the day of installation.

12.4. Appraising the investment: costs, benefits, ROI, NPV, IRR and payback period

12.4.1. Costs and benefits of a digital initiative

Appraising a digital investment starts by recognizing all its costs over a defined horizon, with the logic of the total cost of ownership of chapter 2. There are the initial ones (equipment, licenses, implementation, data migration and training), the recurring ones (subscriptions, support, communications and maintenance) and those that do not appear in the provider's quotation: staff time, process redesign and the drop in productivity while people learn. They are not minor, since, for Brynjolfsson and Hitt (2000), much of the value of information technology depends on complementary organizational investments, often intangible.

Benefits are estimated as the difference between the situation with the project and without it. Some are easily expressed in money: savings in fuel or overtime, fewer errors, additional sales or faster collection. The expected loss avoided also counts (the annual likelihood of the incident times its cost), which translates into dollars the risks prioritized in chapter 11. Other benefits, such as a better customer experience, are real but hard to value; it is better to follow them with indicators than to invent a price for them. Since they grow with adoption, the first year rarely shows their full effect.

Financial appraisal guides the decision, but it does not exhaust it. In the framework of Matt et al. (2015), studied in chapter 3, financial aspects are only one of the four dimensions of a digital transformation strategy. Some initiatives are justified with modest profitability because the law requires them or because they enable others: an orderly record of orders rarely pays for itself, but without it there is no portal to retain customers. With high uncertainty, the investment can be staggered, with a pilot first and each subsequent stage conditional on the results of the previous one.

12.4.2. Indicators for deciding on the investment

With the annual net flows (benefits minus recurring costs) four indicators are calculated. The return on investment (ROI) compares with the amount invested the net benefit of the horizon, that is, the sum of those flows minus the initial investment:

$$ROI = (\text{Net benefit} / \text{Investment}) \times 100$$

ROI is easy to communicate, but it treats a dollar received today the same as one received four years from now. The net present value (NPV) corrects that defect, since it discounts each flow at the minimum rate the company requires of its investments, close to the cost of its credit or to the return of its best alternative, and subtracts the investment. If FNt is the net flow of year t, k the discount rate, n the horizon and $I0$ the initial investment:

$$NPV = FN1 / (1 + k) + FN2 / (1 + k)^2 + \ldots + FN\text{n} / (1 + k)^n - I0$$

A positive NPV indicates that the project yields more than the required rate; a negative one, that the money would yield more in its best alternative. The internal rate of return (IRR) is the rate that makes the NPV zero, and the project is accepted when that rate exceeds the required one. It is easy to communicate, but it may have several solutions if the flows change sign more than once, and when choosing between mutually exclusive projects the NPV prevails. It is obtained by trial and error or with the IRR function of a spreadsheet, from:

$$FN1 / (1 + IRR) + FN2 / (1 + IRR)^2 + \ldots + FN\text{n} / (1 + IRR)^n - I0 = 0$$

The payback period (PP) measures how long the cumulative flows take to equal the investment. If a is the number of full years before recovering it, S the balance outstanding at the close of year a and F the flow of the following year, assumed to be spread evenly:

$$PP = a + S / F$$

With discounted flows one obtains the discounted payback period, longer than the simple one. Both are of interest to an MSME with little liquidity, although they ignore what happens after recovery. The four indicators are best read together. An investment of USD 20,000 with net flows of USD 8,000 over three years has an ROI of 20% and is recovered in 2.5 years, but at 12% its NPV is negative by USD 785.35 and its IRR, close to 9.7%, does not reach the required rate.

12.5. Indicators and the transformation scorecard

Measuring the transformation serves to decide whether each initiative continues, is corrected, is stopped or is scaled. Activity indicators, such as the budget executed or the milestones

met, show effort but not value; adoption indicators are also needed, which reveal whether people use what has been installed, and outcome indicators, which show whether performance changed. The model of Melville et al. (2004) offers a reason for measuring at two levels: technology, combined with complementary organizational resources, first improves business processes and, through them, the performance of the organization.

To organize those indicators, the balanced scorecard is useful, which Kaplan and Norton (1996) conceived in order to translate strategy into objectives and indicators grouped in four perspectives: financial, customer, internal process, and learning and growth. The perspectives are linked by cause-and-effect relationships, and each one combines outcome measures with performance drivers, which anticipate the results and make it possible to correct in time. In digital transformation, for example, trained people and reliable data improve the processes, which serve the customer better and sustain the financial results.

Table 12.1 proposes two or three indicators per perspective for an MSME undergoing transformation, with their calculation, their type and a suggested frequency, and figure 12.3 arranges them by type along the cause-and-effect chain. A short list works better, because eight or ten well-defined indicators are enough for the committee meetings, whereas a dashboard with forty ends up going unread.

Table 12.1

Digital transformation indicators by perspective of the balanced scorecard

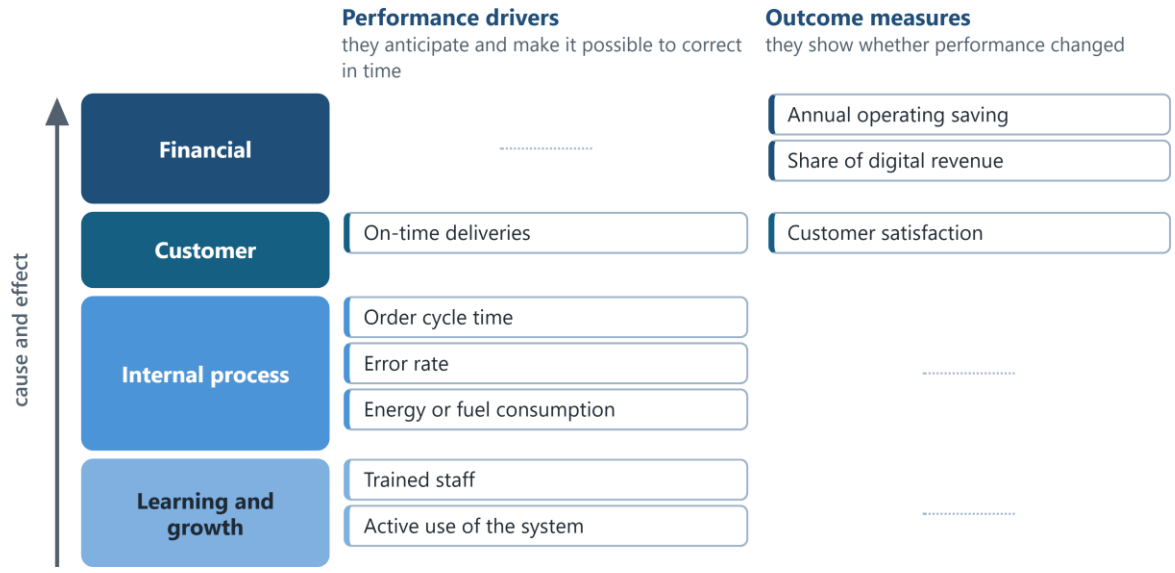
Perspective	Indicator	Calculation	Type	Frequency
Financial	Annual operating saving	Annual operating cost without the project minus annual operating cost with the project	Outcome	Half-yearly
Financial	Share of digital revenue	Revenue from digital channels / total revenue × 100	Outcome	Monthly
Customer	Customer satisfaction	Satisfied customers / customers surveyed × 100	Outcome	Quarterly
Customer	On-time deliveries	Orders delivered within the promised time / total orders × 100	Driver	Monthly
Internal process	Order cycle time	Average hours between the receipt of the order and its delivery	Driver	Weekly
Internal process	Error rate	Documents or orders with an error / total processed × 100	Driver	Monthly

Perspective	Indicator	Calculation	Type	Frequency
Internal process	Energy or fuel consumption	Total consumption / units served (orders, trips or kilometers)	Driver	Monthly
Learning and growth	Trained staff	People trained in the new tool / people who must use it × 100	Driver	Quarterly
Learning and growth	Active use of the system	Active users in the month / enabled users × 100	Driver	Monthly

Note. The authors' own work, based on Kaplan and Norton (1996). Drivers anticipate the results of the next perspective in the cause-and-effect chain.

Figure 12.3

The transformation scorecard: performance drivers and outcome measures



Note. The authors' own work, based on Kaplan and Norton (1996). The cells without indicators draw the pattern of the scorecard: drivers, which can be corrected, prevail at the base, and outcomes, which can only be checked, at the top.

Each indicator needs a baseline measured before starting, a target, a data source and an owner; without a baseline, no improvement can be demonstrated. Moreover, this scorecard, which follows the strategy, is different from the dashboard of chapter 4, which watches daily operations. The table also includes an environmental indicator, as chapter 11 recommends, because the literature on measuring the performance of SMEs undergoing digital transformation treats sustainability as a separate topic (Costa Melo et al., 2023).

Finally, when an initiative completes a year it is useful to recalculate its NPV with the observed flows and compare it with the one estimated at approval. The comparison teaches how to project better and gives credibility to the business cases that follow.

12.6. Scaling and sustaining the change

Many digital initiatives die as successful pilots: they work in one area, are presented with pride and are never extended, because nobody defined with what evidence they would be scaled up or who would pay for the next step. Scaling means taking to the whole organization a solution tested in one area, one branch or one route, and it requires standardizing the process, training more people and reinforcing support. Before doing so it is advisable to check that the pilot's indicators moved, that users adopted the solution and that the costs of extending it are known.

The progression is usually gradual. In the four levels of engagement described by Garzoni et al. (2020), presented in chapter 10, digital collaboration comes before transformation. For an MSME of the region, scaling may mean precisely that: joining suppliers, customers, universities or support programs in a network that shares costs and knowledge.

Sustaining the change requires building it into the routine. Written procedures, the onboarding of new staff and the committee's indicators must reflect the new way of working, and the previous system has to be switched off on an announced date, because as long as the parallel spreadsheet remains available, part of the team will go back to it. In the last steps of his model, studied in chapter 7, Kotter (1996) recommends consolidating gains to produce more change and anchoring the new approaches in the culture.

At the scale of the whole organization, transformation stops being a project with a closing date. Warner and Wäger (2019) describe it as a continuous process of strategic renewal, supported by dynamic capabilities of digital sensing, seizing and transforming (chapter 9). In practice, that means repeating the maturity diagnosis every year, updating the portfolio, withdrawing the initiatives that did not meet their criteria and setting aside part of the budget for exploring new technologies.

Whoever runs the company has tasks of their own at each stage, and Westerman et al. (2014) propose that leaders frame the digital challenge, focus investment, mobilize the organization and sustain the transformation, a sequence parallel to the one in this chapter. The case that follows shows how a small company went through those stages with modest resources.

Illustrative case: the three-year road map of a freight carrier in Santa Elena

A family freight transport company in the province of Santa Elena moves supplies and products in 22 trucks between the peninsula and Guayaquil for shrimp larvae laboratories, ice factories and fishing traders. It coordinated dispatches by instant messaging, wrote mileage down on sheets of paper and invoiced days late. Its maturity self-assessment gave 34 points out of 100, with the lowest scores in processes and data, just when the large customers were beginning to ask online for the status of each shipment.

A committee made up of the manager, the head of operations and the accountant gathered eleven initiatives and placed them in the impact and effort matrix. The first wave, in the first year, brought together foundations and quick wins: digital recording of orders, invoicing connected to that record and telemetry with fuel control in six trucks. The second extended telemetry to the whole fleet and opened a tracking portal for customers, which depended on the order record. The third year was left for route analytics and the search for return loads with other carriers.

The pilot was managed with a predictive contract for the installation and with fortnightly reviews of the reports together with the drivers. At first, the drivers saw the tracking as surveillance; the resistance gave way when the company shared the consumption data and created an incentive for efficient driving. The scorecard was limited to eight indicators, among them consumption per kilometer, empty kilometers, on-time deliveries and trained drivers. Before extending telemetry, the committee required three months of data from the pilot and a positive NPV in a conservative scenario.

12.7. Chapter summary

Between strategy and results stands the road map. It starts from the gaps revealed by the diagnosis, turns them into a portfolio of initiatives, orders them according to their value, their cost, their risk and their dependencies, and accompanies each one with a management approach, a business case and a few indicators. This chapter closes the book, and what was studied earlier is translated here into concrete and measurable decisions.

- The maturity diagnosis provides the gaps by dimension and the strategy defines the desired state; the road map organizes the path between the two in horizons that are reviewed at fixed intervals.

- Prioritizing requires explicit criteria of impact, effort and risk, and a separate analysis of dependencies, which set the order of the waves of execution.
- The management approach depends on uncertainty: predictive for stable requirements, agile for uncertain solutions and hybrid for much of what an MSME undertakes.
- ROI and the simple payback period ignore the time value of money; NPV and IRR incorporate it, and NPV decides when projects are mutually exclusive.
- The balanced scorecard organizes a few indicators in four linked perspectives and combines drivers with outcome measures, always with a baseline.
- Scaling requires evidence from the pilot; sustaining the change requires building it into procedures, onboarding and indicators, switching off parallel systems and renewing the diagnosis and the portfolio every year.

Key terms: *road map, gap by dimension, portfolio of initiatives, impact and effort matrix, quick win, dependency, hybrid approach, minimum viable product, net present value, internal rate of return, payback period, balanced scorecard.*

12.8. Exercises and activities

Comprehension questions

1. What makes a digital transformation road map different from a technology purchasing plan?
2. Why is the priority score of an initiative not enough to decide when it is carried out?
3. Which characteristics of a project call for a predictive approach and which ones for an agile approach?
4. What information does NPV provide that ROI and the simple payback period do not?
5. Which conditions should be verified before scaling a pilot, and what function do driver indicators perform in that decision?

Application exercises

1. The freight carrier of the illustrative case is appraising the extension of telemetry to its whole fleet and its connection with the order record. The initial investment is USD 60,000. The expected annual benefits (fuel savings, fewer empty kilometers and less overtime) are USD 30,000 in year 1, USD 38,000 in year 2 and USD 40,000 in years 3 and 4; the recurring costs (subscription, mobile data and support) add up to USD 12,000 a year. With a discount rate of 12%, a horizon of four years and no residual value: a) calculate the net flows; b) calculate the NPV; c) estimate the IRR; d) calculate the ROI

of the horizon; e) calculate the simple and the discounted payback period; f) recalculate the NPV with benefits 10% lower and recommend a decision to the committee. *Worked solution in Appendix B.*

2. A distributor of agricultural supplies scored from 1 to 5 the impact, the effort and the risk of five initiatives, in that order: A, online store (4, 4, 3); B, cloud inventory with a barcode reader (5, 3, 2); C, automatic payment reminders (3, 1, 1); D, sales dashboard by area (3, 2, 2); E, in-house loyalty app (2, 5, 4). a) Calculate the priority of each initiative with the formula of section 12.2 and rank them. b) Place them in the impact and effort matrix, treating values 4 and 5 as high. c) Propose two waves of execution, knowing that A requires B to be in operation. d) Recalculate with weights of 0.4, 0.4 and 0.2 and comment on what changes. *Worked solution in Appendix B.*
3. A savings and credit cooperative is preparing three projects: a) moving its accounting system to a cloud service, with technical requirements already defined by the provider; b) developing a mobile application for members to apply for microloans; c) implementing a document management system with a fixed closing date and forms that users still have to define. Choose for each one a predictive, agile or hybrid approach and justify the choice with the criteria of section 12.3.
4. Design the transformation scorecard of an MSME you know, with two indicators per perspective. For each one, specify the formula, the baseline, the one-year target, the measurement frequency and whether it is a driver or an outcome measure.

Analysis of the case

1. Which dependencies explain the order of the three waves of the carrier's road map?
2. Why was it reasonable to start telemetry with a pilot of six trucks? Which risks did that decision reduce?
3. Classify the indicators mentioned in the case according to the scorecard perspective they belong to and point out which ones work as drivers.
4. Which actions should the company take at the end of the third year in order to sustain the change and update its road map?

Collaborative activity

1. In groups of four, choose an MSME in the province and build its three-year road map: main gaps, a portfolio of at least eight initiatives, impact and effort matrix, waves of execution and scorecard. Expected output: a one-page road map and a ten-minute presentation to the class, which will act as a board of directors.

2. Organize a debate in which half of the group argues for devoting the annual budget to a single strategic bet and the other half, to several quick wins. Expected output: a one-page record with the decision criteria the group agrees on.

Self-assessment

1. Which input from the maturity diagnosis is most useful for building a road map?
   a) The overall maturity score, not broken down
   b) The gaps by dimension between the current and the required level
   c) The catalog of technologies offered by providers
   d) The IT budget of the previous year
2. In the impact and effort matrix, an initiative of high impact and low effort is considered:
   a) A strategic bet
   b) A minor improvement
   c) A candidate to be dropped
   d) A quick win
3. In which situation is a predictive management approach preferable?
   a) When the requirements are stable and a late change is expensive
   b) When the users do not yet know what they need
   c) When an idea is to be validated with a minimum viable product
   d) When the solution must be adjusted every two weeks
4. A project with conventional flows (an initial investment followed by positive flows) has a negative NPV at 12%. What can be said about its IRR?
   a) It is greater than 12%
   b) It is equal to 12%
   c) It is lower than 12%
   d) It cannot be calculated
5. Which limitation do ROI and the simple payback period share?
   a) They require knowing the IRR beforehand
   b) They are only useful for horizons of more than five years
   c) They ignore the time value of money
   d) They require setting a discount rate

6. In a balanced scorecard, the percentage of staff trained in the new system belongs to the perspective of:
   a) Learning and growth
   b) Customer
   c) Financial
   d) Internal process
7. What distinguishes a driver indicator from an outcome measure?
   a) The driver is measured only once a year
   b) The outcome measure refers only to financial variables
   c) The driver needs no baseline
   d) The driver anticipates the result and makes it possible to correct in time
8. Which practice helps most to sustain a digital change after a successful pilot?
   a) Keeping the previous system running in parallel indefinitely
   b) Building the new process into procedures, onboarding and indicators
   c) Delegating the follow-up to the technology provider
   d) Putting off the measurement of results until the third year
9. A project requires an investment of 10,000 dollars and promises savings of 4,000 dollars a year. Its simple payback period is
   a) 1.5 years
   b) 2.5 years
   c) 4 years
   d) It cannot be computed without the discount rate
10. The net present value of a project is positive. That means that
    a) the project recovers the investment and creates value above the required rate
    b) the project carries no risk
    c) the internal rate of return is lower than the discount rate
    d) all the benefits are monetizable
11. In an impact-effort matrix, quick wins are the initiatives with
    a) high impact and high effort
    b) high impact and low effort
    c) low impact and low effort
    d) low impact and high effort

12. What is the purpose of a minimum viable product in a digital road map?
    a) To deliver the final version at the lowest possible cost
    b) To test with real users the simplest version that allows the team to learn whether the idea works
    c) To cut the scope in order to meet the budget
    d) To replace the design phase

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APPENDICES

Appendix A. Answer key to the self-assessments

This appendix gives the answer key to the self-assessments of the twelve chapters. Every answer comes with a short rationale, so that readers can check not only whether they were right, but why the option is correct.

Chapter 1. Foundations of digital transformation

Table A.1

Answer key for the self-assessment of chapter 1

Question	Answer	Rationale
1	b	Digitization is limited to converting analog information into digital form, without changing the process.
2	d	The definition stresses a process of change in the properties of the entity brought about by combinations of information, computing, communication and connectivity technologies.
3	a	The Fourth Industrial Revolution is defined by the convergence of physical, digital and biological technologies, with unprecedented speed and reach.
4	c	The evidence reviewed in section 1.5 shows that the value of IT depends on complementary organizational change.
5	c	Marginal cost is the cost of one additional unit, and in digital goods copying and distributing another unit costs almost nothing.
6	a	Digitalization modifies an existing process by means of digital technologies, in this case the management of orders and inventories.
7	d	Technology governance requires management to take on the decision rights over the business.
8	b	The mandatory issuing of electronic invoices comes from a rule, unlike the pressures of customers, competitors or technology.
9	b	The technology fallacy consists of attributing to the tool a change that also requires redesigning processes and building skills.
10	c	The evidence on the productivity paradox shows that the return arrives when the organizational complements are in place, not when the tool is installed.
11	d	Digitalization changes the way the process runs; the other three options only change the medium in which information is held.

Question	Answer	Rationale
12	b	Digital transformation means changing how value is created and delivered; a new channel on its own is a small part of that change.

Chapter 2. Enabling technologies

Table A.2

Answer key for the self-assessment of chapter 2

Question	Answer	Rationale
1	b	Databases form the data layer, placed between the infrastructure and the applications.
2	d	Even in SaaS, the client decides who has access, with which credentials and what data are uploaded.
3	a	RPA is suitable for repetitive, high-volume tasks, with clear rules and structured data.
4	c	The cyber-physical system, besides measuring, acts on the physical process through control cycles.
5	d	Supervised learning learns from labeled cases in order to predict the label of new cases.
6	b	Both studies found larger improvements among those who started with less experience or lower performance.
7	a	The chain protects the integrity of what has been recorded, but not the truthfulness of the data at the source.
8	c	TCO includes hidden costs such as migration, training, staff time and the exit.
9	c	In the software as a service model the provider manages the whole stack and the client only uses the application.
10	a	The cyber-physical system closes the loop between sensing, deciding and acting; the internet of things may stop at data capture.
11	b	Total cost of ownership covers every outlay in the life cycle, including starting the tool up and leaving it behind.
12	b	The chapter insists on starting from the problem and the success criterion, not from the available technology.

Chapter 3. Digital strategy and business models

Table A.3

Answer key for the self-assessment of chapter 3

Question	Answer	Rationale
1	b	Digital business strategy integrates both strategies and relies on digital resources to create differential value.
2	d	The four dimensions are the use of technology, changes in value creation, structural changes and financial aspects.
3	a	The model describes how the company delivers value, induces the customer to pay and converts those payments into profit, and it contains a hypothesis that must be tested.
4	c	The margin per subscriber is 25 - 10 = 15 dollars, and 4,500 / 15 = 300 subscribers.
5	a	In two-sided markets the price structure matters, and subsidizing one side serves to attract the other.
6	d	The growth of one side raises the value of the platform for the other side, and that defines a cross-side network effect.
7	b	Disruptive innovation starts with inferior performance on the traditional attributes, but with advantages valued by new or underserved customers.
8	c	Open innovation assumes that the company uses external knowledge and also external paths to take its ideas to market.
9	b	Servitization turns the sale of a product into the continuous provision of a service.
10	b	Digital business strategy stops being functional and subordinate: technology is part of deciding where and how to compete.
11	a	The effect is indirect, or cross-side, because the value for one side of the market grows with the number of participants on the other side.
12	c	Disruption enters from below or through a new market and improves later until it reaches the mainstream segment.

Table A.4

Answer key for the self-assessment of chapter 4

Question	Answer	Rationale
1	b	Information arises when data are organized and contextualized; the judgment to choose belongs to wisdom.
2	d	Veracity refers to the accuracy and reliability of the datum, a condition for the analysis to guide decisions well.
3	a	The question about the causes of an observed result corresponds to diagnostic analytics.
4	c	The data-driven culture is intangible; the warehouse and the budget are tangible resources, and skills are human resources.
5	c	Precision divides the true positives by all the flagged cases: 35/50 = 0.70; recall would require knowing how many left without being detected.
6	a	The less experienced agents improved in speed and quality, while the most experienced ones obtained small gains.
7	d	Data governance sets roles, rules and decision rights over data; it does not replace the law nor is it limited to the tools.
8	b	The habit is recognized in the review routine and in the decisions it produces, not in the number of charts or in who built the dashboard.
9	a	Descriptive analytics reports what happened; explaining why would be diagnostic.
10	b	A false negative is the positive case that is not detected: the real risk the model fails to flag.
11	c	Uniqueness requires each real-world entity to have a single record in the system.
12	c	Without a routine that forces someone to look at it and decide, the dashboard becomes decoration.

Chapter 5. Processes, operations and the digital supply chain

Table A.5

Answer key for the self-assessment of chapter 5

Question	Answer	Rationale
1	b	Handovers accumulate waiting, retyping and losses of information that no area sees in full.
2	c	Discovery produces the model of the current process, which is then analyzed.
3	a	The efficiency is 40 / (40 + 160) × 100 = 20%; 25% comes from wrongly dividing the work by the waiting time.
4	b	The capacity of the process depends on the bottleneck; improving another activity does not raise it.
5	c	RPA occupies the middle stretch: repetitive work whose frequency does not justify integrating the systems.
6	a	Conformance checking points out the deviations between what happened and what was planned.
7	d	The ripple effect describes how a local disruption reaches other links; option b corresponds to the bullwhip effect.
8	d	The value of the structured document lies in its data entering the system without being typed again.
9	b	The bottleneck sets the pace of the whole process: improving another activity does not raise total capacity.
10	b	Process mining starts from the trace the work leaves in the systems, not from how the process is believed to run.
11	c	Robotic process automation pays off in repetitive, rule-based, high-volume tasks.
12	b	The ripple effect is the propagation of disruption; the amplification of demand is the bullwhip effect.

Chapter 6. Customers, digital marketing and electronic commerce

Table A.6

Answer key for the self-assessment of chapter 6

Question	Answer	Rationale
1	d	A review by another buyer on an independent site escapes the control of the company and of its partners, which is why it is a social or external touchpoint.
2	b	The mailing list belongs to the company and does not depend on paying for exposure; the advertisement is a paid medium, and the review and the note are earned media.
3	a	What defines omnichannel management is the integration of channels and touchpoints; independent targets per channel belong to the multichannel scheme.
4	c	The rate is obtained as 600 / 30,000 × 100 = 2%.
5	d	The break-even ROAS is 1 / 0.25 = 4.0; with a lower ROAS, the campaign does not cover its cost.
6	a	The CAC brings together all acquisition spending; counting only the advertisements underestimates it.
7	c	In the advocacy stage the satisfied customer spreads their experience and begins the journey of other people.
8	b	The online marketplace provides traffic, payment and trust from the outset, in exchange for commissions, rules of its own and control of the buyer's data.
9	b	The conversion rate is 80 divided by 4,000, that is, 2%.
10	b	It measures how much it costs to win a new customer, so that it can be compared with the value that customer will contribute over time.
11	b	Omnichannel integrates the channels around the customer; having many channels without integrating them is multichannel.
12	c	Earned media is the exposure the firm obtains without paying for it or controlling it.

Chapter 7. People, culture and leadership in digital transformation

Table A.7

Answer key for the self-assessment of chapter 7

Question	Answer	Rationale
1	b	Kane and his co-authors use that name for looking for a technological fix to what is, above all, a change of people and of ways of working.
2	d	The framework points out that safety and problem solving run across every digital activity, while the first three areas correspond to specific uses.
3	a	In SMEs in Ghana, those capabilities partially mediated the relationship between leadership and digital transformation, and digital strategy did so less strongly.
4	c	Basic assumptions operate without being discussed and guide behavior even when they contradict the espoused values.
5	b	The definition refers to being able to ask, admit mistakes or disagree without fear of ridicule or punishment.
6	d	If the new practice depends on one person and is not built into rules, indicators and onboarding, the change is not anchored and is reversed.
7	c	Automation substitutes for codifiable tasks and complements those that require adaptability, creativity and judgment.
8	a	The retrospective examines the team's own way of working and only works if there is psychological safety to speak frankly.
9	b	DigComp describes levels by task complexity, autonomy and cognitive domain, not by tools or seniority.
10	c	Without psychological safety errors are hidden, and a hidden error in a digital rollout is expensive.
11	b	Change is not sustained by one person: it needs a credible group with decision power spread across the organization.
12	b	The unit that gets automated is the task, not the job; the effect on employment depends on which tasks remain and how work is reorganized.

Chapter 8. Digital maturity: models, measurement and diagnosis

Table A.8

Answer key for the self-assessment of chapter 8

Question	Answer	Rationale
1	b	Maturity is multidimensional and refers to developed capabilities, not to purchases or to an isolated indicator.
2	d	Nolan formulated his hypothesis from the study of data processing expenditure.
3	a	Fashionistas adopt novelties with enthusiasm, but they lack the leadership capability to integrate them.
4	c	In the formative logic, each indicator contributes a different part of the concept.
5	b	One applies (2.8 - 1) / 4 × 100 = 45.
6	a	Offsetting can hide a weak dimension; that is why it is advisable to review the profile or apply the weakest-link rule.
7	d	Multiple informants and evidence reduce the biases of self-reporting.
8	c	Feedback turns the diagnosis into shared priorities and commitments.
9	a	Stage models assume a single path; maturity models accept that a firm may advance further in some dimensions than in others.
10	b	In a formative index the dimensions build the concept; removing one alters what is being measured.
11	c	A badly lagging dimension blocks progress in the others, just as a bottleneck limits a process.
12	b	The practical value of the diagnosis lies in the profile by dimension; the overall number only places the firm.

Chapter 9. Technology adoption: theories and factors

Table A.9

Answer key for the self-assessment of chapter 9

Question	Answer	Rationale
1	c	Discontinuance by disenchantment is the rejection of an already adopted innovation because of dissatisfaction with its performance.
2	a	The model defines perceived usefulness as the belief that using the system will improve the user’s performance.

Question	Answer	Rationale
3	d	Facilitating conditions, such as equipment, connection and technical support, influence use directly.
4	b	Trialability makes it possible to experiment with the innovation on a small scale before adopting it.
5	b	Pressures from customers, suppliers and competitors belong to the environmental context.
6	d	Socially complex resources, embedded in the way of working and deciding, are hard to imitate; those bought on the market are within everyone's reach.
7	a	Sensing consists of identifying opportunities and threats in the environment before mobilizing resources.
8	c	The model places the first effect in business processes, whose improvement then carries over to the performance of the organization.
9	b	TAM explains individual acceptance through those two beliefs; environmental factors belong to other frameworks.
10	b	TOE places the decision in the organization and adds the organizational context and the competitive and regulatory environment.
11	b	Assimilation is the deep incorporation of the technology into daily work, beyond purchase and superficial use.
12	b	What can be bought can also be bought by competitors; advantage comes from combining it with the firm's own capabilities.

Chapter 10. Digital transformation in MSMEs and in emerging economies

Table A.10

Answer key for the self-assessment of chapter 10

Question	Answer	Rationale
1	b	The second level refers to the differences in skills and in types of use among those who already have access.
2	d	In the small firm, the owner concentrates decisions and there is rarely an area to propose technological change.
3	a	Without investment no skills are built and nothing is learned about what technology contributes, and perceived usefulness stays low.
4	c	Frugal innovation combines the essential function, low cost, ease of use and fit with existing processes.

Question	Answer	Rationale
5	b	Firms with more capabilities make better use of the common offering and widen their advantage over the laggards.
6	d	Digital enquiry is the phase in which the firm explores and appraises specific tools.
7	a	Its value lies in guiding firms without the commercial bias of a provider.
8	c	Without follow-up it is impossible to know what results the programs produced or to correct them in time.
9	b	Once access is solved, differences in competence and in type of use remain and produce unequal outcomes.
10	b	It is a self-reinforcing loop that is rarely broken without outside support.
11	b	The first stages solve the basic data and compliance, which are the foundation of everything else.
12	b	Its value lies in closing the distance between what the firm needs and what the technology market offers.

Chapter 11. Governance, ethics, cybersecurity and the regulatory framework

Table A.11

Answer key for the self-assessment of chapter 11

Question	Answer	Rationale
1	b	Governance defines who decides and who is accountable; day-to-day decisions belong to management.
2	c	Govern guides the way the other five functions are applied, and that is why it sits at the center of the framework.
3	d	Recover covers the restoration of assets and operations, including the prior verification of the backups.
4	a	Risk is the product of likelihood and impact: 3 × 4 = 12.
5	c	The processor handles the data on behalf of the controller, who is the one who decides on their purpose.
6	a	Surveillance capitalism uses the surplus of behavioral data to manufacture predictions that are traded.
7	b	Explicability clarifies how the system works and who is responsible for its operation.

Question	Answer	Rationale
8	d	The review groups the contributions into pollution, waste, sustainable production and urban sustainability.
9	b	Governing means allocating decision rights and accountability; the rest is management.
10	b	The processor handles data on behalf of the controller; the controller is the one who decides what it is used for.
11	b	Those are the core functions of the framework, to which version 2.0 adds govern as a cross-cutting one.
12	b	Explainability is aimed at letting the person affected understand the decision and, where appropriate, challenge it.

Chapter 12. The road map: from strategy to execution and the measurement of value

Table A.12

Answer key for the self-assessment of chapter 12

Question	Answer	Rationale
1	b	The road map is built in order to close specific gaps, and the overall score does not indicate where they are.
2	d	Quick wins combine visible results with few resources, so they are worth carrying out early.
3	a	The predictive approach plans everything at the start, which makes sense when the requirements are not going to change.
4	c	With conventional flows, the NPV is negative only at rates above the IRR; therefore, the IRR is lower than 12%.
5	c	Both add up flows from different years as if they had the same value.
6	a	People's capabilities form the base of the cause-and-effect chain of the scorecard.
7	d	Drivers move before the results and give warning of when to act.
8	b	The change is sustained when it is built into the routine and into the control mechanisms of the company.
9	b	Ten thousand divided by four thousand a year is two and a half years; the simple payback period does not discount the flows.
10	a	A positive NPV indicates that the discounted flows exceed the investment at the chosen cost of money.

Question	Answer	Rationale
11	b	They are prioritized at the start because they produce visible results with little resource use and sustain support for the change.
12	b	The minimum viable product exists to learn quickly from real evidence, not to make the deliverable cheaper.

Appendix B. Worked solutions to the application exercises

The numerical exercises proposed in the chapters are worked out here, with their data, the procedure and the interpretation of the result. Readers should attempt each exercise before consulting its solution.

Chapter 1. Foundations of digital transformation

Application exercise 2. Productivity of order entry at three points in time

Data. In the initial situation six employees work 180 hours a month each (1,080 hours) and process 1,620 orders a month. In scenario A, the same six people, working the same hours, process 1,701 orders. In scenario B, five employees working 160 hours each (800 hours) process 2,160 orders.

Procedure. For each point in time the following formulas apply:

Productivity per employee = Orders for the month / Number of employees

Productivity per hour = Orders for the month / (Number of employees × Hours per employee)

Percentage change = (Scenario value - Initial value) / Initial value × 100

Results. The calculations give the following values:

- Initial situation: 1,620 / 6 = 270 orders per employee and 1,620 / 1,080 = 1.5 orders per hour.
- Scenario A: 1,701 / 6 = 283.5 orders per employee and 1,701 / 1,080 = 1.575 orders per hour; both measures grow by (283.5 - 270) / 270 × 100 = 5%.
- Scenario B: 2,160 / 5 = 432 orders per employee and 2,160 / 800 = 2.7 orders per hour; the first grows by (432 - 270) / 270 × 100 = 60% and the second by (2.7 - 1.5) / 1.5 × 100 = 80%.
- To match the productivity per hour of B, the team in A would have to process 2.7 × 1,080 = 2,916 orders a month, that is, 1,215 more than the 1,701 it processes.

Interpretation. The application installed without changing the process raised productivity by barely 5%; the combination of technology, redesign, cleaning up the codes and training raised it by 60% per employee and by 80% per hour. The two measures differ in B because the overtime hours disappeared: the ratio between the growth factors, 1.80 / 1.60 = 1.125, matches the ratio between the working hours, 180 / 160. The comparison does not allow an exact share of the improvement to be assigned to each factor, but it is consistent with the complementarity set out in section 1.5.

Chapter 2. Enabling technologies

Application exercise 1. Total cost of ownership of an in-house server versus a SaaS service

- Assumptions: a three-year horizon, 12 users, undiscounted flows and zero exit costs in both options.
- Option A: initial costs of 5,200 + 1,800 + 900 = USD 7,900; annual costs of 1,800 + 600 + 420 = USD 2,820; replacement of disks in the second year, USD 650.
- Option B: initial cost of USD 1,100; annual subscription of 32 × 12 users × 12 months = USD 4,608; backup link of 30 × 12 = USD 360 a year; total annual cost, USD 4,968.

a) *TCO* of A = 7,900 + 2,820 × 3 + 650 = USD 17,010

TCO of B = 1,100 + 4,968 × 3 = USD 16,004

b) Difference = 17,010 - 16,004 = USD 1,006, that is, 1,006 / 17,010 = 5.9% of the *TCO* of A

c) 1,100 + 36 × (12 × *p* + 30) = 17,010, from which *p* = 14,830 / 432 = USD 34.33

d) Over five years: *TCO* of A = 7,900 + 2,820 × 5 + 650 = USD 22,650; *TCO* of B = 1,100 + 4,968 × 5 = USD 25,940

Over three years, the SaaS service costs 5.9% less, but the margin is narrow: if the fee exceeds USD 34.33 per user per month, the in-house server turns out cheaper. Over five years the conclusion is reversed and the server beats SaaS by USD 3,290; with costs that accumulate evenly, both curves cross around the middle of the fourth year. That result assumes the equipment is not renewed. The decision must also weigh continuity in the face of failures, the backups and security, factors that in the case tipped the balance toward SaaS.

Discounting the flows, as chapter 12 proposes, would favor SaaS somewhat, because its payments are spread over time whereas the server concentrates the investment at the start.

Application exercise 2. Break-even point of a subscription model

Data of the problem:

- A price of USD 39 and a variable cost of USD 9 per subscriber per month.
- Fixed costs of USD 7,200 a month and monthly churn of 4% of the subscribers.
- Free version: a cost of USD 0.30 per user per month and conversion of 5% of the active users.

Break-even subscribers = 7,200 / (39 - 9) = 7,200 / 30 = 240

- a) The contribution margin is USD 30 per subscriber and the break-even point is reached with 240 subscribers.
- b) The break-even base loses 240 × 0.04 = 9.6 subscribers a month. Since there are no fractions of a customer, the company must acquire at least 10 new subscribers every month just to keep it.
- c) If 5% of the active users pay, for every paying subscriber there are 95 / 5 = 19 free users, which cost 19 × 0.30 = USD 5.70 a month.
- c) The effective margin per paying subscriber falls to 30 - 5.70 = USD 24.30, and the break-even point becomes 7,200 / 24.30 = 296.3, which is rounded up to 297 paying subscribers.
- c) The active base needed is 297 / 0.05 = 5,940 users, of which 5,643 use the free version.
- Check: with 297 subscribers, revenue (USD 11,583) exceeds total costs (USD 11,565.90) by USD 17.10; with 296, the result would be a loss of USD 7.20.

Interpretation: the free version raises the break-even point from 240 to 297 paying subscribers, 23.75% more, and forces the company to sustain almost six thousand active users. It is only worth launching if it makes customer acquisition cheaper or if it raises conversion enough to offset that cost.

Application exercise 3. Online marketplace with commission revenue

Data of the problem:

- A commission of 12% on each sale and an average purchase of USD 25.
- A cost of USD 0.90 per transaction in payments and anti-fraud verification.
- Fixed costs of USD 4,400 a month.

Break-even transactions = 4,400 / (0.12 × 25 - 0.90) = 4,400 / 2.10 = 2,095.2

- a) Each sale leaves a commission of 0.12 × 25 = USD 3.00 and a margin of 3.00 - 0.90 = USD 2.10 per transaction.
- b) The quotient 2,095.2 is rounded up: the platform needs 2,096 transactions a month to cover its fixed costs.
- c) The gross value of the sales that must flow through the platform is 2,096 × 25 = USD 52,400 a month.
- Check: 2,096 × 2.10 = USD 4,401.60, enough to cover the fixed costs; with 2,095 transactions it would fall USD 0.50 short.

Interpretation: in order to earn what its fixed operations cost, the platform must intermediate almost twelve times that figure in sales. For that reason, its launch must concentrate on attracting enough workshops and buyers at the same time, for example by seeding supply with selected workshops and focusing at first on a few cities.

Chapter 4. Data, analytics and artificial intelligence for decision making

Application exercise 2. Percentage change in sales

- Data: sales of 42,500 dollars in January, 47,600 in February and 44,030 in March; 39,800 dollars in March of the previous year and 46,200 dollars in April (actual value).

Percentage change = (Current value - comparison value) / comparison value × 100

February against January = (47,600 - 42,500) / 42,500 × 100 = 12.0%

March against February = (44,030 - 47,600) / 47,600 × 100 = -7.5%

March against March of the previous year = (44,030 - 39,800) / 39,800 × 100 = 10.6%

Forecast for April = (42,500 + 47,600 + 44,030) / 3 = 134,130 / 3 = 44,710 dollars

Absolute percentage error = |46,200 - 44,710| / 46,200 × 100 = 1,490 / 46,200 × 100 = 3.2%

- Interpretation: the fall of March with respect to February is not, on its own, a warning sign, because against the same month of the previous year sales grew by 10.6%.
- February was an atypical month: with fewer days, it sold more than January and than March, possibly because of seasonal factors such as a public holiday.
- The forecast underestimated April by 1,490 dollars; an error of 3.2% is usually tolerable for planning purchases, provided that it keeps being measured every month.

Application exercise 3. Metrics of a classifier

- Data: 500 test invoices; the model flagged 80 as risky, of which 48 were paid late, and 420 as punctual, of which 16 were paid late.

- Confusion matrix: true positives (TP) = 48; false positives (FP) = 80 - 48 = 32; false negatives (FN) = 16; true negatives (TN) = 420 - 16 = 404.

$$\textit{Accuracy} = (48 + 404) / 500 = 452 / 500 = 0.904 \ (90.4\%)$$

$$\textit{Precision} = 48 / (48 + 32) = 48 / 80 = 0.600 \ (60.0\%)$$

$$\textit{Recall} = 48 / (48 + 16) = 48 / 64 = 0.750 \ (75.0\%)$$

$$\textit{Accuracy of the naive model} = (32 + 404) / 500 = 436 / 500 = 0.872 \ (87.2\%)$$

- Interpretation: the model is right in six out of every ten alerts (precision) and detects three out of every four invoices that end up late (recall).
- Its accuracy exceeds by barely 3.2 percentage points that of a naive model which declares every invoice punctual and detects no late payment at all; that is why accuracy is of no use for judging it.
- The collections area should watch recall, because an undetected late payment costs more than a preventive call to a customer who would have paid on time.

Chapter 5. Processes, operations and the digital supply chain

Application exercise 1. Cycle time, capacity and cost per order

Data.

- Demand: 1,100 / 22 = 50 orders a day.
- Time available per day: 2 × 420 = 840 minutes in administration and 3 × 420 = 1,260 minutes in the warehouse.
- Before: 20 minutes of administration (6 + 9 + 5) and 20 of warehouse per order; waiting times of 90 + 120 + 45 = 255 minutes.
- After: 4 minutes of administration (1 + 2 + 1) and 20 of warehouse per order; waiting times of 10 + 40 + 30 = 80 minutes; portal costing USD 440 a month.

Procedure and results.

- Cycle time before: 40 minutes of work plus 255 of waiting add up to 295 minutes (4 h 55 min), with an efficiency of 40 / 295 × 100 = 13.6%.
- Cycle time after: 24 minutes of work plus 80 of waiting add up to 104 minutes (1 h 44 min), with an efficiency of 24 / 104 × 100 = 23.1%; the cycle is shortened by 191 minutes (64.7%).
- Capacity before: administration, 840 / 20 = 42 orders a day, and the warehouse, 1,260 / 20 = 63. The bottleneck is administration, which does not cover the 50 orders and needs (50 - 42) × 20 = 160 minutes of overtime a day.

- Capacity after: administration, 840 / 4 = 210 orders a day, and the warehouse, 63. The bottleneck moves to the warehouse, which covers demand with a utilization of 50 / 63 × 100 = 79.4%.
- Cost per order before: 20 × 0.10 + 20 × 0.08 = 2.00 + 1.60 = USD 3.60.
- Cost per order after: 4 × 0.10 + 20 × 0.08 + 440 / 1,100 = 0.40 + 1.60 + 0.40 = USD 2.40. The difference is USD 1.20 per order (33.3%) and USD 1,320 a month.

Interpretation. The improvement in cycle time comes above all from the fall in waiting times, a symptom of a saturated administrative team. The saving of USD 1,320 a month will be money only if the 17,600 administrative minutes freed up each month (16 × 1,100) are reassigned, for example, to collections. With the portal, the warehouse becomes the bottleneck: to go beyond 63 orders a day, picking will have to be improved.

Application exercise 2. Cycle times from the event log in table 5.2

Data.

- Event log of table 5.2: three orders recorded on the same day.
- Prescribed model: recording, credit approval, picking, invoice issue and dispatch.

Procedure and results.

- Order 2101: from 08:10 to 13:20, 310 minutes elapse (5 h 10 min).
- Order 2102: from 08:30 to 16:40, 490 minutes elapse (8 h 10 min).
- Order 2103: from 09:05 to 12:35, 210 minutes elapse (3 h 30 min).
- Average: (310 + 490 + 210) / 3 = 1,010 / 3 = 336.7 minutes, about 5 h 37 min.
- Variants: order 2101 follows the model; 2102 repeats the credit approval (rework); 2103 goes from recording to picking without approval (deviation).
- Rework of order 2102: from 09:50 to 12:15, 145 minutes elapse between the first and the second approval.
- Controls: a list of mandatory documents when recording the order, so that credit is settled in a single review, and an ERP rule that prevents an order from being picked without approved credit.

Interpretation. The fastest order is precisely the one that skipped the credit control: a short cycle time can hide a risk, and that is why conformance checking complements the measurement of times. In order 2102, the 145 minutes between approvals explain most of the 180 minutes by which it takes longer than 2101.

Chapter 6. Customers, digital marketing and electronic commerce

Application exercise 1. Conversion and customer lifetime value

Data.

- Visits: 40,000; orders: 1,000; average order value: USD 25.
- New customers: 400.
- Acquisition investment: USD 4,500 in advertisements and USD 1,500 in content and staff hours.
- Revenue attributed to the advertisements: USD 13,500; gross margin: 40%.
- Purchase frequency: four orders a year; average length of the relationship: 1.5 years.

Procedure.

$$\textit{Conversion rate} = 1{,}000 / 40{,}000 \times 100 = 2.5\%$$

$$\textit{CAC} = (4{,}500 + 1{,}500) / 400 = \text{USD } 15.00$$

$$\textit{CLV} = 25 \times 0.40 \times 4 \times 1.5 = \text{USD } 60.00$$

$$\textit{CLV} / \textit{CAC} = 60.00 / 15.00 = 4.0$$

$$\textit{ROAS} = 13{,}500 / 4{,}500 = 3.0$$

$$\text{Break-even } \textit{ROAS} = 1 / 0.40 = 2.5$$

Interpretation. One in every forty visits ends in an order. Each new customer costs USD 15 and leaves USD 60 of margin, four times what was invested in acquiring them, and the advertisements exceed the threshold of 2.5 with a contribution of USD 900 (13,500 × 0.40 - 4,500): acquisition is sustainable.

Application exercise 2. Profitability of two advertising campaigns

Data.

- Gross margin of the store: 30%.
- Campaign A: investment of USD 2,000; attributed revenue of USD 7,000.
- Campaign B: investment of USD 1,500; attributed revenue of USD 4,200.

Procedure.

$$\textit{ROAS} \text{ of A} = 7{,}000 / 2{,}000 = 3.5$$

$$\textit{ROAS} \text{ of B} = 4{,}200 / 1{,}500 = 2.8$$

$$\text{Break-even } \textit{ROAS} = 1 / 0.30 = 3.33$$

$$\text{Contribution of A} = 7{,}000 \times 0.30 - 2{,}000 = \text{USD } 100$$

Contribution of B = 4,200 × 0.30 - 1,500 = -240 (a loss of USD 240)

Interpretation. Campaign A barely exceeds the threshold and leaves USD 100, 5% of what was invested; B loses USD 240 despite its ROAS of 2.8. Before suspending it, it is worth knowing how many new customers it brought, how much they are worth according to their CLV and whether it helped to generate sales that were attributed to A.

Chapter 7. People, culture and leadership in digital transformation

Application exercise 1. Digital skills gap of the branch advisors

Data

- Levels of advisors A, B, C and D, required level and weight of each area, according to table 7.2 (scale of 1 to 8).

a) Average level and gap by area

Gap = Required level - Current average level

- Information and data literacy: (3 + 4 + 2 + 3) / 4 = 3.00; gap = 4 - 3.00 = 1.00.
- Communication and collaboration: (5 + 4 + 4 + 5) / 4 = 4.50; gap = 5 - 4.50 = 0.50.
- Digital content creation: (2 + 3 + 2 + 3) / 4 = 2.50; gap = 3 - 2.50 = 0.50.
- Safety: (2 + 2 + 3 + 1) / 4 = 2.00; gap = 5 - 2.00 = 3.00.
- Problem solving: (3 + 3 + 4 + 2) / 4 = 3.00; gap = 5 - 3.00 = 2.00.

b) Simple average gap and weighted gap

- Simple average gap = (1.00 + 0.50 + 0.50 + 3.00 + 2.00) / 5 = 7.00 / 5 = 1.40 levels.
- Weighted gap = 1.00 × 0.10 + 0.50 × 0.25 + 0.50 × 0.10 + 3.00 × 0.35 + 2.00 × 0.20 = 0.100 + 0.125 + 0.050 + 1.050 + 0.400 = 1.725 levels.

c) Training priority (gap × weight)

- Safety: 3.00 × 0.35 = 1.050 (priority 1).
- Problem solving: 2.00 × 0.20 = 0.400 (priority 2).
- Communication and collaboration: 0.50 × 0.25 = 0.125 (priority 3).
- Information and data literacy: 1.00 × 0.10 = 0.100 (priority 4).
- Digital content creation: 0.50 × 0.10 = 0.050 (priority 5).
- Comparison: with the simple gap, information and data literacy (1.00) came before communication and collaboration (0.50); once weighted, communication moves up to third place because it carries 25% in the job, against the 10% of information and data literacy.

d) Average individual gap

- Average required level = (4 + 5 + 3 + 5 + 5) / 5 = 4.40.
- Advisor A: (3 + 5 + 2 + 2 + 3) / 5 = 3.00; gap = 4.40 - 3.00 = 1.40.
- Advisor B: (4 + 4 + 3 + 2 + 3) / 5 = 3.20; gap = 4.40 - 3.20 = 1.20.
- Advisor C: (2 + 4 + 2 + 3 + 4) / 5 = 3.00; gap = 4.40 - 3.00 = 1.40.
- Advisor D: (3 + 5 + 3 + 1 + 2) / 5 = 2.80; gap = 4.40 - 2.80 = 1.60. It is the largest, and their widest distance is in safety: level 1 against the 5 required.

Interpretation: the team is strong in communication with members, but its weak point is safety, the area that weighs most in a job that must guide members in the face of fraud. Training should start with safety and problem solving, with an individual plan for advisor D, and the measurement should be repeated after six months.

Application exercise 4. Tasks freed up by automation in an administrative position

Data

- A 40-hour week: typing 12 h, reconciliation 8 h, weekly report 5 h, complaints and negotiation 9 h, coordination of deliveries 6 h.
- Planned automation: 80% of typing and of reconciliation, and 50% of the report.

a) Classification of the tasks

- Routine, because they follow explicit rules: typing, reconciliation and the weekly report; they add up to 12 + 8 + 5 = 25 h, 62.5% of the working week.
- Non-routine: complaints and negotiation, which are interpersonal, and the coordination of deliveries when something unexpected happens, which calls for solving problems; they add up to 9 + 6 = 15 h, 37.5%.
- The report is classified as routine because it consists above all of compiling data; that is why the tool absorbs only half of its hours, and the review and the commentary remain with the person.

b) Hours freed up

$$\textit{Hours freed up} = 0.80 \times (12 + 8) + 0.50 \times 5 = 16 + 2.5 = 18.5 \text{ h per week}$$

- Share of the working week: 18.5 / 40 × 100 = 46.25%.
- Routine hours that remain: 25 - 18.5 = 6.5 h.

c) Redesign of the job

Interpretation: the composition of the job changes. Almost half of the working week is freed up for tasks such as following up overdue receivables, analyzing sales by customer or handling online orders, which require strengthening information and data literacy, communication and collaboration, and safety. Without defined tasks or training, those hours dissolve or become an argument for cutting staff.

Chapter 8. Digital maturity: models, measurement and diagnosis

Application exercise 1. Digital maturity index of a distributor

Data. Averages from 1 to 5 and weights by dimension:

- Strategy: 2.2; weight 0.25.
- Customers: 3.4; weight 0.20.
- Processes: 2.6; weight 0.20.
- Technology: 3.8; weight 0.15.
- People: 1.6; weight 0.20. The weights add up to 1.00.

a) Normalization with $Pj = (Mj - 1) / 4 \times 100$:

- Strategy: $(2.2 - 1) / 4 \times 100 = 30$.
- Customers: $(3.4 - 1) / 4 \times 100 = 60$.
- Processes: $(2.6 - 1) / 4 \times 100 = 40$.
- Technology: $(3.8 - 1) / 4 \times 100 = 70$.
- People: $(1.6 - 1) / 4 \times 100 = 15$.

b) Weighted index and level:

$$DMI = 0.25 \times 30 + 0.20 \times 60 + 0.20 \times 40 + 0.15 \times 70 + 0.20 \times 15 = 41.0$$

- Contributions by dimension: 7.5 + 12.0 + 8.0 + 10.5 + 3.0 = 41.0 points.
- Level: integrated, because 41.0 falls in the band from 40 to under 60.

c) Equal weights and the weakest-link rule:

- With weights of 0.20: (30 + 60 + 40 + 70 + 15) / 5 = 43.0; the level is still integrated.
- The weakest dimension is people, with 15 points, at the initial level; by the weakest-link rule, the overall level cannot go beyond exploratory.

d) Effect of raising the average by 0.8 points:

- An increase of 0.8 in the average is equivalent to $0.8 / 4 \times 100 = 20$ normalized points.
- People: $0.20 \times 20 = 4.0$ more points; the index becomes 45.0.
- Technology: $0.15 \times 20 = 3.0$ more points; the index becomes 44.0.

Interpretation. The integrated level is fragile: the index is one point from the cut-off and rests on the offsetting provided by customers and technology. People constrains the whole and has the greatest room for improvement, 85 normalized points against 30 for technology; the priority is to train the staff and manage the change before buying technology.

Chapter 9. Technology adoption: theories and factors

Application exercise 1. Acceptance survey in the dental clinic

Data: a scale from 1 to 5, an acceptance threshold of 3.5 and 100 respondents: 4 at the front desk, 8 dentists and 88 patients.

$$\textit{Weighted mean} = \Sigma\,(n \times \textit{group mean}) \,/\, \Sigma\, n$$

1. **Perceived usefulness:** (4 × 4.4 + 8 × 3.2 + 88 × 4.1) / 100 = (17.6 + 25.6 + 360.8) / 100 = 404.0 / 100 = 4.04.
2. **Perceived ease of use:** (4 × 2.7 + 8 × 3.8 + 88 × 3.6) / 100 = (10.8 + 30.4 + 316.8) / 100 = 358.0 / 100 = 3.58.
3. **Intention to use:** (4 × 3.0 + 8 × 3.1 + 88 × 3.9) / 100 = (12.0 + 24.8 + 343.2) / 100 = 380.0 / 100 = 3.80.
4. **Gaps with respect to the threshold (group mean - 3.5):** front desk, usefulness +0.9, ease -0.8 and intention -0.5; dentists, usefulness -0.3, ease +0.3 and intention -0.4; patients, usefulness +0.6, ease +0.1 and intention +0.4.
5. **Average for the staff (12 people):** usefulness 43.2 / 12 = 3.60; ease 41.2 / 12 = 3.43; intention 36.8 / 12 = 3.07. Patients contribute 88 of the 100 answers, that is, 88% of the weight.

- **Priority 1, front desk:** ease is 0.8 points below the threshold and intention, 0.5; the double registration of phone calls should be removed, the screens simplified and the staff supported during the first weeks.
- **Priority 2, dentists:** they find the system easy, but usefulness (-0.3) and intention (-0.4) do not reach the threshold; they should be shown the no-show data from the pilot and allowed to reserve slots for their trusted patients.
- **Priority 3, patients:** they are above the threshold in the three constructs; it is enough to keep the telephone option for older patients and to watch ease, which exceeds it only slightly (3.6).

The overall average exceeds the threshold because patients account for 88% of the calculation; among those who operate the system daily, by contrast, ease and intention fall below 3.5. Read

through TAM, the diagnosis separates a problem of effort at the front desk from one of usefulness among the dentists. Although the gap of the latter is smaller, usefulness is the belief most closely tied to sustained use, and that is why it should not be put off.

Application exercise 2. Adoption curve of QR code payment

Data: 200 affiliated stores and new adoptions per year (hypothetical data).

$$\textit{Cumulative percentage} = (\textit{cumulative adoptions} / 200) \times 100$$

- 2018: 4 new; cumulative 4; 2.0%.
- 2019: 10 new; cumulative 14; 7.0%.
- 2020: 26 new; cumulative 40; 20.0%.
- 2021: 44 new; cumulative 84; 42.0%.
- 2022: 52 new; cumulative 136; 68.0%.
- 2023: 34 new; cumulative 170; 85.0%.
- 2024: 20 new; cumulative 190; 95.0%.
- 2025: 10 new; cumulative 200; 100.0%.
- **Year with the most new adoptions:** 2022, with 52 stores.
- **Half of the stores:** by the end of 2021, 42.0% had adopted and by the end of 2022, 68.0%; adoption number 100 therefore occurred during 2022.
- **Phases:** a slow start in 2018 and 2019 (14 stores, 7.0% of the total), acceleration between 2020 and 2022 (122 stores, 61.0%) and saturation between 2023 and 2025 (64 stores, 32.0%), with decreasing new adoptions.

Cumulative adoption draws the S-curve of diffusion theory. The first fourteen stores are the earliest adopters; the acceleration from 2020 to 2022 is consistent with the observability of the payment among neighbors and with the example of the shopkeepers whom others consult. Before putting pressure on the last ten, it is worth finding out whether they face barriers that can be overcome or whether their decision is sensible.

Chapter 10. Digital transformation in MSMEs and in emerging economies

Application exercise 1. Prioritizing barriers with a frequency by impact matrix

$$P = F \times I$$

Data, calculation and quadrant (cut-off of 3.0 on both axes), from highest to lowest priority:

1. Insufficient digital skills: 4.4 × 4.0 = 17.60; quadrant I (high frequency, high impact).
2. Lack of time of the owner: 4.1 × 3.4 = 13.94; quadrant I.
3. Unstable connectivity: 3.6 × 3.5 = 12.60; quadrant I.

4. Initial cost of equipment and software: 2.5 × 4.2 = 10.50; quadrant II (low frequency, high impact).
5. Tax informality: 1.8 × 4.6 = 8.28; quadrant II.
6. Distrust of online payments: 3.5 × 2.3 = 8.05; quadrant III (high frequency, low impact).
7. Customers' rejection of the digital channel: 1.9 × 2.1 = 3.99; quadrant IV (low frequency, low impact).

Interpretation: the three barriers of quadrant I call for action now. Informality (8.28) and distrust of payments (8.05) almost tie in *P*, but the matrix separates them: the first, serious for a few, calls for individual support; the second, mild for many, allows a mass and cheap response. The response to the two priorities, skills and the owner's time, should be led by the trade association, with university support.

Application exercise 2. Revenue per hat by sales channel

$$\text{Net online income} = 48.00 - (0.15 \times 48.00) - 2.50 - (0.05 \times 48.00) = 35.90$$

Data and results:

- Data: USD 22.00 to the middleman; USD 48.00 online, with a commission of 15%, packaging of USD 2.50 and a contribution of 5%.
- Income per hat with the middleman: USD 22.00.
- Income per hat online: 48.00 - 7.20 - 2.50 - 2.40 = USD 35.90.
- Difference: 35.90 - 22.00 = USD 13.90 per hat; 13.90 / 22.00 = 63.2% more.
- Monthly income with the middleman: 10 × 22.00 = USD 220.00.
- Hats to be sold online to match it: 220.00 / 35.90 = 6.13; 7 are needed, because 6 would yield USD 215.40.

Interpretation: the online channel leaves 63.2% more per piece, but the calculation leaves out the time spent on service and packaging, returns over sizing and possible changes in the platform's commissions; those costs should be measured before leaving the middleman.

Chapter 11. Governance, ethics, cybersecurity and the regulatory framework

Application exercise 1. Prioritizing the threats faced by an optician's shop

Data. Five threats rated on scales from 1 to 5, with four classification thresholds: low (1 to 4), medium (5 to 9), high (10 to 14) and critical (15 to 25).

$$\textit{Risk} = \textit{Likelihood} \times \textit{Impact}$$

Part a. The product of the two ratings gives the initial risk of each threat:

- T1, identity spoofing: 4 × 4 = 16 (critical).

- T2, ransomware: 3 × 5 = 15 (critical).
- T3, interruption of the hosting provider: 2 × 4 = 8 (medium).
- T4, loss of the laptop: 3 × 3 = 9 (medium).
- T5, mistaken sending of eye health data: 2 × 5 = 10 (high).

The order of priority is T1, T2, T5, T4 and T3. The two critical threats take the first investment in controls.

Part b. The controls modify only two threats; the rest keep their value:

- T1, with multi-factor authentication and training: 2 × 4 = 8 (medium), 50% less.
- T2, with offline backups that are tested: 3 × 3 = 9 (medium), 40% less.
- Initial total risk: 16 + 15 + 8 + 9 + 10 = 58 points.
- Residual total risk: 8 + 9 + 8 + 9 + 10 = 44 points.
- Reduction of total risk: (58 - 44) / 58 × 100 = 24.1%.
- New order: T5 (10), T2 and T4 (9), T1 and T3 (8).

Interpretation. No critical threat remains and the new priority is T5, with 10 points (high): a human error that exposes health data, sensitive according to the LOPDP, and that is addressed with training, stricter access permissions and encrypted files. Adding up the scores serves only to compare scenarios, because the scales are ordinal and do not measure losses in money.

Chapter 12. The road map: from strategy to execution and the measurement of value

Application exercise 1. Financial appraisal of extending telemetry

a) Net flows:

- Year 1: 30,000 - 12,000 = USD 18,000.
- Year 2: 38,000 - 12,000 = USD 26,000.
- Years 3 and 4: 40,000 - 12,000 = USD 28,000 each year.

b) NPV at 12%:

$$NPV = 18{,}000 / 1.12 + 26{,}000 / 1.12^2 + 28{,}000 / 1.12^3 + 28{,}000 / 1.12^4 - 60{,}000$$

$$NPV = 16{,}071.429 + 20{,}727.041 + 19{,}929.847 + 17{,}794.506 - 60{,}000 = \text{USD } 14{,}522.82$$

c) IRR:

- NPV at 22%: USD 281.49.
- NPV at 23%: USD -900.44.
- Linear interpolation: 22 + 281.49 / (281.49 + 900.44) = 22.24%, the same value returned by the IRR function of a spreadsheet.

d) ROI of the horizon:

$$ROI = [(18{,}000 + 26{,}000 + 28{,}000 + 28{,}000) - 60{,}000] / 60{,}000 \times 100 = 66.67\%$$

e) Payback periods:

- Simple cumulative flows at the close of years 1, 2 and 3: USD -42,000; -16,000 and 12,000.
- Discounted cumulative flows at the close of years 1 to 4: USD -43,928.57; -23,201.53; -3,271.68 and 14,522.82.

$$\text{Simple } PP = 2 + 16{,}000 / 28{,}000 = 2.57 \text{ years}$$

$$\text{Discounted } PP = 3 + 3{,}271.68 / 17{,}794.51 = 3.18 \text{ years}$$

f) Conservative scenario:

- With benefits 10% lower, the net flows are USD 15,000; 22,200; 24,000 and 24,000.

$$NPV = 15{,}000 / 1.12 + 22{,}200 / 1.12^2 + 24{,}000 / 1.12^3 + 24{,}000 / 1.12^4 - 60{,}000 = \text{USD } 3{,}425.72$$

The project creates value: its NPV is positive and its IRR of 22.24% comfortably exceeds the 12% required. The ROI of 66.67% overstates its appeal because it does not discount time, and the discounted payback, a little over three years on a four-year horizon, leaves little margin. Since the NPV withstands the conservative scenario (it would only vanish with benefits about 13.1% lower), the extension should be approved.

Application exercise 2. Prioritizing five initiatives

a) Scores:

- A, online store: $0.5 \times 4 + 0.3 \times (6 - 4) + 0.2 \times (6 - 3) = 3.2$.
- B, cloud inventory: $0.5 \times 5 + 0.3 \times (6 - 3) + 0.2 \times (6 - 2) = 4.2$.
- C, payment reminders: $0.5 \times 3 + 0.3 \times (6 - 1) + 0.2 \times (6 - 1) = 4.0$.
- D, sales dashboard: $0.5 \times 3 + 0.3 \times (6 - 2) + 0.2 \times (6 - 2) = 3.5$.
- E, loyalty app: $0.5 \times 2 + 0.3 \times (6 - 5) + 0.2 \times (6 - 4) = 1.7$.
- Resulting order: B, C, D, A and E.
- **b) Matrix:** B is a quick win; A, a strategic bet; C and D, minor improvements; E, an initiative to be dropped or postponed.
- **c) Waves:** in the first one, B, which also enables A, and C, cheap and with an immediate effect; in the second one, A and D. E is dropped or postponed.
- **d) Weights 0.4, 0.4 and 0.2:** C = 4.2; B = 4.0; D = 3.6; A = 3.0 and E = 1.6.

By giving more weight to effort, C overtakes B: the simplest initiative rises even though it contributes less. Setting the weights is therefore a strategic decision of the committee. The dependence of A on B does not change with the weights: B comes first in any scenario.

Appendix C. Templates and checklists

This appendix brings together four templates that turn the content of chapters 8, 11 and 12 into a working format. The tables are meant to be copied and filled in at the company: the columns for scoring, owner and deadline are left empty because what goes in them depends on each case, and the examples that appear are declared as such. None of the four replaces the judgment of the person using them; their usefulness lies in making sure that no important question goes unasked.

C.1. Checklist for the maturity diagnosis by dimension

The checklist runs through the six dimensions of the reference model of chapter 8 in their original order. Every row states a fact that can be checked and the evidence that supports it, because an answer without evidence is worth little in a diagnosis; the last column records the level from 1 to 5 that the team agrees on, using the descriptors of section 8.2. People from different areas should answer separately, and the differences between their answers should be discussed before the level is set, because that distance is itself a finding.

Table C.1

Checklist for the digital maturity diagnosis by dimension

What to check	Evidence that supports it	Level (1 to 5)
Strategy (chapter 3)		
There is a written digital vision, with targets and deadlines.	The vision document or the minutes of the meeting that approved it.	
Every digital target has a named owner.	List of initiatives with their owner.	
The budget for the year sets aside an amount for digital work.	The corresponding line of the approved budget.	
Customers (chapter 6)		
Digital channels handle orders and queries within an agreed time.	Record of orders and conversations for the period.	
The company knows what share of its customers buys again.	Calculation of the retention rate for the last period.	

What to check	Evidence that supports it	Level (1 to 5)
Customer opinions are collected and reviewed.	Results of the last survey or of the reviews received.	
Processes (chapter 5)		
The core processes are described and assigned to an owner.	Diagram or description of the process in force.	
What is already recorded in one system is not keyed again into another.	Walkthrough of a real order from start to finish.	
Cycle times are measured with data and not by impression.	Event log of the system that supports the process.	
Technology (chapter 2)		
The inventory of equipment, systems and licenses is up to date.	Inventory of technology assets with the date it was reviewed.	
Backups are made and tested by restoring a file.	Log of the last backup and of its restoration test.	
Access is granted per person and withdrawn when someone leaves.	List of active users and of departures for the period.	
People and culture (chapter 7)		
The gap between current and required skills is known.	Result of the digital skills self-assessment.	
There is a training plan with hours, dates and participants.	Training plan for the current year.	
Whoever uses each tool took part in choosing or testing it.	Minutes or record of the pilot test.	
Data (chapter 4)		
Sales and inventory figures come from a single source.	Two reports for the same week, issued by different systems.	
There is a dashboard of indicators reviewed at a fixed interval.	Minutes or screenshots of the last two dashboard reviews.	
Every processing of personal data has a declared purpose and legal basis.	Record of the processing activities and of the basis for each one.	

Note. The authors' own work, based on section 8.3. The dimensions and the chapter each one points to are those of the reference model of the book. The last row of every dimension tends to be the most uncomfortable and the most informative.

C.2. Catalog of indicators with their formula and their frequency

The catalog gathers in one place the indicators that the book defines in different chapters, with the exact formula used to calculate them and a reasonable review frequency. It is not a list to be adopted whole: eight or ten well-defined indicators are enough, and they should be chosen according to what the company decides with them. When the template is copied, every chosen indicator needs its baseline measured before starting, its target and its owner, because without a baseline no improvement can be demonstrated.

Table C.2

Catalog of digital transformation indicators with their formula, frequency and source

Area	Indicator	Formula	Frequency	Data source
Operations	Change in sales	(Sales of the period - sales of the previous period) / sales of the previous period × 100	Weekly	Invoicing system
Operations	Inventory turnover	Cost of sales / average inventory	Monthly	Inventory system
Operations	Complete and on-time orders	Orders delivered complete and on the agreed date / total orders × 100	Weekly	Order records
Operations	Order cycle time	Average hours between the receipt of the order and its delivery	Weekly	Event log of the system
Customers	Conversion rate	Conversions / visits × 100	Monthly	Analytics of the site or the store
Customers	Retention rate	Customers active at the start who remain active / customers at the start × 100	Quarterly	Purchase history
Customers	Customer acquisition cost	Total investment in acquisition / new customers	Monthly	Acquisition spending and new customer records
People	Trained staff	People trained in the tool / people who must use it × 100	Quarterly	Attendance records of the training
People	Active use of the system	Active users in the month / enabled users × 100	Monthly	Access logs of the system

Area	Indicator	Formula	Frequency	Data source
Transformation	Share of digital revenue	Revenue from digital channels / total revenue × 100	Monthly	Invoicing split by channel
Transformation	Annual operating saving	Annual operating cost without the project minus annual operating cost with the project	Half-yearly	Cost accounting
Transformation	Digital maturity index	Weighted average of the normalized scores of the dimensions	Yearly	Diagnosis of chapter 8
Risk	Risk level of a threat	Likelihood × impact, both on a scale of 1 to 5	Half-yearly	Risk matrix of table C.3

Note. The authors' own work, based on tables 4.1, 6.1 and 12.1 and on chapters 5, 8 and 11. The frequency is a suggestion: an indicator is reviewed as often as what it measures can be corrected.

C.3. Risk matrix of the digital project

The matrix applies to the project the prioritization method of section 11.2: likelihood runs from 1, rare, to 5, almost certain; impact runs from 1, insignificant, to 5, severe, and their product ranks the priorities out of a maximum of 25. A common reading classifies the result as low between 1 and 4, medium between 5 and 9, high between 10 and 14 and critical between 15 and 25. As an example, a risk rated with a likelihood of 4 and an impact of 3 reaches 12 points, high, and is dealt with before another of likelihood 2 and impact 4, which reaches 8. The risks in the first column are those the book identifies most often; the planned response states the measure that each chapter recommends.

Table C.3

Risk matrix of a digital transformation project

Project risk	Where it arises	Likelihood	Impact	L × I	Planned response
Low adoption of the tool that was installed	People and culture (chapter 7)				Involve those who will use it in the pilot test and train with real cases.
Unreliable data or data duplicated in two systems	Data and processes (chapters 4 and 5)				A single source per item of data, periodic reconciliation and a named owner.

Project risk	Where it arises	Likelihood	Impact	L × I	Planned response
Dependence on a single supplier or a single person	Technology and governance (chapters 2 and 11)				Data exit agreed in the contract and documentation of the system kept at the company.
Cost overrun or missed deadline of the initiative	Project management (chapter 12)				Short waves with verifiable deliverables and periodic review of the road map.
Security incident that stops operations	Cybersecurity (chapter 11)				Multi-factor authentication and offline backups that have been tested.
Processing of personal data without a legal basis	Data protection (chapter 11)				Review of the purpose and the legal basis of each processing before it starts.
Benefit that cannot be demonstrated when the project closes	Value measurement (chapter 12)				A baseline measured before starting and a written target per indicator.
Insufficient connectivity or equipment at the workplace	Infrastructure (chapters 2 and 10)				Test on site before committing to the solution, and an offline alternative.

Note. The authors' own work, based on sections 11.2 and 12.2. The three numerical columns are left empty because their value depends on each company and should be discussed with the people who know the operation; the L × I column is the product of the two before it.

C.4. Script of the road map by phases

The script follows the six phases of figure 12.1 and turns each one into the questions it must answer and the output that closes it. The phases overlap and repeat, so the script orders the work without imposing a calendar; when the template is copied, a column for the deadline and another for the owner should be added. A phase that leaves no output has not finished, however many meetings it has held.

Table C.4

Script of the digital transformation road map by phases

Phase	Questions it must answer	Output that closes it	Who takes part
1. Diagnosis and vision	Where is the company and where does it want to be in three years?	Maturity profile and desired state, with the gaps ranked.	Management and area owners
2. Portfolio of initiatives	Which projects close those gaps and what does each one cost?	One record per initiative with its objective, owner and estimated cost.	Area owners
3. Prioritization and sequence	Which one goes first, by impact, effort, risk and dependencies?	Prioritization matrix and waves of execution defined.	Management and the project committee
4. Business case and funding	Is the investment justified and where do the resources come from?	Costs, benefits and the investment indicators of section 12.4.	Management and accounting
5. Execution in waves	What is delivered in this wave and how is it checked to work?	Pilots and projects delivered, with evidence of real use.	Project team and the people who use the tool
6. Measurement, adjustment and scaling	Did performance change and what is worth extending to the rest of the company?	Updated scorecard and revised road map.	Project committee

Note. The authors' own work, based on figure 12.1 and section 12.6. The last column is a suggestion that every company adjusts to its size: in a micro-enterprise, several of those roles fall to the same person.

GLOSSARY OF TECHNICAL TERMS

A/B test. Comparison of two versions of a page or a message, shown at random to equivalent groups, to decide which works better with data rather than opinions.

Abandoned cart. Purchase started online that the customer does not complete; recovering it is one of the highest-return actions in electronic commerce.

Actionable indicator. Indicator that, when it moves, makes clear which decision has to be revisited; the opposite of one that merely informs.

Algorithmic bias. Systematic error of a model that harms a group, usually inherited from the historical data it was trained on.

Analog complements. Non-technological conditions, such as regulations, skills and institutions, on which the ability of digital technology to produce economic and social benefits depends.

Analytical capability. The combination of technological, human and intangible resources that allows an organization to turn data into decisions systematically.

Assimilation. The stage in which the use of a technology is built into work routines and no longer depends on reminders or supervision.

Balanced scorecard. A system of indicators that translates the strategy into measurable objectives, grouped in the financial, customer, internal process, and learning and growth perspectives.

Baseline. Initial measurement against which later measurements are compared in order to estimate progress.

Basic assumptions. The deepest level of organizational culture: beliefs that the group takes for granted and that guide behavior without being discussed.

Big data. Datasets whose volume, variety and velocity exceed conventional tools and demand new ways of capturing, storing and analyzing them.

Blockchain. A distributed ledger in which transactions are grouped into cryptographically chained blocks validated by consensus; altering a past record requires rebuilding the chain.

Bottleneck. The resource or activity with the lowest capacity in a process; it limits the number of cases the process completes per period.

Bullwhip effect. The amplification of variations in demand as orders move toward the upper links of the chain.

Business case. Document that justifies an initiative by comparing its costs, its expected benefits and its risks against the option of doing nothing.

Business intelligence. The processes, tools and practices that integrate the data of the organization in order to report on its performance and support decisions.

Business model. The logic by which an organization creates, delivers and captures value. It expresses management's hypothesis about what customers want and about how to serve them profitably.

Business process. A collection of events, activities and decisions involving actors and objects that produces an outcome of value for at least one customer.

Business process management. The discipline that identifies, discovers, analyzes, redesigns, implements and monitors the processes of an organization in a continuous cycle of improvement.

Channel. Means through which the firm communicates its proposition and delivers the product or service: physical store, website, messaging, online marketplace or distributor.

Cloud computing. A model of on-demand network access to shared and configurable computing resources, which are allocated and released rapidly and are paid for according to use.

Compatibility. Fit of an innovation with the values, needs and current practices of the adopter.

Competitive advantage. Set of conditions that allow a firm to obtain results above those of its competitors in a sustained way.

Complementary investments. Changes in processes, ways of working, skills and incentives that allow investment in technology to translate into performance improvements.

Complementary work. Task people take on once automation handles the routine part, usually involving more judgment and more contact with the customer.

Composite index. A measure that aggregates several indicators or dimensions into a single figure through explicit rules of normalization and weighting.

Confusion matrix. A table that crosses the actual classes with those predicted by a classifier and makes it possible to calculate its accuracy, its precision and its recall.

Conversion funnel. Representation of the stages a visitor goes through before buying, with the share that moves on at each step.

Conversion rate. The percentage of visits that complete the action defined as the objective, such as a purchase, a booking or a sign-up.

Critical mass. Minimum number of users beyond which a platform becomes attractive on its own and network effects start to sustain growth.

Customer acquisition cost (CAC). The total spending devoted to acquiring new customers in a period, divided by the number of customers acquired.

Customer journey. The set of stages a customer goes through before, during and after the purchase, together with the touchpoints that take part in each one.

Customer lifetime value (CLV). An estimate of the margin a customer will leave over their whole relationship with the company; its rigorous version weights retention and discounts future margins.

Customer segment. Group of customers whose needs and behavior are similar enough to be served with the same proposition.

Cyber-physical system. A system that integrates computing and physical processes through cycles of measurement, calculation and control; its digital component acts on the material world.

Cybersecurity. Risk management aimed at preserving the confidentiality, the integrity and the availability of information and of systems.

Cycle time. The time that elapses between the start and the end of a case; it includes effective work and waiting.

Data governance. The set of roles, rules and decision rights that establishes who defines, captures, corrects and uses each datum.

Data lineage. Ability to reconstruct where a figure came from and what transformations it went through before reaching the report.

Data literacy. Ability to read, interpret and question data in order to make decisions, without needing to know how to program.

Data minimization. Principle requiring that only the data necessary for the declared purpose be collected.

Data processor. The natural or legal person who processes personal data in the name and on behalf of the data controller.

Data quality. The degree to which a datum is accurate, complete, consistent, timely, unique and valid for the use intended for it.

Data subject. Natural person to whom personal data refers and who keeps rights over it even after handing it to a firm.

Datum. The elementary record of a fact, without interpretation, which on its own does not indicate what decision to take.

Dependency. A relationship by which an initiative needs another one to be finished or under way in order to be carried out or to yield its benefits.

DigComp. The European reference framework of the digital competence of citizens, organized in five areas and 21 competences, with eight proficiency levels.

Digital business strategy. An organizational strategy formulated and executed by leveraging digital resources to create differential value. It integrates IT strategy and business strategy into one.

Digital carbon footprint. Emissions associated with the devices, networks and data centers that support an organization's digital services.

Digital competence. The combination of knowledge, skills and attitudes that makes it possible to use digital technologies with confidence, a critical sense and responsibility in order to learn, work and take part in society.

Digital divide. The distance between people, firms or territories in access to digital technologies, in their use and in the benefits they obtain from them.

Digital economy. The set of economic activities that depend on information in digital form, on communication networks and on platforms that connect producers and consumers.

Digital good. Good whose substance is information and which can be reproduced and distributed at a marginal cost close to zero, such as a file, a template or an online course.

Digital innovation hub. A point of contact, neutral with respect to providers, that informs, raises awareness and trains SMEs so that they adopt digital technologies with judgment.

Digital leadership. The capacity of managers to set a direction that takes advantage of what technology makes possible, to mobilize people toward it and to govern the resulting change.

Digital maturity. The degree to which an organization has developed the capabilities that allow it to take advantage of digital technologies in its different dimensions, judged against a reference model.

Digital readiness. The willingness and ability of an organization to undertake changes based on digital technologies; it looks toward future action rather than toward the level already reached.

Digital scale effect. Ability to serve many more customers without costs growing in the same proportion, because the digital part of the service is replicated at no cost.

Digital sustainability. The set of activities with which organizations use digital technologies to tackle grand challenges, such as climate change.

Digital transformation. The continuous process by which an organization combines digital technologies with changes in its strategy, its structure and its culture in order to create value in ways that were not possible before.

Digital transformation road map. A plan that arranges over time the initiatives with which an organization moves from its current digital situation to the desired one, with owners, resources, milestones and indicators.

Digital transformation strategy. A plan that coordinates, prioritizes and sets in motion the changes a company undertakes with digital technologies; it is analyzed in four dimensions: technology, value creation, structure and finance.

Digitalization. The use of digital technologies to modify existing processes and the way the organization works with information.

Digitization. The technical conversion of analog information, such as paper documents or signals, into digital form.

Discontinuance. The rejection of an innovation after having adopted it, whether by replacement with a better alternative or by disenchantment with its performance.

Discount rate. Rate that translates a future flow into today's value; it reflects the cost of money and the risk of the investment.

Disruptive innovation. An innovation that at first performs worse on the attributes valued by mainstream customers, but offers a lower price, simplicity or convenience and improves until it displaces the established offering.

Driver indicator. A measure that anticipates a future result and makes it possible to correct in time, such as the percentage of trained staff against the later reduction of errors.

Dynamic capabilities. The ability of a firm to integrate, build and reconfigure internal and external competences in the face of rapidly changing environments.

Early win. Visible, quick result achieved in the first weeks of a change, used to sustain internal support.

Ecosystem. The alignment structure of the set of partners that need to interact for a value proposition to materialize.

Elasticity. Property of a cloud service that allows contracted capacity to grow or shrink with demand, paying only for what is used.

Electronic signature. Data associated with an electronic document that identify the signatory and make it possible to verify that the content was not altered.

Executive sponsor. Senior manager who backs an initiative, assigns resources and clears the obstacles the team cannot clear on its own.

Explicability. An ethical principle of AI that combines the intelligibility of the system with accountability for who answers for its operation.

Facilitating conditions. The resources, knowledge and support that a person perceives as available for using a technology; in UTAUT they influence use directly.

False negative. Positive case the model fails to detect. In a fraud alert, a fraudulent transaction that goes through.

False positive. Case the model classifies as positive when it is not. In a fraud alert, a legitimate purchase that gets blocked.

Feedback of results. A session in which the results of the diagnosis are presented and discussed with those who took part, in order to agree on priorities.

Force field analysis. A tool derived from Lewin's work that identifies the forces driving a change and those holding it back, in order to decide which ones to strengthen and, above all, which ones to weaken.

Formative indicator. An indicator that makes up the concept being measured; leaving it out trims the concept, and its quality is not assessed with internal consistency tests.

Fourth Industrial Revolution. Stage of technological development characterized by the fusion of technologies that blurs the boundaries between the physical, digital and biological spheres.

Freemium. A model that offers a basic version free of charge to a wide base of users and charges for an advanced version contracted by a minority.

Frugal innovation. The design of solutions with scarce resources, concentrated on the essential function, low in cost, easy to use and compatible with existing processes.

Frugal solution. Solution designed with minimal resources that solves the essential problem at a very low cost and withstands adverse conditions.

Generative AI. A type of AI that produces new content, such as text, images or code, from instructions in natural language.

Guiding coalition. A group with authority, knowledge and credibility that leads a change process in Kotter's model.

Hybrid approach. A way of managing a project that combines predictive planning for the stable components with agile iterations for the uncertain ones.

Imitative adoption. Decision to adopt a technology because similar businesses nearby adopted it, rather than because of the firm's own analysis.

Impact and effort matrix. A tool that classifies initiatives into four quadrants according to the expected value and the resources they demand: quick wins, strategic bets, minor improvements and initiatives to be dropped.

Industry 4.0. The application of cyber-physical systems, connected machines and data to manufacturing, in order to produce in a flexible and individualized way.

Informality. Condition of a productive unit that operates outside registration and regulation; it limits access to credit and to support programs.

Information. A set of data organized and placed in context in order to answer a specific question.

Informed consent. Free, specific and unambiguous statement by which a person authorizes the processing of their data for a given purpose.

Innovation intermediary. An organization that connects SMEs with knowledge, technologies, partners and resources of the ecosystem, such as a trade association, a technology center or a university.

Intangible asset. Resource with no physical existence that creates value, such as software, data, brands or organizational knowledge. Its weight grows with digitalization.

Intention to use. A person's stated willingness to use a technology; in acceptance models it is the immediate antecedent of actual use.

Internal rate of return (IRR). The discount rate that makes the NPV of a project equal to zero; it is compared with the minimum required rate.

Interoperability. Ability of two systems to exchange data and use it without manual transformations.

IoT (Internet of Things). A network of physical objects endowed with identification, sensors and connectivity that exchange data and cooperate to reach common goals.

IT business value. The effect of information technology on the performance of processes and of the organization, which depends on complementary resources and on the environment.

IT governance. The specification of the decision rights and of the accountability framework that guide the use of technology in an organization.

Labor productivity. The ratio between the output of a period and the labor used to obtain it, measured in people or in hours.

Last mile. The final stretch of the delivery of an order, from the last distribution point to the customer’s home.

Latency. Time a piece of data takes to travel between two points of a network. It determines which applications can run in the cloud and which need local processing.

Leading indicator. Indicator that moves before the result and allows timely correction, such as the number of orders captured in the system against the quarter's revenue.

Liquidity constraint. Lack of available cash that prevents an investment from being made even when it is profitable in the medium term.

Machine learning. A branch of AI made up of algorithms that improve their performance from examples, instead of following hand-programmed rules.

Maturity model. A sequence of levels representing an anticipated, desired or typical evolution path, accompanied by criteria for placing an organization on it.

Metadata. Data that describes other data: its origin, its date, its unit of measurement or the person responsible for it. Without metadata, a dataset is hard to reuse.

Milestone. Verifiable point in the schedule that marks the end of a phase and enables the next one.

Net present value (NPV). The sum of the future net flows discounted at the required rate, minus the initial investment; if it is positive, the project yields more than that rate.

Network effects. The change in the value obtained by each participant according to the number of participants. They are direct when they come from the same group and cross-side when they come from the other side of the platform.

Non-monetizable benefit. Valuable result that is not easily turned into money, such as fewer errors or better customer treatment; it is measured with its own indicators instead of forcing a figure.

Observability. Ease with which the results of an innovation are visible to others, which speeds up its diffusion.

Omnichannel management. The integrated management of channels and touchpoints so that the customer moves from one to another without interruptions and the performance of the whole is as good as possible.

Ongoing support. Sustained accompaniment, as opposed to one-off training, that stays with the firm while it builds the tool into its routine.

Online marketplace. A digital platform on which multiple sellers offer products to buyers, in exchange for commissions and under rules set by the operator.

Online review. Public rating left by a customer; it works as earned media and directly affects the purchase decision of someone who does not know the business.

Open innovation. An approach in which the company combines internal and external ideas, as well as internal and external paths, to bring its innovations to market.

Operating model. Specific way in which a firm organizes people, processes and technology to deliver its value proposition.

Operational backbone. A coherent set of systems, data and processes that supports the core operations of a company.

Opportunity cost of time. Value of what the owner-manager of a micro firm gives up while learning or implementing a tool.

Outcomes divide. The third level of the digital divide: differences in tangible results, such as sales, productivity or access to markets, among those who already have access to technology and use it.

Owned media. Channels that belong to the company, such as its website, its mailing list or its catalog, and that do not depend on paying for exposure.

Paid media. Distribution space the firm buys, such as advertisements in search engines, on social media or on third-party sites.

Payback period. The time the cumulative net flows, simple or discounted, take to equal the initial investment.

Peer comparison. Contrast of a firm's result with that of others of similar size and sector, which turns an isolated number into a position.

Perceived ease of use. The degree to which a person believes that using a system will be free of effort.

Perceived usefulness. The degree to which a person believes that using a system will improve their job performance.

Popular and solidarity economy. A form of economic organization recognized in the Constitution of Ecuador, made up of associations, cooperatives and community organizations that give priority to work and cooperation.

Portfolio of initiatives. The set of digital projects and improvements, candidate or under way, that is managed as a whole in order to balance value, risk and capacity.

Predictive analytics. The use of statistical or machine learning models to estimate what is likely to happen.

Prescriptive analytics. Analytics that recommends the best action among alternatives, given certain objectives and constraints.

Prioritized improvement plan. Document that turns the diagnosis into actions ordered by impact and effort, with an owner and a deadline.

Process map. Graphic representation of the activities of a process, their order and their owners, used to spot duplication and waiting time.

Process mining. A set of techniques that discover, check and improve process models from event logs.

Productivity paradox. Observation that investment in technology does not show up immediately in measured productivity, because the benefits appear once the complementary investments are completed.

Proof of concept. Small, bounded implementation used to check whether a technology works in the firm's real setting before committing the investment.

Psychological safety. The belief shared by the members of a team that it is safe to take interpersonal risks, such as asking, admitting mistakes or disagreeing.

Purpose of processing. Declared reason for which data is collected; using it for anything else requires a new legal basis.

Reference group of users. Set of similar firms whose adoption acts as a signal for those still hesitating.

Reflective indicator. An indicator that expresses a common underlying concept; reflective indicators are interchangeable and must correlate with one another.

Relative advantage. The degree to which an innovation is perceived as better than the practice or the technology it replaces.

Residual risk. The risk that remains after the controls have been applied; management decides whether to accept it, reduce it, transfer it or avoid it.

Resistance to change. Set of behaviors that slow an initiative down; it usually expresses a perceived loss of control, competence or status rather than plain stubbornness.

Response scale. Ordered set of options used to measure each item of the diagnosis; its wording determines how comparable firms are.

Retrospective. The meeting with which an agile team closes each cycle in order to examine its way of working and agree on specific improvements.

Return on advertising spend (ROAS). The ratio between the revenue attributed to the advertisements and the investment in them; it measures the efficiency of advertising, not its profitability.

Revenue stream. Specific way in which the firm charges: unit sale, subscription, commission, advertising or licensing.

Reverse logistics. Set of operations that handle the return of a product from the customer back to the firm.

Rework. Work that has to be repeated because the first execution went wrong; one of the most expensive and least visible sources of waste.

Robotic process automation. The use of programs that operate the interface of other applications as a person would in order to carry out rule-based tasks.

Robotic process automation (RPA). The use of programs that imitate, on the user interface, the repetitive tasks of an employee without modifying the existing information systems.

Routine task. An activity that follows explicit and repeatable procedures, so it can be codified into rules and automated relatively easily.

SaaS. Acronym for *software* as a service: a cloud model in which the company uses a complete application, administered by the provider, in exchange for a subscription.

Safety stock. Additional inventory a firm keeps to absorb swings in demand or delays from suppliers.

Security breach. An incident that affects the confidentiality, the integrity or the availability of personal data and that, as a general rule, must be notified to the authority.

Self-assessment. Evaluation the firm completes about its own practices; it is cheap and fast, but tends to overstate the level unless it is checked against evidence.

Sensitive data. Personal data whose improper processing may give rise to discrimination, such as health data, biometric data or data revealing ethnicity or religion.

Service level agreement. Agreement that sets the availability, the response times and the remedies the provider guarantees to the client.

Servitization. The shift from selling a good to selling the service, the availability or the result that the good produces, charging for use or for performance.

Skills gap. Distance between the digital skills a role requires and those the person has; it is the input for any training plan.

Stage model. A description of a sequence of phases through which all organizations supposedly pass, with a single axis of progress and a fixed order.

Staged digitalization route. A reasoned sequence of steps that takes a company from the basic order of its processes to new business models, adjusted to its starting point.

Structural heterogeneity. The coexistence, within one economy, of firms and sectors with very different levels of productivity; it is a persistent trait of Latin America.

Subjective norm. Perception that people who matter to someone expect them to use (or not use) a technology.

Subsidized side. In a two-sided market, the group of users charged little or nothing in order to attract the other side, which is the one that pays.

Sunk cost. Outlay already made that cannot be recovered and that therefore should not influence the decision to continue or stop a project.

Supply chain resilience. Ability of a supply chain to keep operating and to recover after a disruption.

Surveillance capitalism. An economic order that turns human experience into behavioral data in order to manufacture and sell predictions about behavior.

Systems integration. Connection between applications so that a datum captured once travels onward without being typed again.

Target profile. The set of cybersecurity outcomes an organization intends to reach; compared with the current profile, it reveals the gaps to be closed.

Technology adoption. The decision of a person or of an organization to bring in a technology; it is the first step of a process that continues with use, assimilation and the obtaining of value.

Technology architecture. The layered organization of the digital resources of a company (infrastructure and connectivity, data, applications and experience) and of the relationships among them.

Technology fallacy. The belief that transforming consists, above all, of choosing and installing technologies, without attending to the people and to the way the organization works.

TOE framework. A framework that explains the adoption of innovations in organizations from the technological, organizational and environmental contexts.

Total cost of ownership (TCO). The sum of the costs of acquiring, installing, operating and abandoning a technology over its useful horizon, including those that do not appear in the quotation.

Touchpoint. An interaction of the customer with the brand, with its partners or with other sources that influences their experience; it may be under the control of the company or beyond its reach.

Traceability. The ability to follow a batch to its origin and to its recipients along the supply chain.

Two-factor authentication. Identity check that combines two independent elements, such as a password and a temporary code.

Two-sided market. A market in which a platform brings together two groups that need each other and in which the way prices are split between them matters.

Unfreezing. The first stage of Lewin's model, in which the current equilibrium is weakened so that the group recognizes the need to change.

Value proposition. Set of benefits the firm offers to a customer segment and that explains why those customers choose it.

Value-added time. Part of the cycle time in which the work actually advances toward what the customer receives; the rest is waiting, moving and rework.

Vendor lock-in. Situation in which switching technology provider becomes very costly because of how the data is stored or how the integration was designed.

Verifiable evidence. Datum or document that backs an answer in the diagnosis, such as an electronic invoice issued or a screenshot of the system in use.

Vicious circle of low digitalization. The chain in which low digitalization reduces productivity and margins, limits investment in technology and training and perpetuates the lag.

Weakest-link rule. A classification criterion according to which the overall level cannot exceed by more than one step the level of the lowest dimension.

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