Digital Coach [2020-1-DE02-KA202-007683] – Intellectual Output 05

Corporate strategy for digital transformation and agile project management

Self-study module for Digital Coaches (Subtitle)

Budapest University of Technology and Economics

The editor would like to thank the Digital Coach project partners for their active participation during the implementation of the project and all those involved who so generously gave us their time.

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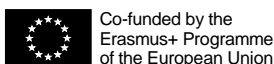
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Think
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INTRODUCTION

While digital transformation strategy is a detailed plan for using digital solutions to improve the physical aspects of one's business across engineering, manufacturing, and service, digital transformation is a broad business strategy. Developing a roadmap for short- and long-term digital transformation, guided by business outcomes, not technology, is the essential foundation and requires a corporate strategy.

Companies of all sizes are seeing enviable business outcomes from digital transformation efforts, such as improving efficiency, maximizing revenue growth, and reducing operational costs. In fact, a recent survey of industry professionals[1] found that 92 percent of companies are already pursuing digital transformation. However, according to a Wipro Digital survey[2], more than one-third of executives cite the lack of a clear corporate strategy as a key barrier to achieving the business' full digital potential.

Why is a developing a corporate strategy for digital transformation important? Because it ensures that there is impactful, measurable, and concerted effort toward key business goals. Any team can engage in digital transformation initiatives, but it's not going to move the needle for a business unless there is a coordinated and strategic initiative.

With that in mind, this self-study module details the key steps and best practices to developing a successful corporate strategy for digital transformation. The module starts with strategic thinking, which focuses on finding and developing unique opportunities to create value for your business. Strategy development, decision-making processes and strategy deployment issues are discussed to serve as a guide as you build your strategy from the ground up.

From skills and competencies perspective, a digital coach needs a thorough combination of technical and project management skills, leadership skills, and strategic and business management skills. Project management methodologies are introduced in detail with a focus on Agile and Scrum. Basic ICT knowledge, quality assurance and Industry 4.0 are discussed in subsequent chapters of this module and serve as a base for technical skills of the digital coach.

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[1] https://www.ptc.com/en/resources/iiot/white-paper/state-of-industrial-digital-transformation
[2] https://wiprodigital.com/news/new-survey-highlights-leadership-crisis-digital-transformation/

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1. Strategic Thinking

<table>
<tr><td>█</td><td>LEARNING OBJECTIVES IN THIS CHAPTER</td></tr>
</table>

The learner can…

distinguish between planning and strategy
understand the competitive advantage and competing strategies

Decide whether a competency can be a source of competitive advantage

1.0.   Evolution of strategic thinking

Strategic thinking has its roots deep in the history of humanity. Long before the emerging of capital market structures kings, military commanders, and leaders developed strategies to defeat their enemies. In one of the oldest written instructions on warfare Sun Tzu's *Art of War,* Sun Tzu writes *"Know the enemy and know yourself in a hundred battles you will never be in peril.".* In today's business environment, of course, companies do not consider each other enemies but competitors and we do not speak about war, but we speak about competition. However, Sun Tzu's advice about knowing your capabilities and keeping informed about the competition or in a broader sense the environment is essential for developing strategic thinking.

Strategic thinking in a modern business environment started in the 20th century and most prominently after the second world war. Researchers and practitioners agree that the evolution of strategic planning can be divided into multiple phases.

Phase 1: Financial planning focuses on short-term (usually annual) goals. It decides about production and sales activities taking liquidity and other financial measures into consideration in order to achieve expected profit rates. It is rather considered planning than strategy since the base for the goals was the previous year's achievement.

Phase 2: Foresight-based long-term formal planning is characteristic of the post-second world war era, which is described as rapid economic recovery. The fast technology development and increase in consumption resulted in higher demand than the current supply capacity. This demand-driven environment allowed the companies to establish multi-annual plans still based on financial goals and controls.

Phase 3: Strategic planning became necessary when the demand-driven economy started to change to supply-driven as companies increase their production rapidly and the energy crises in the 1970s swept through the world. The market environment became less predictable and therefore a paradigm shift towards externally oriented planning was necessary. Companies needed to think about where they wanted to be in the future and started to develop customer orientation. Marketing and innovation became key factors.

Phase 4: Strategic management thinking started to emerge as researchers saw well-established strategies failing or were unable to explain how companies with different strategies could perform similarly, while

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others with similar strategies achieved different performance levels. Scholars and practitioners realized that strategic planning, realization, and importantly feedback must be integrated into corporate management. Feedback means, that not only strategy shapes corporate policy but if changes in the environment make it necessary, the strategy must be adapted as well.

1.1.   Schools of strategic thinking

Harvard school

This school is also known as business policy or process-based view and was developed mainly in the 1960s. According to this school of thought, it is of utmost importance to define in which environment and industry is the company competing. They argue that strategic planning is a rational process, and the future is predictable. The company must employ tools to analyze its future environment and a successful strategy can be deployed to achieve a competitive advantage. Its strategy-making process can be described as seen below.
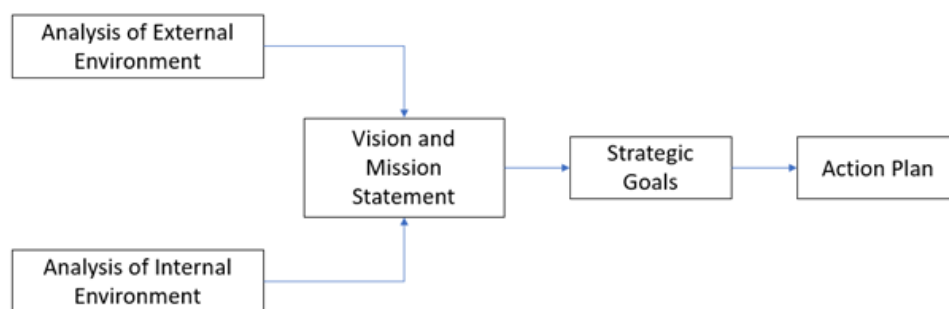
1. Figure Strategy development, based on (Mészáros, 2022)

Competitive strategy

Also known as the industry structure-based view and was developed after the learnings of the oil crises in the 1970s. Michael E. Porter's book *Competitive Strategy* is one of the most cited books in business literature. In his book, Porter extends the space of competition and defines the forces that shape the company's playing field. He defines five forces that shape the competitive environment. These are the industry rivalry, threat of new entrants, threat of substitution, bargaining power of suppliers, and the bargaining power of buyers. These are also referred to as Porter's five forces. Porter also defines 3 generic strategies which are cost leadership, differentiation, and focus on niche market segments. The most important lesson is that a company must choose from these three generic strategies to attain a competitive advantage. *„Being "all things to all people" is a recipe for strategic mediocrity and below-average performance because it often means that a firm has no competitive advantage at all."*

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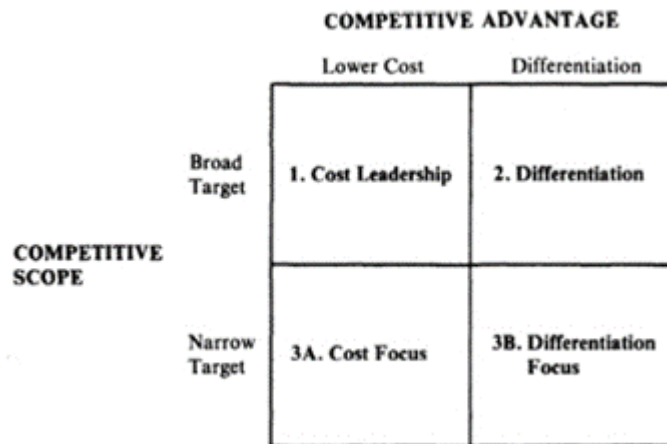
2. Figure Three Generic Strategies (Porter, 1998)

Porter also notes that in one industry there might be different strategic groups. The real competition is within these groups. If one disregards this, one might arrive at a false conclusion, and it can result in bad strategic decisions.
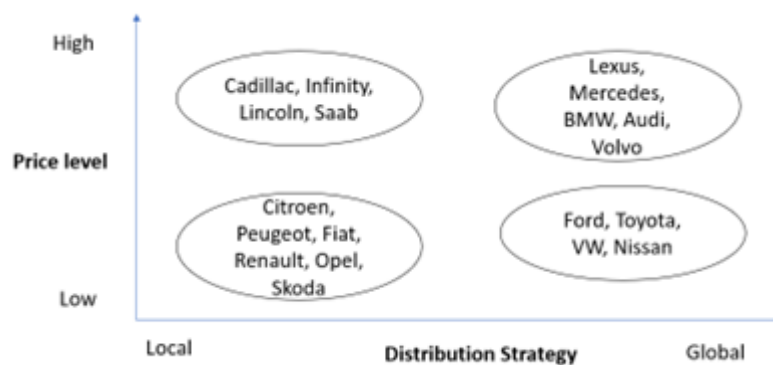
3. Figure Industry strategy groups, based on (Chickán, 2008)

Case study

Audi, Skoda, and VW are owned by Volkswagen AG. These brands are positioned differently in the industry groups. What are their competition strategies? How can VW AG avoid product cannibalization?

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Resource-based view

While Porter's view on strategy focuses strongly on the firm's environment, the resource-based view builds on the core competencies of the company. It argues that the source of competitive advantage is that the company possesses advantageous abilities and resources that other competitors do not. This theory was developed to explain how Japanese companies at the time were able to stay competitive albeit the not-so-unique price-value characteristic of their products. According to this view, the long-term profitability of companies is derived from the capabilities that can result in the creation of non-expected products. Such competence is for example miniaturizing competence at Sony or Canon's superb optics technology capability. In general, Barney identified the following attributes for the company's resources to become sources of sustained competitive advantage (VRIO):

Valuable: a core competence increases the organization's effectiveness and efficiency

Rare: it is uncommon, and a large demand is existent.

Imitable: it is <u>costly</u> to imitate other companies.

Organization: the core competence must be embedded into the company's processes, policies, and organizational structure

Case study / Working scenario XYZ

Apple Inc. Is the third on the Fortune 500 list in 2022. What do you think, what are the core competencies of the companies? Do your ideas check with the VRIO test?

1.2.   IT as a source of competitive advantage

In the last couple of decades with the rapid development of the computational power of the hardware, the spread of fast broadband internet access business software has flooded the marketplace. Whether it is simple business software to automate invoicing or complex integrated ERP systems supporting all business activities, companies can choose from a wide range of products, services, and providers. The decision for managers can be difficult because of the different capabilities and features of this software. There is no common understanding among researchers on whether IT can be strictly viewed as a source of competitive advantage. The ones who disagree argue, that IT became a commodity, therefore alone investment in IT cannot contribute substantially to developing a competitive edge in the company's business strategy. However, other studies show, that combining IT capabilities and organizational skills can contribute to building a competitive advantage.

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1.3. Summary

> **Definition of Strategy**
>
> The determination of the long-run goals and objectives of an enterprise, the adoption
>
> of courses of action, and the allocation of resources necessary for carrying out these goals.
>
> —Alfred Chandler, Strategy and Structure (Cambridge, MA: MIT Press, 1962)

In this chapter we have seen the evolution of strategic thinking and how it was linked to different economic eras and environments. The phases of this strategic thinking are not independent of the different schools, which were introduced. They all focus on different aspects of the company's strategy and from each school one can learn important lessons. The tool or approach to be used to assess or develop a strategy is dependent on the situation of the company and the focus of the strategy.

1.4. Conclusion

Summary / Key Takeaways

The strategy does not equal planning

Good strategies consider the internal and external environment of a firm

"All things to all people" strategies are likely to fail

IT capabilities can create a competitive advantage when they are combined with organizational skills.

Self-test tasks/questions

1. How do you define strategy?

2. What are the winning possible competing strategies according to Porter?

3. How does the strategy making the process look according to the Harward school thinking?

4. Which attributes make a competency a core competence?

5. How can IT capability become a competitive advantage?

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1.5. Sources

Chickán, A. (2008). *Vállalatgazdaságtan* (4. kiadás).

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Porter, M. E. (1998). *Competitive Advantage Creating and Sustaining Superior Performance.*

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2. Strategy Development

LEARNING OBJECTIVES IN THIS CHAPTER

The learner can…

talk about the basic steps of strategy development

suggest tools to analyze the internal and external environment of the firm

advise on how to set strategic goals

2.1 Strategy development process

In the previous chapter, the different schools of strategic thinking were presented. In this chapter, we will see, how these concepts and models can be used simultaneously to develop a business strategy. Through business strategy development the company can understand the internal capabilities of the organization and the external situation of the company. Furthermore, a formal strategy helps communicate the goals of the leadership and create a common understanding of what the company is doing and why. The basis for the process will be the strategy-making process of the Harvard Business School approach. For the different process steps, models and techniques are borrowed from the competitive strategy school and resource-based view approach.
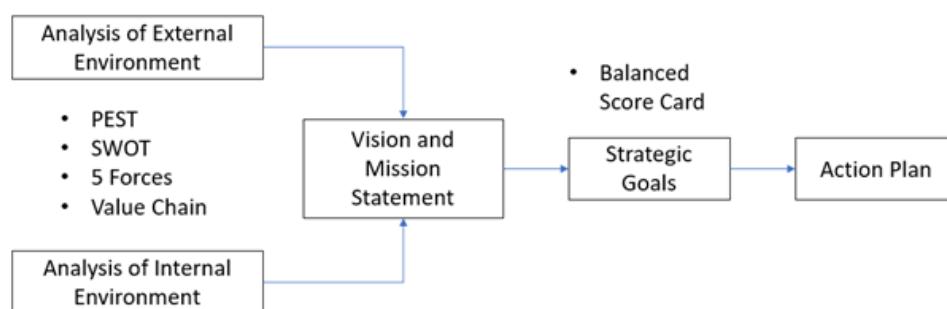
1. Figure Strategy development process, based on (Mészáros, 2022)

2.2 Analysis of internal and external environment

PESTEL: Pestel is an acronym made of the initial letters of Political, Economic, Social, Technological, Environmental, and Legal words. It is widely used in strategic planning and gives a good guideline to analyze the external environment of the company. The bigger the firm the more useful a PESTEL analysis can be. It is

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also frequently used for internationalization strategies. It is paramount that these analyses are revised and updated regularly.

SWOT: The name is derived from the **S**trength, **W**eaknesses, **O**pportunities, and **T**hreats. It analyses the internal environment (S+W) and the external environment (O+T) of the firm. Although it seems a straightforward information gathering, it might be as well time-consuming if one wants to build it on thorough analysis, rankings, and prognosis. Information from the PESTEL analysis might be used to fill the Opportunities and Threats field. It is essential, that after collecting and categorizing the information, the following analysis is also carried out meticulously:

Strength to Opportunities: Define how opportunities can be used with the help of strength.
Strength to avoid Threats: Use strength to lessen the impact of potential threats or learn how to avoid them.

Weaknesses and Opportunities: Decide whether opportunities can help to overcome weaknesses or define a retreat strategy.

Weaknesses and Threats: Where weaknesses and threats align retreat.

Case study

However, SWOT analysis is widely used by consulting firms some researchers criticize it. It is not always straight forward if something is a strength or weakness or an opportunity or threat. What do you think:

Is Steve Jobs a strength for Apple for his ingenuity or was it a possible source of vulnerability because of his illness?

Is climate change a threat for the carmakers or opportunity to develop greener means of transportation?

Five forces

This analysis focuses on defining industry attractiveness by analyzing the dynamics in the industry. This is not only affected by the number of companies within the industry but also by other external players.

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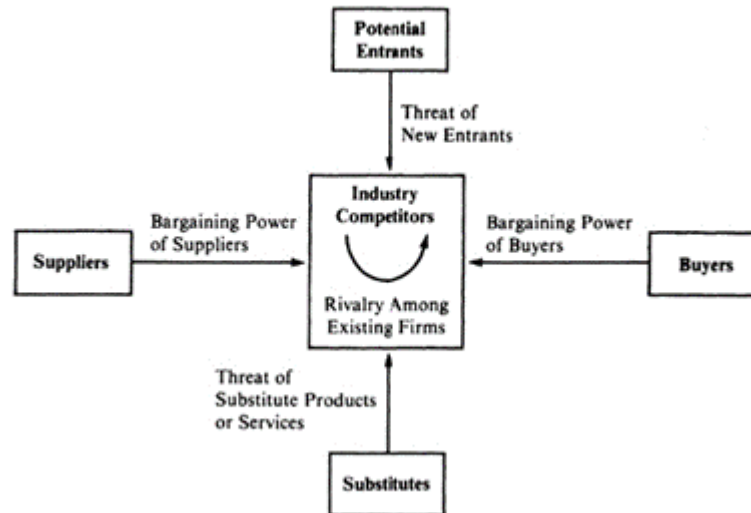
2. Figure Five Competitive Forces (Porter, 1998)

Industry rivalry: This looks at the intensity of competition. How many rivals does the company have and how strong or competitive they are? At what stage is the industry? Is it an emerging one or already matured? Are there underutilized capacities? What are the fixed costs etc?

The threat of New Entrants: The company's position can be affected by potential new rivals. Barriers to entry such as complex distribution networks or high up-front investment costs can help to reduce the threat. Incumbent companies may also use a scale of economies to drive down costs and prices creating a competitive advantage over newcomers.

The threat of Substitutes: If switching costs for buyers are high, then the threat of substitution can be lessened. This is dependent on the buyer's propensity to substitute and the relative price performance of the substitutes as well.

Bargaining Power of Suppliers: If a company has many suppliers to choose from, it can limit their bargaining power. This means lower purchasing costs and higher profit potential.

Bargaining Power of Buyers: Buyer power strongly influences the price a company can charge for its products. The number of buyers is a strong influencing factor as well, since if the number of buyers is low compared to the suppliers', it may drive down prices.

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Value chain model
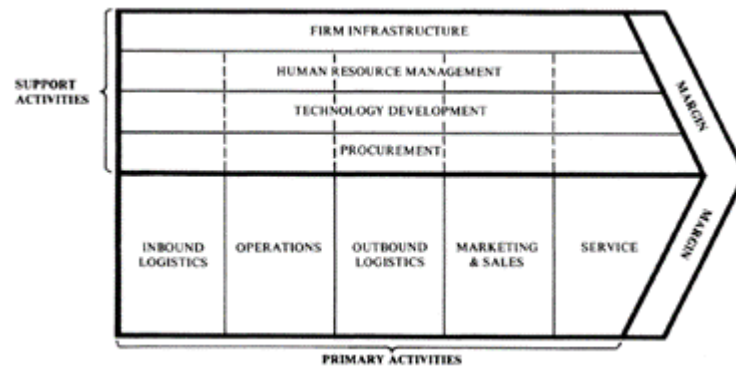
3. Figure The Generic Value Chain (Porter, 1998)

Companies are a collection of activities and at the end of this activity, a product or service is delivered. The value which is created by these value activities and the margin will be represented by the price the buyer is willing to pay.

These activities can be categorized as primary or support activities. Primary activities are involved in the physical product creation process and in the sales and transfer activities. These can be seen in the lower part of the chart in the vertical boxes and include inbound logistics, operations, outbound logistics, marketing and sales, and after-sales service. The dotted lines represent, that the primary value activities employ the support activities. Each primary value activity uses some sort of technology, human resources, and procurement to perform its tasks.

Constructing the values chain model can help to understand how value is created through the organization and can help to position the company in the competitive environment.

2.3   Vision, Mission

Defining the vision and mission of the firm is the follow-up logical step after the analysis of the internal and external environment. The reason why they should be included in strategic thinking is twofold. Firstly, in a rapidly changing business environment, such "soft" elements can be easier included, than for example target values of a financial plan, therefore they are more stable. Secondly, they represent the focus of the strategy and the outcome of the previous analysis.

Vision statement: Describes the desired position of the company in the future. They may contain a list of activities or innovative goals based on discovered new demands.

Mission statement: Defines the aim of the purpose of the company's existence, the values, and principles along its operation. It may contain internal values, self-positioning towards stakeholders, or company philosophy.

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Case study

Look at some companies' vision and mission statements what similarities and differences can you find? Are they specific or general in your opinion? Do you think companies live their values?

https://www.ge.com/about-us

https://www.volkswagenag.com/en/news/2019/07/goTOzero.html#

https://www.shell.com/about-us/our-values.html

2.4   Goals

To define the goals a so-called balanced scorecard method is used by many practitioners. The balanced scorecard represents and links together four types of performance goals and measures. As with every model, this can be also tailored to specific needs, and if necessary further performance goals and measures can be included. Some researchers however warn, that with too many, one can lose focus easily. The balanced scorecard also helps to define measures for performance goals and by keeping strategy and mission in focus.
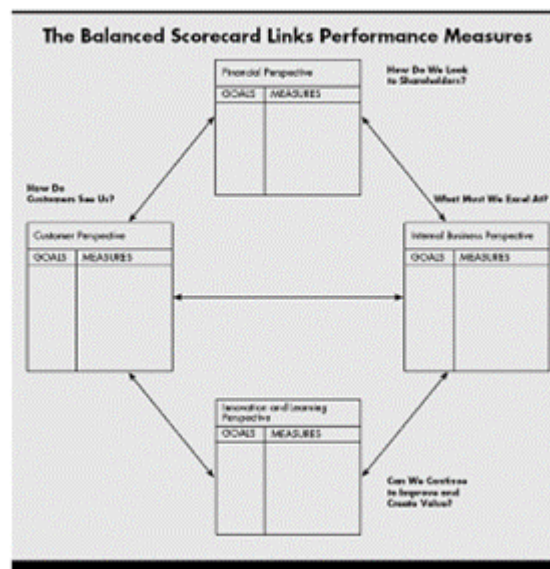
4. Figure The Balanced Score Card (Kaplan & Norton, 1992)

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Further literature/literature tip

Kaplan, S. R., & Norton, D. P. (1992). *The Balanced Scorecard—Measures that Drive Performance*. Harvard Business Review. https://hbr.org/1992/01/the-balanced-scorecard-measures-that-drive-performance-2

2.5   Action planning

At this stage of strategy development, detailed plans are constructed which are already ready to be executed. The actionable plans are worked out in detail at different corporate divisions, where exact goals, resources, and responsibilities are defined. This way we can talk about HR strategy, marketing strategy or financial strategies.

2.6   Summary

In this chapter, we saw how information about the internal and external environment of the company can be collected, organized, and analyzed in a structured way with business management tools that are widely used by academics and practitioners. These tools include PESTEL, SWOT, Porter's five forces, and value chain analysis. Based on this information the vision and mission statements can be formulated. These statements serve as the backbone for setting goals with the help of a balanced score card. Action plans based on these score card measures and goals can be derived at each corporate division.

2.7   Conclusion

Summary / Key Takeaways
Business strategy helps in setting and communicating goals.
Analyze the internal and external environment of the company for a good business strategy
Formulating a Vision, Mission and Goals will help communicate the strategy to stakeholders

Self-test tasks/questions
What are the SWOT and PESTEL analyses? How can they be combined?
What are the "Five forces" that influence the competitive environment?
What is a primary and a secondary value activity and how are they related?

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2.8   Sources

Kaplan, S. R., & Norton, D. P. (1992). *The Balanced Scorecard—Measures that Drive Performance.* Harvard Business Review. https://hbr.org/1992/01/the-balanced-scorecard-measures-that-drive-performance-2

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3. Decision-Making Processes

LEARNING OBJECTIVES IN THIS CHAPTER

Finishing this chapter, the learner can…

Understand the importance of the decision at DC roles

Influence decisions to achieve the most efficient changes

Map decision-making processes at businesses

Recognize the special needs of a family business

3.1   Introduction

The DC arrives at the client's environment and would like to initiate some changes. Usually, this is not a recently established venture. There are existing organizational goals and operation models. They are already defined by a series of decisions made by the previous management - which could be the same as the current one. This way, the DC can get easily into an uncomfortable situation where he must convince the management to decide something different than their previous decisions. It seems a nearly impossible mission but with a systematic approach, DC can overcome these.

DEFINITION

"Decision is a choice that you make about something after thinking about several possibilities."
Cambridge Dictionary *(https://dictionary.cambridge.org/dictionary/english/decision)*

All activities of a DC should reflect the management strategy and expectation of changes. This way the DC must delegate all the decision rights to the management within the organization. The DC must insert decision points into his project plan to ensure enough time to

1. understand the goal - get involved with others if necessary
2. qualify the possible (selected) solutions - with quantification of the possible risks
3. announce the decision in a proper way

Most of the project timelines are slipping because of the underestimation of decision-making processes. Often you can find a not enough prepared decision as a failed project's root cause.

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DON'T Forget

1. All digital transformation projects are a **series of decisions**.
2. DC **just initiates** changes via the decisions of the management.
3. End of the day the final responsibility of a decision is on the management, but **DC is responsible to support the best decision-making process**.

3.2   Decision-making basics in general

Freedom of choices

In the modern Western World, Liberty has had a very high prestige since the French Revolution (1789.). The civilizing Europe connected this with the "freedom of choice" equally for leaders or citizens. This approach extended its power until today. Most of the European countries constitutionally enshrined the individual rights of decisions. This is reflected in the entire life even in businesses.

FREEDOM AND DECISIONS

"When we speak of people who are "free" we are referring to those who feel accountable for their behavior, who can do what they really want to do or refrain from doing what they do not want to do."
Aarti Br. Singh - Psychoanalyst: "The importance of Personal Freedom – Freedom and Decisions"(Published on April 27, 2021 - The importance of Personal Freedom – Freedom and Decisions – share heart)

With this cultural background, DC should be more cautious when and how he presents, influences, or forces changes. Neglecting the customers' right to choose is one of the most dangerous behaviors because they can feel their liberty has been questioned. Decisions are states of change. Behind these changes, there are initiation forces. The Internal and External Forces act together. There are also some unpredictable satellites like industry trends, consumer demands, the competition which can effectively bias the changes.

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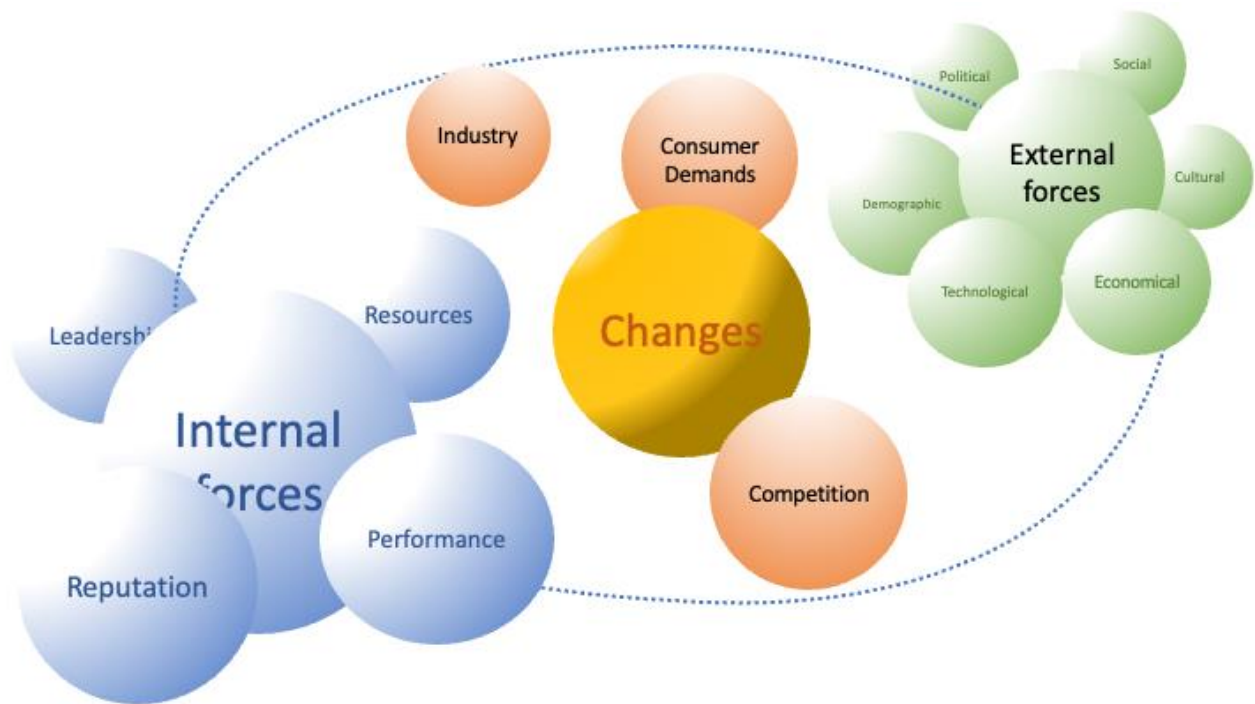
1. Sphere of Changes

Based on the drawing of MGMT805 – Organizational Behavior course at Granite State College.-

15.2 Change Management

The recognition of all of these forces is mandatory for a DC. Drawing a map as a desk-research helps to discover dependencies and acts as a valuable advisor in the eyes of customers.

Influencing Decisions

Most of the cases DCs arrives outside of the organization and are loosely connected to the decision-makers. If DC feels it necessary, She/He can try carefully influence the decisions. To do this DC should count on all the stakeholders' interests which might have an impact on the final words of the decision makers (DM).

DC is not an illusionist or psychotherapist who can stimulate the DMs in a certain direction. DC should respect all the previous decisions that a DM should change with a new one. The only way to respect a decision of the past if DC clarifying the circumstances and the motivations and also the dependencies were at that time.

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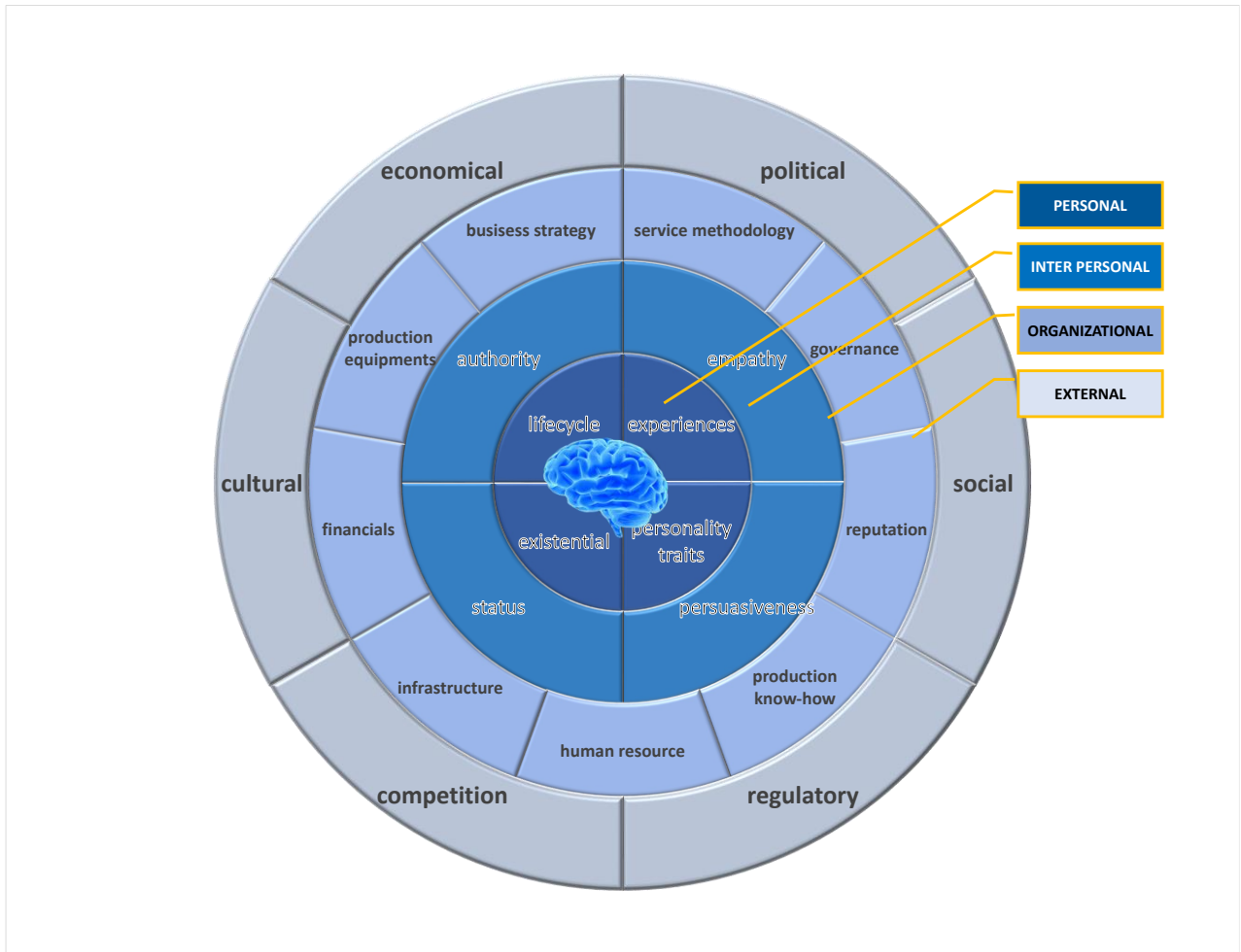
1. Circles of influence

We can identify three influencing circles around personal parameters. As a rule of thumb receding the center the influential power is weaker and weaker but the forcing power act in the opposite way. (E.g. -The personal lifecycle has a higher influential power to a decision than the organizational reputation. On the other way a regulatory change – a new taxation law can overwrite a verdict even if it's dictated by the inner soul. This is an example of the forcing power.)

EXTERNAL CIRCLE

- Indirect connection to the decision-makers.
- Their channel is mostly dominated by books, press, and social media, but it could be business events also.

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Influencing this area is very complicated, and requires a lot of work and time, what is most cases not in balance with the efforts. Even if DC tries to conduct the DM's awareness toward a new direction, the outcome wouldn't be guaranteed.

ORGANIZATIONAL CIRCLE

In the Organizational Circle DC can find all the assets and capabilities that a DM should be aware of before the investment or order changes.

- Most DMs are too closely related to the current corporate assets.
  a. Some of them are treated as traditional artifacts and saving them to the last minute.
  b. Others are just treated as garbage to get rid of.
- The influencing power of the assets is very much related to the DMs background (see in the Personal Circle)

Understand this is the area where DC should invest a lot. Influencing here means collecting evidence and allies from the given area to convince the DMs. Having honest, professional relations with tier two/three management is key. If the chemistry fails than it could escalate to the DM's level and ruin DCs trust.

INTERPERSONAL CIRCLE

DM's Interpersonal capabilities just artificially can separate from personal things. While DC analyses the interpersonal behavior in parallel DC must consider the personal attributes also.

Most DMs are people managers and some of them have a given place on the organization chart. Interpersonal behavior has a huge impact on how they access information and how he listens to the "messenger".

DC usually can't change the given dependencies of the DMs but discovering the real background can work out a more efficient way of communication.

PERSONAL CIRCLE

As mentioned earlier personal attributes have the most influence on decisions.

Dominance of subconscious

„Many processes in the brain occur automatically and without the involvement of our consciousness. This prevents our minds from being overloaded by simple routine tasks. But when it comes to decisions, we tend to assume they are made by our conscious mind. This is questioned by our current findings."

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Prof. Dr. John-Dylan Haynes - Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig: (Nature Neuroscience, April 13th, 2008)

With this knowledge with all the best efforts to >80% predict anyone's decisions in an algorithmic way is almost impossible. All human decisions are dominated by the subconscious. Understanding and analyzing these layers gives the opportunity to explore the reasons behind them. Applying this approach DC can bridge common sense with customers.

DECISIONS AND RISKS

To decide means to take risks, to decide means you may be doing wrong — who knows, that is the risk."
Osho - Philosopher: "The Book of Wisdom" (Publisher   OSHO Media International ISBN-13   978-0-9818341-1-5)

3.3   Business Decision-making structures

Decisions in the everyday life or business life are not so different from each other. In businesses, you can find more collective decisions.

Business size and management structure are what matter as the traits of decision-making. In the EU for statistical reasons set up criteria for micro, small, medium, and large enterprises by the number of FTEs and revenue, but in the case of decision processes, the most definitive is the type of organization.

Most SMEs have a "Flat" organization with a maximum of two middle managerial levels under the top business decision-makers. The company as bigger in FTEs the number of middle managerial levels is increasing. Enterprises mostly are "Functional" organizations, or they decreased their complexity to a "Divisional" structure. Functional organizations have multiple middle managerial layers and a lot of strict rules for limitation responsibilities. Divisional organizations are much more like flat organizations grouped in the same ownership. They have some predefined independency.

- Duration of decisions
  - o **Flat:** There are only a few BDMs (business decision-makers) who must agree. This way this is the quickest. The usual bottleneck is the top manager's very busy calendar.
  - o **Functional:** Because of the multiple steps of escalations and the bureaucratic procedures this could be the longest. DC should suggest appointing a dedicated project BDM from the top management with enough authority.

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- o **Divisional:** If the project could be resolved within the division limits the duration will be the same as in the case of flat organizations, but if it exceeds then it could be more similar to functional organizations.
- The weight of the decisions
  - o **Flat:** In this case, even the DC is closer to the final BDMs. Maybe a more complex organization has more mature decisions considering the choices from more angles, but BDMs at these smaller organizations more often keep open their doors for a second opinion.
  - o **Functional:** In a hierarchic organization usually, they do not question publicly the decisions. In a structured chain of escalated proposals and the final decisions are almost irreversible.
  - o **Divisional:** The heads of the divisions keep the development of decisions in the division, this is their ticket for independency from other corporation leads. It means DC should be aware of it.
- Strategic approach
  - o **Flat:** In most of these companies the needs are more immediate, in the here and now. This is influencing the decisions and they aren't interested too much in long-term investments where the return is expected in years.
  - o **Functional:** Usually these complex organizations need more long-term business strategy. A decent number of people challenge their opinions and ideas. This is an advantage of larger corporations because they are easier able to survive the negative curves of the investment periods.
  - o **Divisional:** This organization has a holistic corporate strategy to follow but, in the meantime, they should develop a strategy that is valid for the division only. This way in the case of decisions it can combine the positive sides of both.

3.4 Decision-making in family businesses (FB)

More than 60%[3] of European ventures are FBs so the DC's potential customers are owned, managed, and run by family members or relatives.

According to various EU research unfortunately FBs has a vast resistance to external advisors or consultants. DC's most efficient superpower is trust, in a skeptic or even hostile environment they should invest more to gain their customer's respect.

GAIN respect by Showing respect

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[3] https://ec.europa.eu/growth/smes/supporting-entrepreneurship/family-business_en

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- Listen, learn, and ask their help to understand them better if needed,
- Never rush fellowship, or point out your expertise,
- Be trustful, tell the truth without blaming or hurting others,
- Be positive an enjoy your task!

Informal roles and responsibilities may result from more complex dependencies than witnessed in non-FB DM processes.
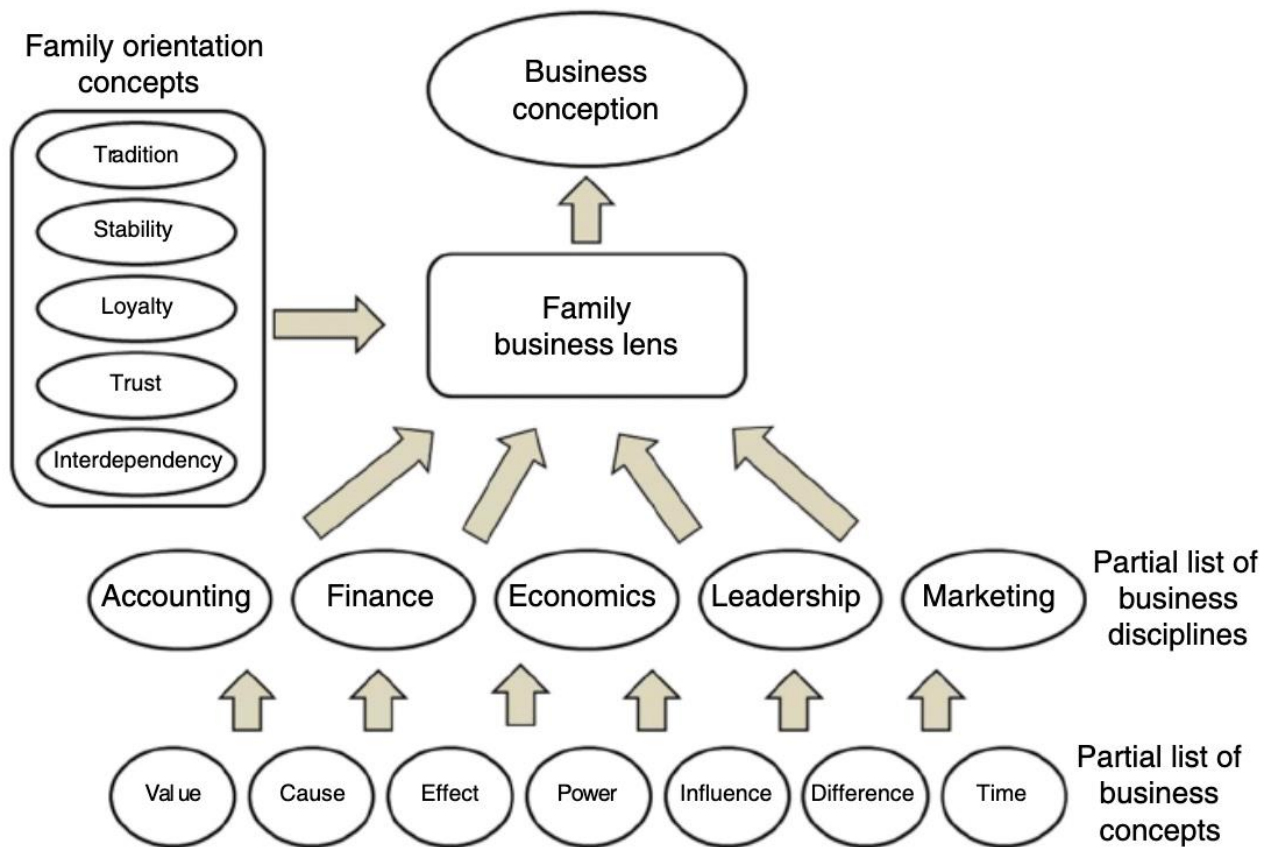
1. Family Business Conception[4]

In a non-FB organization, the business concepts and disciplines dominate the decisions flavored by personal attributes. At FB companies this is mostly that objective flow extended by family orientation concepts and modifying the perspective with a new and more dominant angle. DC should pay attention to these factors.

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[4] Source: Rethinking family business education - www.emeraldinsight.com/2043-6238.htm

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3.5   Possible scenarios

Here are four simplified decisions to examine as an example.

ToyStar Owner:

At a board meeting of a medium size factory, an HR shortage came to the table. After a long negotiation Mr. White, the Owner of the company closed the discussion with the following sentences. **„As far as I can see there are too many workers dealing with wrapping finish goods. If we resolve this with robots, then we can utilize our colleagues for other important tasks."**

FoodStar Sales Director:

A successful food-processing company last year went live with its new sales tracking system. The novelty of this solution is an AI module that can discover hidden relations of data. The Sales Manager Mr. Green is willing to utilize the AI results to reform automated sales. **„Analyzed our Sales data, now it's clear that 80% of our consumption is related to the V. district. This way we should concentrate our vending machines on this part of the city."**

IronStar CEO:

Recently a new EU fund was announced by the government portal. With this exceptional fund, an SME can reach up to 250K EUR with a 35% co-payment. The CEO Mrs. Red announced her initial proposal for the Owners:" **If we want to beat our competition, we should change our old handling robots for collaborative ones immediately..."**

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> **ElectroStar Co-owner:**
> Mr. Brown founded ElectroStar for decades. Some years ago, he passed the leadership to his son Junior but kept the majority in the company. Junior recently revolutionized the production line and planned to connect the automated machines with 5G. When he explained the expected results of this investment to the board his father expressed his counter-opinion: „I'm not an IT expert, but with this M2M we possibly jeopardize our corporate IP. I don't want to waste the IP that we built in the last 30 years."

3.6 Conclusion

Summary / Key Takeaways

- DC must delegate all the decision rights to the management what is in connection with the future operation of the customers' organization

- Influencing decisions is a duty of DC, but DC should respect all the previous decisions on what a DM should change.

- Business size and management structure are what matter in the traits of decision-making. One of the duties of DC is to discover the formal and informal structures.

- Family Businesses have a different decision-making approach where sometimes the business-related arguments overwrite by family orientation concepts.
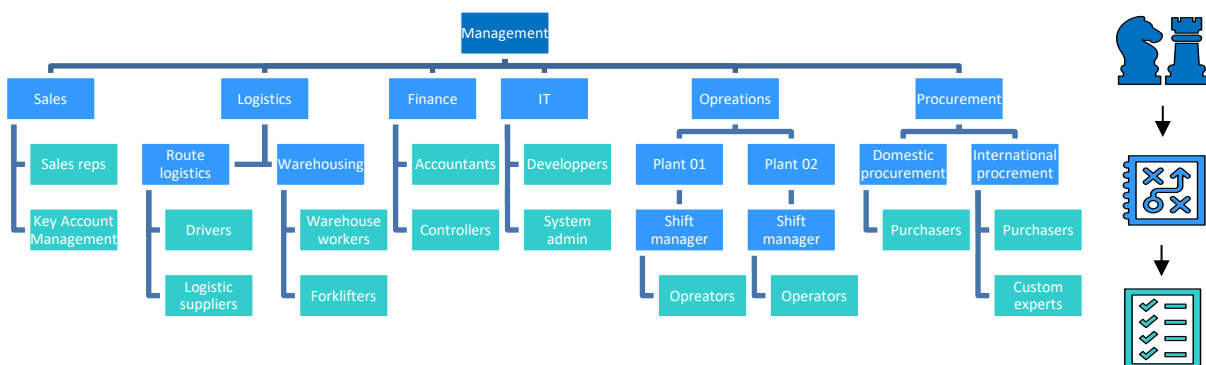
Self-test tasks/questions

- Examine the scenarios at Possible scenarios!

- Think over the possible consequences of each scenario if this decision would be the final. Are you satisfied with these suggestions?

- Try to figure out what kind of previous impressions and influences resulted in these sentences! The influencing circle can help you to highlight all the aspects: Influencing Decisions

- In the ElectroStar scenario, Mr. Brown has concerns about Junior's innovative acts. What kind of Decision making in family businesses (FB) is behind his comment? How do you going to resolve them?

- Go through again this chapter and if there is a topic that particularly interests you then make research on the Internet. There are dozens of articles and studies to help you be successful in the field of Customers reach us by writing a mail to our <<email>> address.

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4. Strategy Deployment

LEARNING OBJECTIVES IN THIS CHAPTER	
The learner can…	
1.	understand the meaning and goal of strategy deployment;
2.	understand the strategy deployment process;
3.	practice and apply one key strategy deployment tool;
4.	understand key aspects of digital transformation integration to corporate strategy;
5.	understand key aspects of digital solutions' implementation.

4.1   The Goal of Strategy Deployment

The overall goal of Strategy Deployment is to create executable action plans that are in line with business strategy. The greater the number of members of an organization the higher the risk that individual tasks and actions are little in line, or not in line at all with the overall business strategy. The chance that contradictory goals and interests of individual members of a greater team overwrite collaboration for achieving common targets increases with the same. When money, profit, and employment are at stake in business competition, it is important to prevent such situations within business organizations. Hence, strategy deployment tools and processes are key elements of well-working, highly competitive companies. Digital transformation can be easily proven as a strategic priority, but related projects and action plans can quickly fall into the trap of contradictory interests of other running, equally well-grounded projects and priorities. Their alignment with business strategy is therefore a necessity for success. The below figure shows the scheme of a typical company hierarchy (left) and symbols of decision levels (right), where management decides at the strategic level (chess pieces), leaders of departments and larger teams decide at the project level (routing symbol), employes decide at execution level (checklist).

1. Figure: Scheme of a typical company hierarchy and the symbols of decision levels

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Even at a smaller company of 30-50 employees, the distance between execution and business strategy can be surprisingly "far" from each other, and the link between them can become indirect and weak easily. Effective execution of business strategy – especially development projects, investments, and implementations of new processes and methods – can be difficult when projects and action plans are not aligned through a formalized process. The answer to this difficulty is often the direct intervention of management at operational level, resulting in stressful micromanagement and mental-physical overload of all.

Critical note / Management responsibility

Company management needs to make sure that the everyday execution of tasks in operations, project goals, and leaders' efforts are in line with management decisions and strategic objectives. Strategy deployment process and tools support and ease this need.

Case study / Contradictory individual goals

Let's imagine a company that produces welding products and equipment. Welding equipment at construction sites needs to be always accessible and replenished immediately if needed. Therefore, a one-day delivery capability is one of the top competitive advantages on the market. Management set targets for each department based on classical break-up: quality, cost, delivery, and safety. Marketing and sales work on delivery to reach a high service level; operations work on efficient production to reach great productivity; finance tries to keep costs at the lowest possible, and so on. Bonuses of leaders are linked to KPIs. The promise of one-day delivery to customers always requires the availability of products in finished goods warehouses since orders need to be delivered on the same day of registration by customer service. Where's the contradiction? Sales leaders will put a lot of effort (persuasion, power) to keep a high quantity of every possible item in stock to meet one-day delivery capability; the financial leader and procurement manager will try to do everything to spend less on inventory. Depending on who's lobby force is higher, inventory reduction projects and stock replenishment activities will alternate with each other, pulling everyone in the supply chain back and forth. People will spend energy persuading and cheating others to achieve their own KPIs, even if it makes other KPIs fail – instead of working on activities that bring value to customers.

Lack of alignment of projects and targets will result in competition between departments and managers instead of collaboration. Proper application of strategy deployment tools and processes prevents competition within the organization and eases collaboration that supports competitiveness in the market – where it belongs to.

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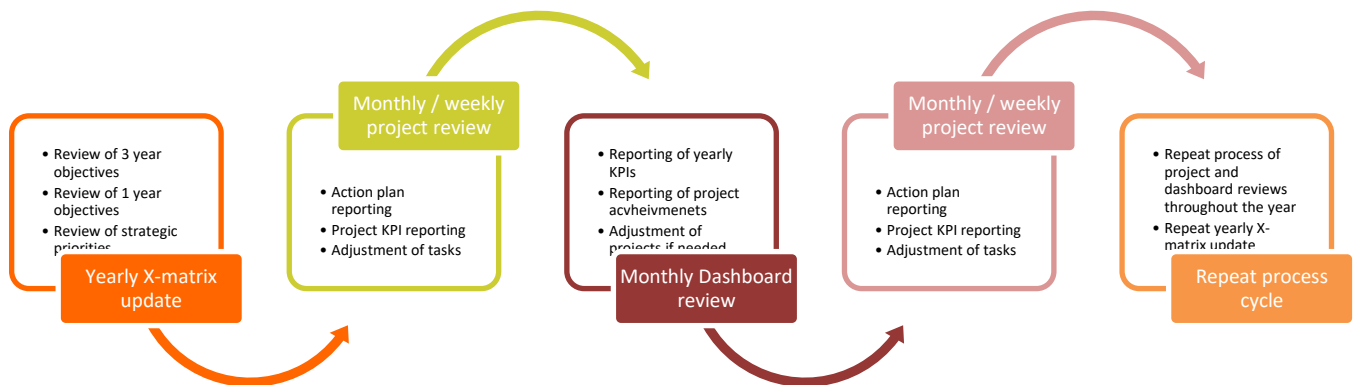Budapest University of Technology and Economics

4.2   Strategy Deployment Process

Strategy Deployment is a process – it has a goal, an output that is used by its customer; it is a sequence of steps that are repeatable; it consumes resources, and it has a process owner. Organizations often think of Strategy Deployment as a single task to be completed once a year – a mistake that deviates Strategy Deployment from its purpose. There is indeed one yearly task in Strategy Deployment: preparation or update of the X-matrix requires typically one yearly effort, but it makes up only 25% of the process. The rest – 75%! – requires continuous work and dedication.

Yearly process cycle

Strategy Deployment consists of 4 larger elements that complete a full yearly cycle.

1) X-matrix – Hoshin Kanri. X-matrix is the heart and primary tool for creating strategy deployment. It makes a link between 3-year strategic objectives and short-term improvement projects and activities.
2) Action plans. Projects are broken down into action plans that are carried out as part of everyday work.
3) Project reviews. Projects and actions are reviewed regularly (weekly or monthly).
4) Dashboard. KPIs that are showing project achievements and improvement in business results are reviewed regularly as well. These meetings are forums for reporting and give the possibility of change in plans and projects if needed.

2. Figure: Strategy Deployment Process' Yearly Cycle

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4.3   Hoshin Kanri – X-matrix

The origin of Hoshin Kanri goes back to early modern-age Japan, most probably to The Book of Five Rings[5]. Hoshin (ho = method, shin = compass) can be translated as "methodology for setting strategic direction" and Kanri (kan = control, ri = logic) as "administration or management". Hoshin Kanri is therefore the way of setting up an administration that carries out a strategy – which is strategy deployment, practically. This principle was naturally adopted by Lean management as the implementation of Hoshin Kanri effectively reduces non-value-added time to work and administration in an organization. X-matrix is a primary tool to set up and keep strategical control over improvement projects and activities of an organization, hence, it is a key element of the Hoshin Kanri principle. Hoshin Kanri and X-matrix are so linked to each other that they are often used as synonyms. The following figure is the basic layout of an X-matrix. Easiest is to prepare it in an Excel spreadsheet, but it can be drawn by hand or in other software or application.

| X-matrix title												
1Y Obj 4	1Y Obj 3	1Y Obj 2	1Y Obj 1		KPI 01	KPI 02	KPI 03	KPI 04	Owner 1	Owner 2	Owner 3	Owner 4
●	●			Strategic Priority 05			●		●			○
	●			Strategic Priority 04				●			●	
		●		Strategic Priority 03			●				○	●
○	●	●	○	Strategic Priority 02		●			○	●		
	●	●		Strategic Priority 01	●				●	○		
1Y Objective 4	1Y Objective 3	1Y Objective 2	1Y Objective 1	Strategic Priorities / 1-year objectives / Targets to Improve / 3-year objectives	KPI 01	KPI 02	KPI 03	KPI 04	Owner 1	Owner 2	Owner 3	Owner 4
		●	●	3Y Objective 1			**KPIs**			**Owners**		
	●			3Y Objective 2			Disc: primary responsibility or direct link					
●				3Y Objective 3			Circle: supportive responsibility or indirect link					

3. Figure: X-matrix Scheme

Parts of the X-matrix

X-matrix consists of 5 parts – each belongs to one step of its compilation that is consecutive to each other, as follows:

[5]http://mcts.com/Hoshin-Origins.htm

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1) **3-year objectives**. 3-year objectives are breakthrough objectives that drive the company to implement solutions that improve current ways of working and require a visible change from the organization. 3-year objectives are derived from the company's mission and vision. 3-year objectives are expressed as measurable targets, they are typically seen as the "TOP KPI-s" of the company. X-matrix starts with these 3-year objectives by simply stating them on the lower part of the matrix. 3-year objectives answer the question: how far do we want to go within 3 years?
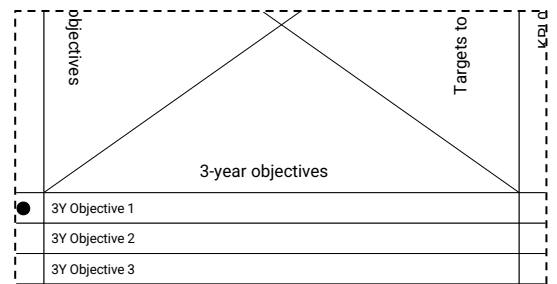
2) **1-year objectives**. 1-year objectives are derived from 3-year objectives, it's the first level of breakdown. In most cases, 1-year objectives are the same KPI-s as 3-year objectives, with different values to be achieved. What matters is the value to be achieved within a year. They answer the question: out of the distance we want to go within 3 years, how much shall we make within 1 year? Generally, it is better to break down the distance from the current state to a 3-year objective following a logarithmical path than a linear path. It's always better to set a high bar for the first year than trying to hurry to close a large gap at the end of the 3-year cycle[6].
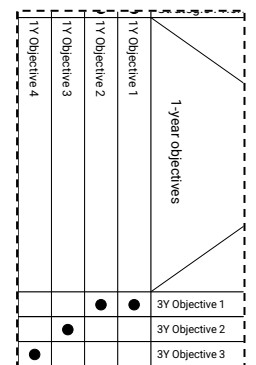
3) **Strategical Priorities / Projects**. Once next year's target is set for a given objective, it's time to think about what the organization needs to change to achieve yearly objectives. Larger organizations that consist of several sites, will set up strategic directions called strategic priorities that are distributed to sites or larger departments. Strategic priorities are larger initiatives and responsible owners need to break them down further into individual projects. Smaller organizations will directly define projects and don't need to repeat the breakdown task several times. This is the part of the X-Matrix where numbers (KPI targets) are translated into activities. At this point, strategic priorities and projects need to be cross-checked against each other: it is very important that there are no priorities and projects that work against the others – consuming others' resources or creating processes and solutions that impact negatively other projects' achievements.

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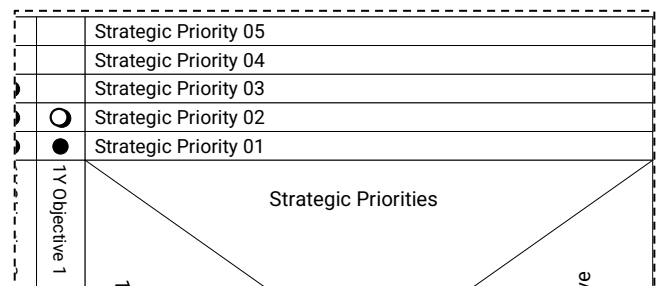
[6] This is a mindset that often contradicts to everyday human behavior. When we see a target that is far away from us (3 years) we tend not to take big steps in the beginning. To be successful in business, organization needs to behave contrary: take a big step first so you have much more time to fine tune and modify later if needed.

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4) **Targets to Improve**. Assigning individual targets to priorities or projects is a must-have. Any type of KPI (*Key Performance Indicator*) is acceptable (Y/N, Ratio, Quantitative, Qualitative). These KPI-s will likely be different from 3- and 1-year objectives: they are project specific and measure local performance. Create project KPI-s that are SMART: Specific, Measurable, Attainable, Relevant, and Time-bound.

5) **Project Owners**. Any action, task, project, or priority needs an owner. Without ownership, people working on the project will be lacking control, feedback, and motivation, therefore achievement will be missed. Apply the "many to one" link between projects and owners: one owner can own several projects, but one project can have only one owner. Select owners based on the 5A requirements: owners need to be **a**ssigned, **a**ppropriate, **a**dequate, **a**vailable, and **a**ccountable. If owner assignment is not possible for a project, it means that our resources are insufficient, and it is a risk to be considered. Ask yourself and the team: do we need more resources, or do we need to scale down our efforts to lower content?
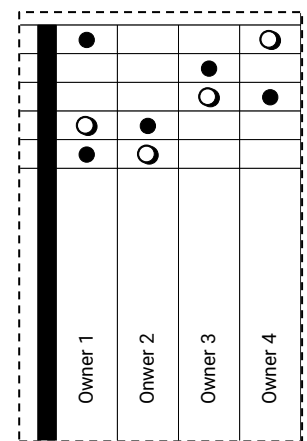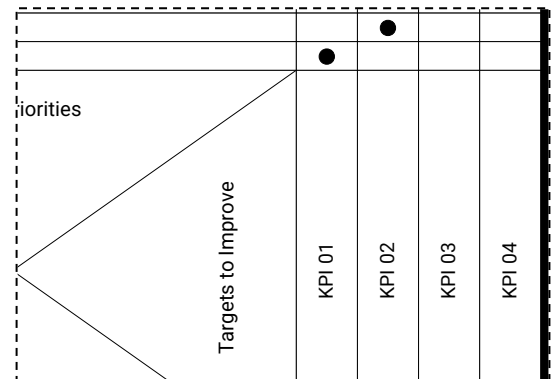
Drill-down to Point of Impact

It was stated above that a) larger organizations will set strategic priorities that need to be broken down into projects by their owners; b) the goal of strategy deployment is to align through an organization with high-level objectives and create executable items with the same attribution. Strategic priorities are not action items, or projects either – there is a need to go deeper to reach the **point of impact** where executable actions are. Once priorities and projects are set, this can be done individually by the owners using their own tools and techniques, however, X-matrix is also a good tool to support this task. Because an X-matrix can be cascaded down by "turning" it and reach higher granularity and details in outputs. Replace 3-year objectives with 1-year objectives, replace 1-year objectives with priorities, and start adding projects on top where priorities used to be. Make sure you keep the original links (discs and circles)! Then, you can associate a project owner with a project and add business KPIs that are related to them. You can repeat the task with projects and break them down into action items: this way, you can use X-matrix as a task allocation tool. Just keep in mind: don't go too much into detail! Drill down to the point of impact and find the level where root causes are addressed.

Case study / Strategy deployment in a small organization

Strategy deployment can be used at all company sizes. Industry 4.0 Technology Center (TC) at Budapest University of Technology and Economics went into creation of its X-matrix and started to implement the strategy deployment process to ease carrying out its

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own 3-year development plan. All started with understanding TC's mission and vision, available current and future resources for the next years. Then, 3 years and 1-year objectives, and 3 main Strategic Priorities have been created, that are driving TC to fulfill the mission. Development projects were created based on Strategic Priorities, and already existing projects were added also to where they fit. First, each project received a project owner who is responsible for creating project KPIs and project execution.

As the days and weeks were passing by, it became clear, that KPI setup and project execution didn't go as expected. TC staff consists of one leader, 3 specialist and few university students working part time in the Center. Resources are scarce and most of them did not practice Strategy Deployment before. Here comes the need and strengths of looking at Strategy Deployment **as a process**. Team made a revision of X-matrix few months after the first workshop, simplified and tailored the projects in terms of number and content as well. Then, instead of letting project owners working alone, project KPIs were identified in a series of kaizen-type meetings, and KPIs became the "pulling force" that started to drive project execution. To improve KPI results, one needs to create and work on tasks that move project execution forward. Team has reached the Point of Impact.

The road from Mission to Point of Impact

1. **Mission statement:** TC's aim is to increase global competitiveness of Hungarian SME-s through usage of industry 4 technologies.
2. **3 years objective derived:** Count of 30 Hungarian SMEs that advanced in digitalization by TC's support.
3. **1 year objective derived:** Count of 15 Hungarian SMEs that advanced in digitalization by TC's support.
4. **Strategic Priority derived:** Marketing.
5. **Project derived:** CRM. Creation and improvement of a CRM system that ease administration, reach out and contact keeping of partners and possible clients of TC.
6. **KPI derived: CRM functionality level (%).** Out of specified CRM functions, how many are operating properly, expressed as a percentage (n°of working functions / n°of all specified functions).

In a small organization such as TC, that has not yet undergone improvement projects using Strategy Deployment Process, the Point of Impact is at KPI level – because KPIs did not exist there before. Now, owner of the KPI knows that it is by working on development tasks about CRM functions that will move forward his or her project, that will lead to move forward the respective Strategic Priority (Marketing) and finally reach objectives and fulfill the mission – **and this impact is formally validated**. Structured work can begin with the specification of CRM functionalities, creation of modules, programming, testing, etc. That is the level where root causes are addressed, executable action items are found, feedback and reckoning can be done effectively.

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Explanatory visuals

TC X-matrix level 1 – from 3-year Objectives to Strategic Priorities:

TC X matrix level 2 – from 1-year Objectives to Projects:

TC X-matrix level 3 – from Strategic Priorities to KPIs:

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Summary

Small organizations can also use Strategy Deployment process efficiently and effectively. Key point N°1 is process thinking. Dare to revise, reshape, and refine X-matrix and derived projects, even more: plan with revision activities upfront. Key point N°2 is drilling down to Point of Impact. You need to find the level where owners are capable to carry on with the work individually and turning the strategy into executable actions. At large or mid-size companies, where work with projects and KPIs is a known practice, you'll likely find this point at projects. At companies that are small, or do not have the practice with project-based working and KPIs, you'll likely need to drill down to KPIs, set them up and lean on them to create tasks and drive actions.

4.4   Integration of Digital Transformation into Corporate Strategy

You have been hired by a company that is now undertaking digital transformation. Your assignment is signed by the CEO, and you are ready to work! In the Digital Coach´s Guide to Digitalization, we assumed that Digitalization is a strategical direction the company decided upon – otherwise, your position would have not been opened. It is still important to understand other strategical directions and priorities of the organization, to simply check if the digitalization strategy has been properly aligned with other priorities or if this is still a task worth consideration of doing. It is quite a typical situation when you are uncertain about the correct link between your job's outcome and the company's short- and long-term objectives.

Use the X-matrix approach backward!

You can use the X-matrix approach "backward" to check if your priority fits the existing corporate strategy: start at the last element of the matrix, the owner: that's you. Digital transformation is your strategic priority or project. And your questions to be answered are:

1) What are my KPI targets to improve? Are there any, or do I need to set them up?
2) What are the resources my priority and derived projects will be using?
3) Are these resources available, adequate, and appropriate?
4) Are there competing priorities and projects for the same resources?
5) Are there priorities and projects that might handicap me?
6) What are the existing 1-year objectives that are positively impacted by my priority?
7) What are the existing 3-year objectives that are positively impacted by my priority?
8) Are there any existing objectives – 1-year or 3-year – that can be negatively impacted by my priority?

If you find positive answers to your questions, you are good to go! If you find more than two negative answers or uncertainties (especially at questions 3-8), allocate enough time and effort to initiate a Strategy Deployment workshop with management participation where your priority will be correctly integrated into company strategy and will find its place between already existing priorities and projects.

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Impacts of digital transformation

Once your priority is properly integrated into the company strategy, you need to start the work by planning. You'll read detailed information about project planning in the following chapters (**Fehler! Verweisquelle konnte nicht gefunden werden.**, 5, **Fehler! Verweisquelle konnte nicht gefunden werden.**, **Fehler! Verweisquelle konnte nicht gefunden werden.**), here we give you a short list of typical effects that can negatively impact the progress of your priority and projects – plan with them accordingly. Let's go through the **impacts of digital transformation**:

a. Digital transformation brings a lot of change into everyday work. Employees at companies that have not yet undertaken a real digital transformation initiative can easily think of digitalization as some IT job or function that has something to do with programming and keeping the company intranet safe from data loss. Therefore, often, they do not understand why they need to participate in it. All, why digital transformation is so important? Whenever you present your projects or involve someone in them, start explaining the why:
    i. Because digitalization is part of strategical priorities that will give a positive impact on the company's high-level KPIs – 1 & 3-year objectives.
    ii. Because the proper application of digital tools & techniques reduces time spent on administration, product, and process control, increases error proofing, gives reliable and objective performance measurement of any process, and provides data that is turned back into further improvement of quality and performance.
b. It is likely that many employees' everyday work will change – any profession can be supported by digitalization, even purely administrative functions; it is not immodest to say that sooner or later, everyone will be participating in this transformation. Outlining the timeframe and time development of your projects to involved employees removes the perceptible amount of their uncertainty and fears. Take time to set up a good timeline of your priority and projects and communicate it properly to participants.
c. Digitalization changes old routines and tools used – it is indeed a new way of working.
    i. Education and coaching of participants are critical in digital transformation.
    ii. Assurance of new tools (software, hardware) is non-neglectable – get ready to explain CAPEX demand to management, so it is self-evident to them as well.
d. Digital transformation can bring the company working performance to a higher level. As explained in point a/ii, its proper application creates an environment that can run at higher standards in terms of quality, productivity, and delivery. Taking part in the transformation brings new knowledge and a lot of nourishment to interested and ambitious souls, and you'll also meet a lot of people who do not see at once the benefits of this change: make sure you give regular feedback to everyone, so they all see the results of their efforts.

4.5 Implementation of Digital Solutions

Implementation of digital solutions in practice can be very different. Depending on the platform selected, the business type, the operations, the size of the company the already existing digital tools and techniques, the many-many type of processes that are set, not yet set, or to be upgraded at the company, not talking about individual needs of employees and management. It seems impossible to describe detailed guidelines

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of how to implement digital solutions however, there are 3 considerations you can always keep in mind that will give you a good guideline of what to take always care of.

N°1 consideration: change management.

Digitalization changes our everyday life, and it changes "big-time" the life of workers and employees. The previous section, Impacts of digital transformation lists key elements and consequences of this change. There is no successful project without thoughtful change management: people are sensible to change, and projects are run by people. When you plan your digital transformation program, plan with the impacts of change and prepare a change management section.

N°2 consideration: process management.

Only good processes are worth digitalization. Digitalization from one point of view is the creation of the physical world in digital space. If a process does not work efficiently in real life, its digital twin will also follow the same pattern. Before moving processes into the digital world, map and analyze them using "old school" techniques: identify value streams, map process steps, and list possible improvements that can be done without digitalization. Then, once these improvements are feasible to implement, you can design the new process in a way that contains digital elements. Start digitalization with measurement applications: set up quality gates and performance measurement applications that are digital and measure the efficiency and performance of the process. Use digital data to improve further the process; further digitalization including automation, robotization, and digital planning comes when current, non-digital tools and applications can't be improved further. Learn LEAN principles and apply them to processes first! Another important aspect: digitalization increases the use of digital and electric tools and systems that are working based on processes and process rules. All in all: digitalization requires process thinking.

Further details

You can learn more details about process management, including lean management and process improvement in the self-learning module "Value Creation Processes".

N°3 consideration: documentation.

Documentation, documentation, documentation. Rules and routines, including inputs and outputs that make digital tools work, are also digital, therefore non-tangible, and hidden. They are hidden in computers, e-mail servers, digital folder structures, and databases – things that do not have real extent and are difficult to examine and analyze. It is crucial that processes that are related to digitalization are clearly documented.

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4.6   Conclusion

Summary / Key Takeaways

1. Strategy Deployment is a principle to transform Business Strategy into executable projects and actions.

2. Strategy Deployment is a process of alignment, communication, execution, and continuous improvement of Business Strategy by focusing on vital breakthrough objectives.

3. X-matrix is a tool to effectively perform Strategy Deployment, and create and assign KPIs, priorities, projects, and project owners that are linked to and support Business Strategy.

4. Digital Transformation as a Strategic Priority or Project is the subject of Strategy Deployment. It must follow and be in line with Business Strategy, financial and human resources, and their limitations.

5. Implementation of Digital Solutions requires consideration of change management, process management, and documentation.

Self-test tasks/questions

1. What are the 5 main parts of an X-matrix?

2. What is the difference between Strategic Priorities and Projects?

3. Why do we need an owner?

4. What are 3-year objectives?

5. What are the Targets to Improve?

6. Create your first X-matrix!

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5. Key Project Management Methodologies

LEARNING OBJECTIVES IN THIS CHAPTER

Finishing this chapter, the learner can…

Understand the principles of basic project management methodologies

Identify methodologies for dynamic projects (Agile, Waterfall)

Identify methodologies for general projects (CPM, PERT, PRINCE2)

Understand the advantages and disadvantages of the methodologies

Recognize the needs and select suitable methodologies for the digitalization project

Project management methodologies (PMM) are a set of rules, principles, and techniques that defines:

•How your team should perform on a project

•What tools will your team use

•How you can check and evaluate the outcome

Project management methodologies are widely used in the IT-sphere, but not only. We can use them in any field including digitization which requires an in-depth approach to a project. PMMs break down complex projects or activities by factors, including time, the size of the team, the project budget, and quality metrics.

Each methodology has its own advantages and disadvantages. Although the list of PMMs seems pretty long, one doesn't have to know all of them or follow them step-by-step.

However, we need to spend some time thinking over our project's rules and tools. We can even mix different project management methodologies to create our own methodology to fit our project better.

Critical note
When estimating the resources for your project, always remember that time is the most valuable asset you have. Use time-tracking apps to manage your project time and the working time of your team.

Let's have a look at the most popular and most used project management methodologies and examples.

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5.1   General Project Management Methodologies

General project management methodologies suit a broad range of projects. One can implement them for small- and large-scale activities. And even those involving different budgets and a number of members in the team.

Critical Path Method (CPM)

The Critical Path Method was developed for large-scale, multi-action projects. It has a mathematical algorithm at its core that helps identify a critical path in your project.

Critical Path's main feature is the way it calculates the shortest project duration possible by lining up the longest sequence of dependent tasks necessary to complete the project. CPM makes time and task planning a priority, helping you to stay on track with deadlines while performing complicated tasks.

To implement the CPM method, you need to follow the following steps[7]:

1) Gather and systemize your tasks
    a. Making a list of your tasks
    b. Assigning each task with a name or a shortcode
    c. Defining each task's duration and deadline
2) Order task flow
    a. Putting your tasks in a logical line-up
    b. Identifying dependencies of your tasks
3) Create a network diagram
    a. Making your task line-up visual by using a network diagram
    b. Connecting your tasks in the chart
4) Allocate the time
    a. Determining the time you need to complete each task in the project
5) Identify the critical path
    a. Finding the longest sequence of project tasks in the diagram.

To calculate the time for each task and prioritize them easily, it's best to use a time tracker. This will help you to accurately monitor and evaluate the time on your project.

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[7] An online video on CPM can be found here: https://youtu.be/4oDLMs11Exs

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Critical note

If you run into a lengthy delay while completing any task of your project, you'll have to move the entire project deadline to a later date.

PERT Network Chart

The Program Evaluation Review Technique (PERT) is similar to the CPM methodology. This methodology was originally designed for the US Navy and implemented in a submarine missile program.

For the Critical Path Network, you need to use a deterministic approach to estimation. I.e., in the CPM, you can't account for completion time variance. In PERT, you create three timelines for each task to estimate your risks better.

The PERT Network acknowledges that there will be a time variance due to uncertainty and therefore uses a probabilistic approach to estimating for each activity. To estimate an activity, use this formula: *Expected time = (Optimistic + 4 x Most likely + Pessimistic) / 6.*

To successfully adopt the PERT methodology, you should follow these steps:[8]

1) Systemize your tasks
   a. Writing down all of the tasks you need to do
   b. Figuring out the steps you should take to fulfill each task
2) Order your tasks
   a. Analyzing your tasks if you're missing out on any steps
   b. Prioritizing your tasks by deadlines and length
3) Build a diagram
   a. Linking your tasks visually in a diagram by showing the transition between the phases
   b. Some tasks can be done in parallel to proceed to the next one
4) Allocate the time for each task
   a. Estimating the three possible scenarios for each task[9]
   b. Making calculations on the expected time (ET), using the formula
5) Calculate your critical path
   a. Identifying the longest path in your diagram
   b. Calculating the time of all tasks in the longest path (SUM them up)

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[8] An online video on PERT can be found here: https://youtu.be/1bmaDMSQe04

[9] Optimistic time – the shortest time needed to do the task. Probable time – you're highly likely to do the task at this time. Pessimistic time – the longest time needed to fulfill your task

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Advantages of PERT methodology

- Easy to estimate and analyze the time and resources needed for a project.
- You can manage and track your team and duty holders, budget, and other resources at any stage of the project development.
- You can perform a "what-if" analysis, highlighting the probabilities and minimizing potential losses.

Critical Note

PERT requires good estimation and analysis skills. Otherwise, your calculations may be subjective and do not reflect the real costs and time of the project. The PERT methodology focuses on time and is less flexible with the budget and technical aspects of the project. Furthermore, it requires intense preparation and in-depth analysis of documentation and expert opinions before scheduling tasks.

We can conclude that PERT is more suitable for medium and large companies with a sustainable base of experts and resources that run large and complex projects.

PRINCE2

PRojects **IN C**ontrolled **E**nvironments (PRINCE2) is one of the most popular government project management methodologies. It was developed in the UK and has been proven in the most unpredictable of environments. That's why such countries as the USA, Germany, Spain, and others extensively use this style in public administration and for running profitable businesses.

PRINCE2 helps to organize all the project stages and activities efficiently. It helps to arrange and analyze in detail each project step and addresses the most common issues businesses encounter when establishing complex objectives.

Prince2 values the expectations of all parties involved in the project:

- The Customer expects results and benefits from the project.
- The Contractor predicts the methodologies on how to accomplish the project and possible challenges.
- Both customer and contractor should predict the future end-users' opinions about the product.

Based on the participation of the three parties, there are 7 basic principles to follow in project performance:

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1) Feasibility. Is there a reason to continue the project (for example, you have a customer and substantial benefits)?
2) Learning from mistakes. Make a list of unfortunate decisions to analyze them and avoid them in future projects.
3) Clear role distribution. Each project member should know what to do and what they are responsible for. As a project manager, you can delegate tasks. All the work should be performed and presented by the responsible members.
4) In stages management. Divide the project into distinct stages that are easy to monitor and evaluate.
5) Product focus. Evaluate the product's quality at each stage of project development.
6) Flexibility. If a process is too long to perform, but not critical, you need to simplify it. For example, if it takes a lot of time to create a report on the results. Is it possible to report orally or send a quick email?

To successfully adopt the PRINCE2 methodology, you should follow these steps:[10]

1) Create a Project team
   a. Your team should include: Customer, Executive Director, and User Orientation Manager
   b. Establishing the project brief and project approach
   c. After defining the internal document to proceed to the next stage
2) Initiate the project
   a. Detailing further project plans, control methods, and possible risks.
   b. As you have an idea of all the procedures and workflow of the project, move to the next stage.
3) Direct the project
   a. Exploring project direction and establishing the end date of the project.
4) Control the project stages
   a. The project manager analyzes the ongoing work: introduces changes as necessary, handles emerging challenges, and reports on pressing issues to the Project team.
5) Manage your team
   a. The project manager delegates tasks and monitors that the work is done according to the schedule
6) Manage the project stages
   a. If the project has encountered any serious challenges, it should be re-evaluated and updated by the team
   b. Your team should analyze the experience and the flaws that appeared in the project
7) Close the project
   a. Prepare the outcome report
   b. Evaluating the product quality by the end-users
   c. Analyzing end users' opinions on the product.

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[10] An online video on PRINCE2 can be found here: https://youtu.be/Rz4o-kR87ls

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To conveniently monitor each participant's work in the project, we can use simple project management tools. These help us keep track of the project and its participants.

Advantages of the PRINCE2 methodology

- Robust project management methodology at its core. Clear project and team management. Each project member knows his duties and responsibilities.
- The project manager takes the role of an advisor rather than a guidance counselor and interferes in the process only when the workflow starts getting out of control.
- The Project team represents the interests of businesses, users, and contractors, providing a balanced decision.
- PRINCE2 was created for large-scale projects and ensures successful project accomplishment which has been proved by many businesses and countries.
- PRINCE2 applies to a vast range of projects starting from construction and ending in the IT-sphere.

Critical Note

Not applicable to small flexible projects with unstable requirements. As the team won't cope with the number of reports and mistakes monitoring.

Novices in project management may fail to establish all the PRINCE2 stages and processes correctly and on time. This methodology requires extra training. Some project managers notice that PRINCE2 doesn't include conflict management. This means that they need to search for additional practices on team building to include in the project management.
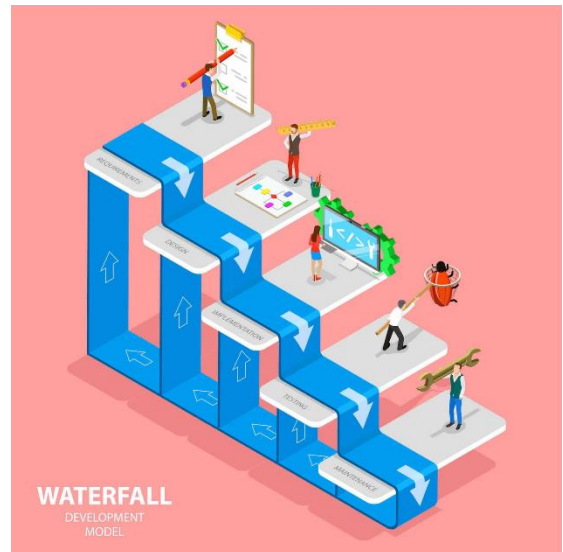
Waterfall

The Waterfall method is one of the first methodologies created for managing such dynamic projects as software development. Essentially, if we take the Traditional Project Management approach and apply it to the IT-sphere we will obtain the Waterfall model.

It's called Waterfall as its steps resemble water flowing down the mountain, like a real-life waterfall.

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To apply the Waterfall methodology, one should take the following steps

1) Setting the requirements
   a. Identifying the business needs
2) Creation of documentation
   a. Creating business requirements and specifications
   b. Developing software development architecture
   c. Choosing software development technology
3) Development of the product
   a. Creating the product
4) Probing and testing the product
   a. Software developers conduct unit tests
   b. QA engineers test the software product
5) Release and maintenance of the product
   a. Releasing your product
   b. Providing necessary support to the users

Critical Note

The Waterfall methodology is best suited to small outsourcing projects or straightforward software engineering projects, where little change is expected or budget constraints apply. The requirements for the product change less often than in outsourcing companies, and the risks are lower.

Advantages of Waterfall methodology

- Stable and well-developed documentation from the start until the end of the project.
- More accessible training of newcomers that can study a project from the elaborated documents.
- Better time planning for the team members as the responsibilities are clear and the work is scheduled.
- Clients have a complete understanding of the product they'll receive at the Release stage. Transparent budget spending, and trackable working time of each employee.

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- The project is easy to estimate and measure progress.
- High-quality product due to detailed documentation and allocated time for testing.

Critical Note

Once you've finished a stage in the Waterfall model, it's almost impossible to go back and fix the flaws. As a result, the planning stage bears the responsibility for the whole project. Also as there is no rollback, all the errors made, transfer to the next stage with little chance to correct them, resulting in a drop in product quality. If you're late at one stage of your project, the project deadline moves to further dates.

QA testing starts too late when the code is ready and mistakes correction gives little result. If a project is late, some businesses try to cut time at the testing stage, causing bugs and system faults in the product.

Too slow in its implementation. By the time of release, the client's requirements may change due to the business needs and the final product may become irrelevant. The Waterfall model doesn't allow for any unforeseen issues, meaning that your team can run into them during the project.

5.2   Project Management Methodologies for Dynamic Projects

IT projects as well as many digitization projects, are fast-moving, flexible, and dynamic. That's why they require a specific set of project management methodologies to match. These project management methodologies aid IT product development and its delivery. IT and digitalization projects are often characterized by their complexity, involving business processes, organizational structure, and risks. Therefore it's essential to set clear aims, purposes, and assessment strategies.

When starting a new project, project managers can mix several general or IT management methodologies. This approach makes such projects flexible, enables the teams to release their products fast, and monitors user feedback on the product.

Agile

The idea of agile business all began back in 2001. In the Wasatch mountains of Utah, seventeen people got together to ski, relax, share ideas, and of course, sample some tasty food. Amongst them were Agile pioneers Alistair Cockburn and Ken Schwaber. The participants were a group of software developers and programmers who all agreed that a change was needed. Furthermore, they brought their own well-defined methods to the table, including Extreme Programming (XP), SCRUM, and Crystal. The meeting culminated in the Agile

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Software Development Manifesto', in response to the need for an alternative to the heavyweight, documentation-driven software development processes of the time.

Agile is a kind of work philosophy or framework. Agile project management is an iterative, flexible approach to project management that focuses on breaking down large projects into more manageable tasks, like several „stages" or so-called „sprints".

Due to the iterative nature of Agile approaches, continuous involvement with the client is necessary to ensure that the expectations are aligned and to allow the project team to adapt to changes throughout the process. Agile incorporates a cyclic and collaborative process, while in traditional methodologies like "waterfall" or the "V-model" (in IT project management) there is a sequential methodology that can also be collaborative, but tasks are generally handled in a more linear process. So agile approach is to release benefits throughout the process rather than only at the end. Agile doesn't work on the goal of just delivering the final, predefined output of a project. It works on delivering the sections of a project, or mini-projects.

Agile Project Management doesn't require central control, in some cases, it doesn't even have a classical project manager in it. Instead of central project management, Agile greatly builds on teams and their constant collaboration with stakeholders. These small, entrepreneurial groups are designed to stay close to customers and adapt quickly to changing conditions. When implemented correctly, they almost always result in higher team productivity and morale, faster time to market, better quality, and lower risk than traditional approaches can achieve. Unfortunately, there is no formula for the perfect agile team, but as we can see later, there are different roles.

In the modern global world economy, when services and post-services form the core of the economy of developed countries, and the just-in-time or lean manufacturing, and taking advantage of long-tail distribution, Agile has gone beyond the software development sector. Its methodologies and philosophy are used in the automobile, construction, and pharmaceutical industry and in almost any startup.

Unlike in Waterfall Methodology, where the steps resemble water flowing only one way down the mountain, Agile uses iteration. This is used for error correction and flexible analysis of customer demands and software development methods.

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Elements of agile project management methodology

- Change is welcomed: Meaning that the customers, the team, and the project managers are ready for alterations to the original project that will be discussed and implemented to the product along with the project's deployment.
- Incremental development: The product improves after each iteration and is developed gradually. An iteration means that each product component is discussed, created, checked, and implemented completing the project as successfully as possible.
- Frequent releases and feedback: To meet customer expectations, the software being designed undergoes short development cycles in increments. After each iteration, the team presents its product result for customer feedback.
- Client participation in product design: The client delivers feedback and suggests product modifications, as part of the project team.

Values of Agile Project Management

To understand and teach, or to be able to use Agile in practice, you should know its values and principles. These came from the "Manifesto for Agile Software Development", from 2001. They describe a culture in which change is welcome, and the customer is the focus of the work.

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The Four Values of The Agile Manifesto

Each Agile methodology applies the four values in different ways, but all of them rely on them to guide the development and delivery of high-quality, working software. It is important to point out that although the whole of agile started from software development; its values are now widely spread.

1. Individuals and Interactions Over Processes and Tools

Valuing people more highly than processes or tools is easy to understand because it is the people who respond to business needs and drive the development process. If the process or the tools drive development, the team is less responsive to change and less likely to meet customer needs. Communication is an example of the difference between valuing individuals versus process. In the case of individuals, communication is fluid and happens when a need arises. In the case of process, communication is scheduled and requires specific content.

2. Working Software Over Comprehensive Documentation

Historically, enormous amounts of time were spent on documenting the product for development and ultimate delivery. Technical specifications, technical requirements, technical prospectus, interface design documents, test plans, documentation plans, and approvals are required for each. The list was extensive and was a cause for the long delays in development. **Agile does not eliminate documentation**, but it streamlines it in a form that gives the developer what is needed to do the work without getting bogged down in minutiae. Agile documents requirements as user stories, which are sufficient for a software developer to begin the task of building a new function. **Agile values documentation, but it values working software more.**

3. Customer Collaboration Over Contract Negotiation

Negotiation is the period when the customer and the product manager work out the details of delivery, with points along the way where the details may be renegotiated. Collaboration is a different creature entirely. With development models such as Waterfall, customers negotiate the requirements for the product, often

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in detail, prior to any work starts. This meant the customer was involved in the process of development before development began and after it was completed, but not during the process.

Agile describes a customer who is engaged and collaborates throughout the development process. This makes it far easier for development to meet the needs of the customer. Agile methods may include the customer at intervals for periodic demos, but a project could just as easily **have an end-user as a daily part of the team** and attend all meetings, ensuring the product meets the business needs of the customer.

4. Responding to Change Over Following a Plan

Traditional software development regarded change as an expense, so it was to be avoided. The intention was to develop detailed, elaborate plans, with a defined set of features and with everything, generally, having as high a priority as everything else, and with many dependencies on delivering in a certain order so that the team can work on the next piece of the puzzle.

With Agile, the shortness of an iteration means priorities can be shifted from iteration to iteration and new features can be added to the next iteration. Agile view is that changes always improve a project; changes provide additional value.

These values are used to support organizing teams in agile projects, those that embrace change and speed. It serves the mandate of iterative and evolutionary development. To do this, managers need agile tools such as scrum, kanban boards, and product roadmaps.

The 12 Principles of The Agile Manifesto
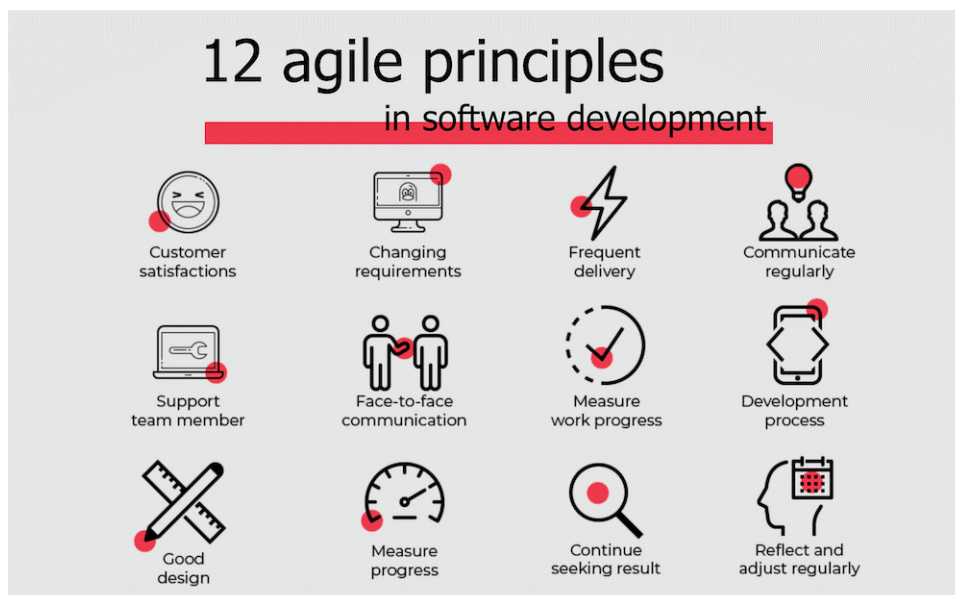
The twelve principles of agile development reinforce the four values. Let's look at each of these 12 principles to learn what they are and how they can help you manage your projects.

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1. Satisfy the Customer Through Early and Continuous Delivery of Valuable Software

By shortening the time between documenting the project, reporting to your customer, and then getting feedback, you can focus on the real goal of the project, which is delivering what the customer wants, not what you planned. Customers are happier when they receive working software at regular intervals, rather than waiting extended periods of time between releases.

2. Welcome Changing Requirements, Even Late in Development

Embrace change. The ability to avoid delays when a requirement or feature request changes. Even when the customer requests a change late in the project phase, implement it. Why wait for another project to explore another iteration when you can do it now and get the results immediately? Agile wants you to stay nimble and on your feet so you can pivot without having to constantly reinvent the wheel.

3. Deliver Working Software Frequently

If you're going to embrace change, then you're going to have to give up on your etched-in-stone schedule, or at least create a shorter range to run your tasks. One way agile does this is by cutting out a lot of the documentation that is required with traditional project management when planning your schedule before you ever start a task. The trouble is a lot of that paperwork isn't necessary. It only slows things down.

You need to reach an agreement with your team and stakeholders to come up with an agile release planning that satisfies both parties. **Scrum** accommodates this principle since the team operates in software sprints or iterations that ensure regular delivery of working software.

4. Businesspeople and Developers Must Work Together

It's like they're talking two different languages, and in a sense, they are, but both the business and developer sides of the project are crucial to its success. You must build a bridge between the stakeholders so they can understand each other and, as importantly, work together. Use the same tools you would manage remote teams to facilitate an exchange of ideas that both sides understand and are on board with. **Better decisions are made when the business and technical teams are aligned.**

5. Build Projects Around Motivated Individuals

In other words, **don't micromanage**. It doesn't work. It takes you away from what you should be focusing on. It erodes morale and sends talent packing. Motivated teams are more likely to deliver their best work than unhappy teams. You assembled the best, now let them do what they're good at. If you did the due diligence beforehand, then you can trust them to do the work. Of course, you'll monitor that work, and step in as needed, but stay out of their way.

6. Promote Face-to-Face Conversations

Documenting conversations, creating email narrative streams, and even using collaboration software like Slack, are all well and good. But when you're trying to move swiftly, you don't have time to wait for a reply.

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You need immediate answers, and the only way to achieve that speed of response is by talking to your team member or team in person. You can do this by working in the same physical space or having distributed teams and meeting online. Agile principles were mostly made before the Covid-19 pandemic, and the wide application of the home office, but the need for fast response, and availability is a key to agile. **Communication is more successful when development teams are co-located**. That creates a more collaborative environment.

7. Working Software Is the Primary Measure of Progress

That means, is the software (or whatever product or process you're working on in the project) working correctly? You're not measuring progress by checking off tasks and moving across your scheduled timeline, but by the success of the software (or whatever) is the subject of your project. Basically, it's staying focused on what's important. The process is what gets you to achieve the goal of the project, but the goal of the project isn't the process.

8. Agile Processes Promote Sustainable Development

Teams establish a repeatable and maintainable speed at which they can deliver working software, and they repeat it with each release. One reason for short sprints of activity is not only that they lend themselves to accepting change more readily, but they also help to keep your teams motivated. If you're working on a project for an extended period, there's going to be burnout. It's unavoidable. Don't overtax your team with too much overtime. It's going to impact the quality of your project. So, get the right team for the job, one that will work hard but not overextend themselves and put the project quality in jeopardy.

9. Continuous Attention to Technical Excellence and Good Design Enhances Agility

Whether you're working on code or something more concrete, you want to make sure that after each iteration it's improving. You don't want to have to come back and fix things later. Fix them now. Better still, make sure they're getting better. Use scrum, an agile framework for completing complex projects, to help review and keep the project evolving.

The right skills and good design ensure the team can maintain the pace, constantly improve the product, and sustain change.

10. Simplicity—the Art of Maximizing the Amount of Work Not Being Done—is Essential

Develop just enough to get the job done right now. If you're looking to move quickly through a project, then you're going to want to cut out unnecessary complexities. Keeping things as simple as possible is a great ethic to streamline your process. You can do this in many ways, including the use of agile tools that cut out the busy work and give you more control over every aspect of the project.

11. The Best Architectures, Requirements, and Designs Emerge from Self-organizing Teams

When you have a strong team, you want to give that team the autonomy to act independently. This means they can adapt to change more rapidly. In fact, they can do everything with greater agility because you've

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given them the trust to act without second-guessing them. If you've done your job in collecting the right people, then they'll do their job addressing issues and resolving them before they become problems.

12. Have Regular Intervals

Another benefit of creating a well-rounded team is that they will stop, reflect, and tweak the way they do things throughout the course of the project. They don't act by rote or just blindly follow protocol but think through their relationship to the project and adjust when necessary. Self-improvement, process improvement, advancing skills, and techniques help team members work more efficiently. The last thing you want is a complacent team, one that stands on its laurels. What you need is an ever-evolving group that is constantly engaged and looking for ways to improve productivity.

The Six Steps of Agile PM - implementation

For the practical implementation of values and principles, we need some "necessary steps". There are usually fewer agile methodology steps to cover than other project management approaches. The steps associated with agile project management are as follows:

1. Develop a plan.

The first step is the same for virtually all projects and programs, which is to develop a plan. A good project manager bases the plan on a measurable and attainable goal or set of objectives. This is typically determined by the client or the company which is funding the project. The plan also includes an outline for how to achieve these goals and objectives. You can determine the project's scope at this point as well, although the adaptable nature of this methodology means that this isn't always the best idea.

The scope is different from the objectives because it's a lot more detailed and specific regarding project deliverables. The reason many project managers use the agile methodology is so they can adapt to changing client needs. This makes a pre-determined scope unnecessary in most cases.

2. Assemble an appropriate team.

If you're the project manager, you're usually going to be in charge of deciding which candidates to hire for the project team. Some of this may already be pre-determined based on the organization you work for. What's important is that you assemble a team that has all of the skills necessary to complete the project, that they can communicate effectively and rapidly, and that you have confidence in them.

3. Plan the project's sprints.

The agile methodology uses numerous, smaller development cycles called **'sprints'**. These typically last between one and four weeks, and it's usually best if you can make sure they're all the same length. This helps you to ensure that the rate of development remains stable and predictable. Sprints represent realistic targets and quantifiable objectives. It's important to remember that sprints aren't used to develop a refined final product but to produce a working item that can be further refined or altered based on client feedback and other factors.

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The use of sprints is one of the main reasons why the agile methodology benefits from having teams that communicate well. The short time frames require that everyone involved is closely aware of what their colleagues are doing. This is important as team members can then factor in how this impacts their own work.

4. Hold meetings every day.

The importance of communication and rapid task completion means that daily meetings are almost always included in this methodology. These meetings, known as **'stand-ups'**, are typically quite short, lasting around 15 to 20 minutes. During these stand-ups, each member of the team reports on their progress and is held accountable for it. Everyone explains what they did the previous day, what they plan to do on the day of the meeting, and whether they've identified any problems, risks, or opportunities.

If you're managing the project, it's important to make use of these meetings as they can give you an early indication of delays, the need for additional resources, and how well your team members are working together. You can also use these opportunities to give feedback of your own, in addition to relaying any feedback or requests from the client. This ensures that everyone on the team receives crucial information and updates in a timely manner which helps avoid any potential confusion.

5. Organize post-sprint meetings.

Every time your project team finishes a sprint, you hold two separate meetings. One of these meetings is with the client or project stakeholders, and the other is between you and your team. The client meeting allows you to show them the progress you've made, such as a product prototype, new feature, or component. Eventually, a meeting like this is where you're going to present them with the final version of the product. It's usually a good idea to have as many members of the project team in attendance as possible at these meetings, even if they're just listening.

The second meeting is typically held after this and includes the project manager and the entire project team. In this meeting, you can jointly discuss the positive and negative aspects of project progress, how to address the client's needs and feedback, changes to future sprints, and your own concerns as a project manager. The decisions and information from these meetings can help inform the next sprint and thereby help it progress more efficiently.

6. Product release and support

Once your project team completes the final sprint in the development of the product and the client is happy with it, you can start producing the final version. Depending on the nature of the project and the product, the process may or may not end here. For instance, if the project was a software application, then further support to identify bugs and improve performance may extend beyond the project's official timeline. This can also include larger updates to its functionality, appearance, and customer service. This is also true of products that produce their own outputs, such as data.

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Other tools in the implementation

As mentioned earlier, Agile is a kind of philosophy. Thus, it also appears in the everyday life of the company, most spectacularly in the design of the building and offices. Agile interior design supports teamwork in designing office spaces.

Scrum and Kanban

Scrum project management is one of the most popular Agile methodologies used by project managers. Scrum is the gateway to Agile for most companies because it is relatively easy to understand and therefore easy to implement. Whereas Agile is a philosophy or orientation, Scrum is a specific methodology for how one manages a project.

In Scrum project management, the project team, which can be led by a project manager, consists of a product owner, Scrum master, and other cross-functional team members. The Scrum methodology is characterized by short phases or "sprints" when project work occurs. During sprint planning, the project team identifies a small part of the scope to be completed during the upcoming sprint, which is usually a two to four-week period of time.

At the end of the sprint, this work should be ready to be delivered to the client. Finally, the sprint ends with a sprint review and retrospective—or rather, lessons learned. This cycle is repeated throughout the project lifecycle until the entirety of the scope has been delivered.

In many ways, this mirrors aspects of traditional project management. One of the key differences, however, is how one creates "shippable" portions of the project along the way rather than delivering everything at the very end. Doing so allows the client to realize the value of the project throughout the process rather than waiting until the project is closed to see results.

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The Scrum workflow

Scrum is a framework that helps agile teams to generate value. Usually, the operation of Scrum is used to be represented by the following illustration, the so-called "Scrum Cycle".
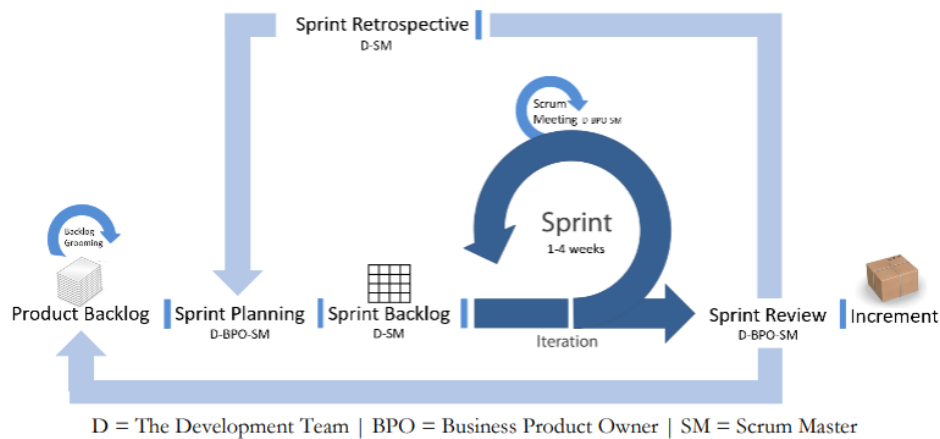
Scrum workflow

Artifacts of Scrum

Scrum's artifacts represent work or value to provide transparency and opportunities for inspection and adaptation. Artifacts defined by Scrum are specifically designed to maximize the transparency of key information so that everybody has the same understanding of the artifact. The 3 main Scrum Artifacts are:

·   Product Backlog
·   Sprint Backlog
·   Product Increment

The product backlog is a dynamic document that evolves as the project does. It is a list of new features, enhancements, bug fixes, tasks, or work requirements needed to build a product or finish a project. It's compiled from input sources like customer support, competitor analysis, market demands, and general business analysis.

The sprint backlog is a set of product backlog tasks that have been promoted to be developed during the next product increment. Sprint backlogs are created by the development teams to plan deliverables for future increments and detail the work required to create the increment.

A product increment is the customer deliverables that were produced by completing product backlog tasks during a sprint. It also includes the increments of all previous sprints. There is always one increment for each sprint and an increment is decided during the scrum planning phase. An increment happens whether the team decides to release to the customer.

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Roles of Scrum

The fundamental unit of Scrum is a small team of people, a Scrum Team. The Scrum Team consists of one Scrum Master, one Product Owner, and "Developers" (of course never forget about the stakeholders!). Within a Scrum Team, there are no sub-teams or hierarchies. It is a cohesive unit of professionals focused on one objective at a time, the Product Goal.

In the Scrum methodology, the Scrum Product Owner is usually a project's key stakeholder—typically someone from marketing or product management, or the lead user of a system. They have a deep understanding of users, the marketplace, competitors, and trends. They have a pivotal position on the product development team, communicating the goals and vision to customers, business managers, and the development team. They may also provide a product road map to the team—a high-level, strategic visual summary of the vision and goals.

A Scrum Master helps the product team to learn and apply Scrum for reaching all business values. He/she is not a team manager, a project manager, or a team lead, but serves the team, helping to remove impediments, protecting colleagues from outside interference, and helping them to adopt Agile practices. SM coaches educate and guide the Product Owner, team, and the rest of the company in the appropriate use of Scrum.

Developers are people working together to develop and deliver the requested and committed product increments. Scrum developers are cross-functional members who are capable to achieve Sprint goals. The team may include software engineers, architects, system admins, analysts, UI designers, QA experts, etc. They build the product that the Product Owner indicates: the website or an app, for example.

Kanban

Scrum teams commit to shipping working software in set intervals called sprints. Their goal is to create learning loops to quickly gather and integrate customer feedback. Scrum teams adopt specific roles, create special artifacts, and hold regular ceremonies to keep things moving forward.

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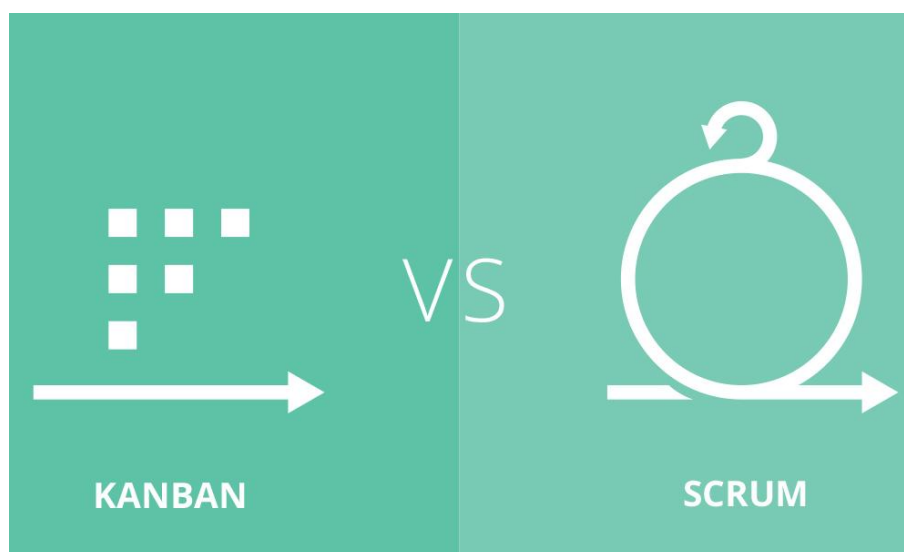
Kanban is all about visualizing your work, limiting work in progress, and maximizing efficiency (or flow). Kanban teams focus on reducing the time it takes to make a project (or user story) from start to finish. They do this by using a Kanban board and continuously improving their flow of work.

Kanban is ideal for businesses that are ready to provide quick results. Meanwhile, they spend their resources on frequent product fixing, improvement, and close cooperation with their customers.

Advantages of Agile methodology

- Quick implementation in the next iteration after discussions with a client
- Resource minimization due to frequent negotiations of further steps
- Product and teams are flexible and adaptable
- Efforts are more focused on product development
- Quick defect detection and early product testing
- More satisfactory product as an outcome due to customer involvement in product development
- Quick and frequent feedback

Critical Note

Not everyone is ready to adopt Agile. Some companies will have to run into a whole company structure renovation. For example, they will need to change workflow, teach employees, and negotiate with current clients. To get results, you should know how to implement them. That means that you and your employees will need extra training.

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5.3   Conclusion

Success means choosing a methodology that suits your project 100%. But remember, you can mix several methods together or implement their best practices in your project without choosing just one.

Summary / Key Takeaways

1. Project management methodologies are a set of rules, principles, and techniques.

2. IT projects as well as many digitalization projects, are fast-moving, flexible, and dynamic and require a specific set of project management methodologies to match.

3. Scrum and Kanban are two of the most popular Agile project management methodologies.

4. The Waterfall method is one of the first methodologies created for managing dynamic projects.

5. The Critical Path Method is suitable for large-scale, multi-action projects. It has a mathematical algorithm at its core that helps identify a critical path in your project.

6. The PERT methodology is more suitable for medium and large companies with a sustainable base of experts and resources that run large and complex projects

7. The PRINCE2 methodology is suitable for large companies or governmental projects with a lot of processes and people involved in a project

8. Each methodology has its own advantages and disadvantages. Take them into account when deciding the best methodology for your digitalization project.

Self-test tasks/questions

1) Give examples of dynamic projects. Explain your choice.

2) Compare the Agile approach with the Waterfall model. Which one would be more suitable for a digitalization project in a medium-scale company?

3) What are the stages of CPM?

4) What are the advantages and disadvantages of the PERT Network Chart methodology?

5) What kind of project would be the PRINCE2 methodology most suitable for?

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6. Basic ICT knowledge

6.1   Introduction

Definition of ICT

The ICT – Information and Communication Technologies – the term covers a wide range of technologies used in IT and communication systems, which are the basis of any kind of digitalization.

In the professional literature, in several cases IT and ICT has the same meaning – now we make difference, what we can describe in a formula: ICT = IT + CT. We can also split IT into two key parts: infrastructure and application, we may say IT systems. Nevertheless, we must add, that the term "IT infrastructure" usually covers computer networking, which is part of the "C" also, but rarely contains people-to-people communication, which is a key part of the CT.
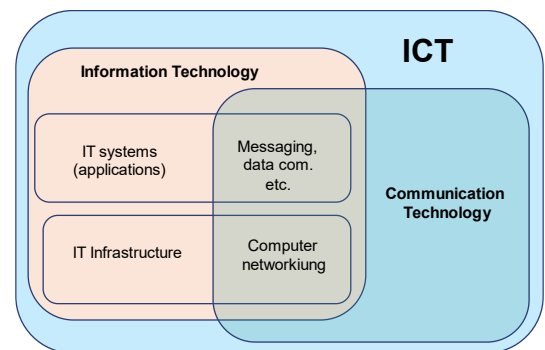
Why are IT and communication handled together? The IT and CT technologies in the last decades evolved in the same direction. With the emerging of the Internet, the IT system cannot exist without networks – networking is an integrated part of computers. And they need very similar knowledge to build and operate.

Nowadays this knowledge, fortunately, is more and more built into basic education, the younger generations use these technologies at a skill level. But people in leadership positions are often averse to these technologies, albeit they must make investment decisions that are based on or at least contain a kind of IT or communication systems almost daily. It makes essential for managers to understand the basics of ICT and became conscious buyers in this market.

In this learning material, it's impossible to teach everything about ICT, but we discuss the key alternatives and paradigms to be able to make good decisions. In this chapter, we collected the key ICT technologies used

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in industrial digitalization, went through planning a complete IT system, and discuss what technology to be considered in building a digitalization solution.

6.2   An overview of a digital factory

To connect the ICT to the factories, we go through a case study, in which we are digitalizing a small enterprise. But before we start, we must define another important term: Operation Technology, OT. It means the different systems and tools which assure the daily operation and maintenance of our machinery.

As we discussed the convergence of IT and communication in the previous chapter, we must talk about another trend in the industry. Since modern manufacturing equipment almost always uses some kind of IT system to control and operate, IT and OT are also more and more converging. In a modern company, we do not separate these two – we are talking about IT / OT environment and systems. This means that sooner or later the IT and OT organizations must also be integrated.

This is usually a big challenge for companies, even though colleagues working in production and IT have a very different ways of thinking and very different priorities. While IT prefers standard business applications, manufacturing typically requires special, unique solutions. In IT, security and the minimization of access are critical aspects, while in production, ensuring the continuity of production is a significantly more important aspect. We have already seen many Industry 4.0 projects that have stalled due to the opposition of the two areas.

Case study / digitalizing an enterprise

Assume that we are the production director of a mid-size company producing leader seats for premium car manufacturers.

The automotive industry is built on Lean principles – they are working based on customer pull, and the production requires just-in-time delivery of all different parts. Meanwhile, it's essential to get the ordered products on-time, not to suspend production. To make sure that the delivery is assured, they request real-time production information from the whole supply chain.

Our company also requested to make the status of production accessible on-line. The management initiated a project to implement an ICT solution.

First, we must understand what components are necessary to build this system. Let's look at this figure – it shows the key units and the connections between them.

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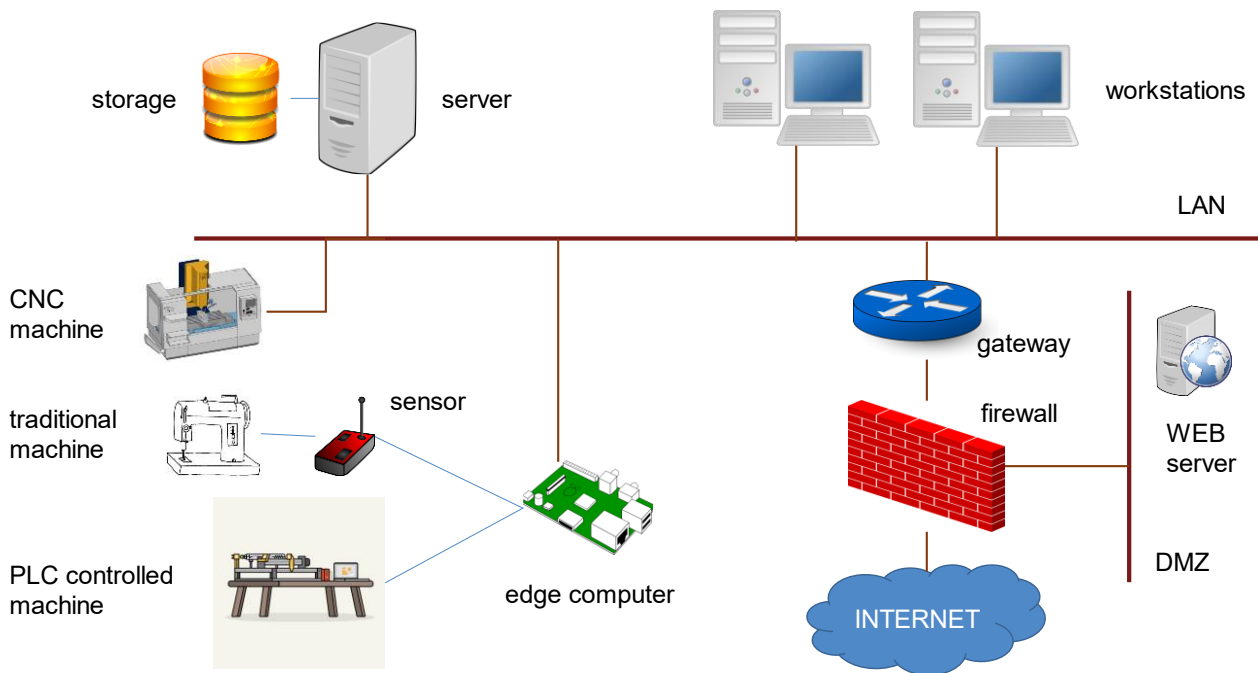
Briefly, Start with data collection. There are many machines on the shopfloor – CNC machine for making parts for the steel skeleton of the seats, PLC controlled cutting machine for cutting the leather, several manually operated, industrial sewing machines, and manual assembly workstations. How to get data out of this machinery? We can have a different solution for the different machines. We are discussing the possibilities in a dedicated chapter.

The other end is processing this data. We need a special computer called a *server*, which runs our application. Usually, there is a separate unit attached to the server, or communicates with the server via the network, which stores the data – it is simply called storage. Then we need workstations to access the application. Why do we need 2 computers, a server, and a workstation? The functions and the requirements against the computers are very different on the server and on the workstation side. Moreover, the server side can be placed anywhere – even outside the company borders, called "*in the cloud*", meanwhile the workstations are always on-site. We dedicate a separate chapter to discuss this subject.

How does the data get to the servers? We need appropriate data communication – actually, one of the key elements of our infrastructure is the internal data network, which is called the *local area network*, LAN. To be able to communicate with the external word, we need to be connected to the Internet. We can connect our LAN to the Internet using a gateway, called a *router*. To defend ourselves from network attacks coming from the Internet, we use a security device, which can filter the traffic, called a *firewall*. We discuss the communication in more detail in a separate chapter.

Now we are almost ready. The infrastructure is set – "only" the application is missing, which processes our data collected, and helps us control and optimize the production.

Let's start, jump to the details!

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6.3   The IT infrastructure

IT infrastructure

The components required to operate and administer company IT environments are referred to as Information Technology Infrastructure, or IT Infrastructure. It can be utilized to provide services or resources to customers both inside and outside of a company. A well-designed IT infrastructure aids organizations in achieving their objectives and potentially increasing profits.

IT infrastructure provides a positive user experience by allowing for easy access to the company's product, real-time data exchange, increased employee productivity, established cross-functional and interpersonal connections, as well as improved customer satisfaction and overall performance.

In a nutshell, IT infrastructure is the collection of hardware, software, network resources, and services that are required to maintain, operate, and administer a corporate IT system. IT infrastructure, which is usually internal to a company and installed within owned buildings, allows an organization to deliver IT solutions and services to its employees, partners, and/or customers.

https://www.atatus.com/glossary/it-infrastructure/#What-is-IT-Infrastructure?

So, what infra to build at our imagined company?

We must be careful - in several cases, the companies make a big mistake: first, they buy the infrastructure – servers, and storage systems. This part of the project – to buy and install the servers – is quite spectacular – we can show the racks with computers, and it looks like we've done something. But, this is the easiest part of an IT project - the computing infrastructure became kind of a commodity product. If we specify the key parameters – like the size of memory, type of CPU, size of storage, etc. we can buy it off the self, any vendor can deliver it. Of course, there are differences between brands regarding quality, extensibility, delivery time, and support – these are the key parameters to consider in an investment.

Why do we say that buying infra first is a mistake? Because what we need is not the infra – we need an application with the required functionality. So first we must plan our application, including architecture, redundancy, and interfaces, and estimate the necessary computing power, and storage area for the selected system – this is the right order two avoid either buying an oversized, expensive infra or having continuously the lack of the performance using our application.

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Let's assume, we know what parameters our new systems require. First, we must check the system architecture. It shows what functional units are to be built (like database server, application server, communication server, etc.) and what additional hardware devices are necessary (like backup devices, special interface units for the physical systems, etc.).

Our simple system architecture will be like here. It shows that we need 2 servers, one is running the modules of our application, and the second is running the database server. We also have to decide how many environments we should build – let's assume that the development is done on our vendor side, so we need only a live and a test system.
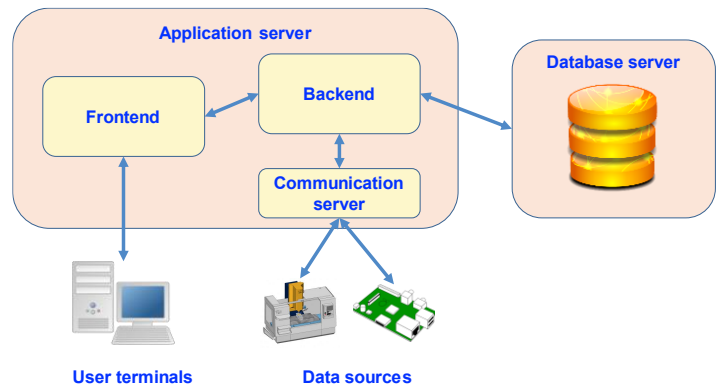
We gave information to the vendor like the number of users, the number of different machines connected (CNC, cutting, sewing), and the frequency of data polling – based on this, the vendor calculated sizing information for the necessary hardware resources. We summarized this information in a table.

	N° of users	N° of CPU cores	Memory	SSD (fast access)	HDD (high-volume)
Application server - live	10	8	64 GB	500 GB	n/a
Application server - test	4	4	32 GB	500 GB	n/a
Database server - live	10	4	64 GB	1 TB	32 TB
Database server - test	4	2	64 GB	1 TB	2 TB

You may have noticed that there is now information about how many computers we need – in modern IT environments we often use **virtualization,** which means in a physical server we run more virtual machines, which provide separated environments, in fact, they run several separated operating systems like Windows server or Linux. A software example for virtualization is VMWare.

A big advantage of using virtualization is that the necessary resources to run an application (memory, CPU cores) can be dynamically re-configured, so **our application will be scalable**. Even the virtual machines can be easily moved between servers – this way we can be very flexible. We can easily move out the application from our premises, and we can go to the Cloud.

So, we are facing an important decision – shell we invest in servers, and storage devices? If we are planning our system using virtualization, instead of buying infra (building on-premise infrastructure) we can simply go to the cloud – use the IT infrastructure placed at a service provider remotely, through the Internet.

Let's compare these options.

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	On-premises	Cloud
cost	High investment cost Yearly support/maintenance fee	No investment Monthly fee, based on real usage
operation	Internal IT staff necessary – backups, patches, security	Included in the service
scalability	With hardware extension	On-demand
security	Depends on our internal capabilities.	Assured by professional staff. Secured by contract and insurance.

Which options would you choose?

Cloud or on-premise?

It always depends on the preferences of the company. If there are more on-premise IT systems and an educated IT staff, it makes sense to add these new systems to the existing infrastructure. A question also what the finance department support – do they prefer investment or running costs? If we summarize the preferences, the pros, and the cons, we can make the decision easily.

Some examples of Cloud services

- Amazon AWS (Amazon Web Services)
- Microsoft Azure IaaS (Infrastructure as a Service)

Both companies have services like computing infrastructure, storage, and databases on a pay-as-you-go basis, or in several cost-saving pricing models. The benefit of this pricing is that we pay based on real usage, which can be dynamically modified.

Some examples of IT infrastructure elements

If we decide to buy on-premises infra, we can get an offer from several hardware vendors like DELL, HP, etc. An example of a physical server:

This is a DELL POWEREDGE R530 SERVER. It has 8 slots for hard drives so in smaller systems no need for separate external storage devices. It can accommodate 12 DDR4 max 32 GB modules, and 2 processors with a maximum of 22 cores each, so it can easily run all the environments in or small company.

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If we have hundreds of terabytes of data, we may have to invest in special storage systems – it can be a **Network Attached Storage, NAS**, it can be directly connected to the server using fast, usually, optical interfaces called **Directly Attached Storage, DAS,** or we can implement a special, high-speed network of storage systems and servers, called **Storage Are Network, SAN.** Here is an example of a DAS / SAN storage, DELL PowerVault ME5012 Storage Array – it can accommodate a disk up to 2,4 PB.

6.4   The Communication Infrastructure (The "C")

In the last decades, communication turned almost fully digital. The IT systems became distributed, in several cases cloud-based – this kind of IT simply cannot work without appropriate communication – fast enough with short latency, reliable, and accessible from any place.

What kind of networking protocol do you use?

If I ask my audience in any kind of workshop, what kind of network they use, usually I get tens of different answers – Ethernet, WiFi, TCP/IP, Internet, 4G, etc. All these people do use different communication systems. No, definitely not! The truth is, almost everyone uses all of these. So why do we have so many of these protocols? Now we try to put them to order.

The ISO-OSI model

This model was defined in the seventies, but still the basis of all communication networks. The essence of it is that it splits the communication into layers, especially 7 of those. Each layer has a well-defined function, uses the services of the layer underneath, and provides service for the layer above. We can use any kind of protocol/system at each level if they provide the required function. We have addressed each level to identify the given entity.

We can make a similarity with the postal services – the lowest layer there is the physical transportation of letters – there are several options, like lorries, trains, or even airplanes. From the service point of view, it doesn't matter which one you chose – what is only important, this service must deliver the sack of letters to the corresponding post office. The difference "only" is in the parameters of the delivery – the speed, cost, availability, etc. – that's why we have so many options. The address in this level is the id of the post office – mainly the postal code.

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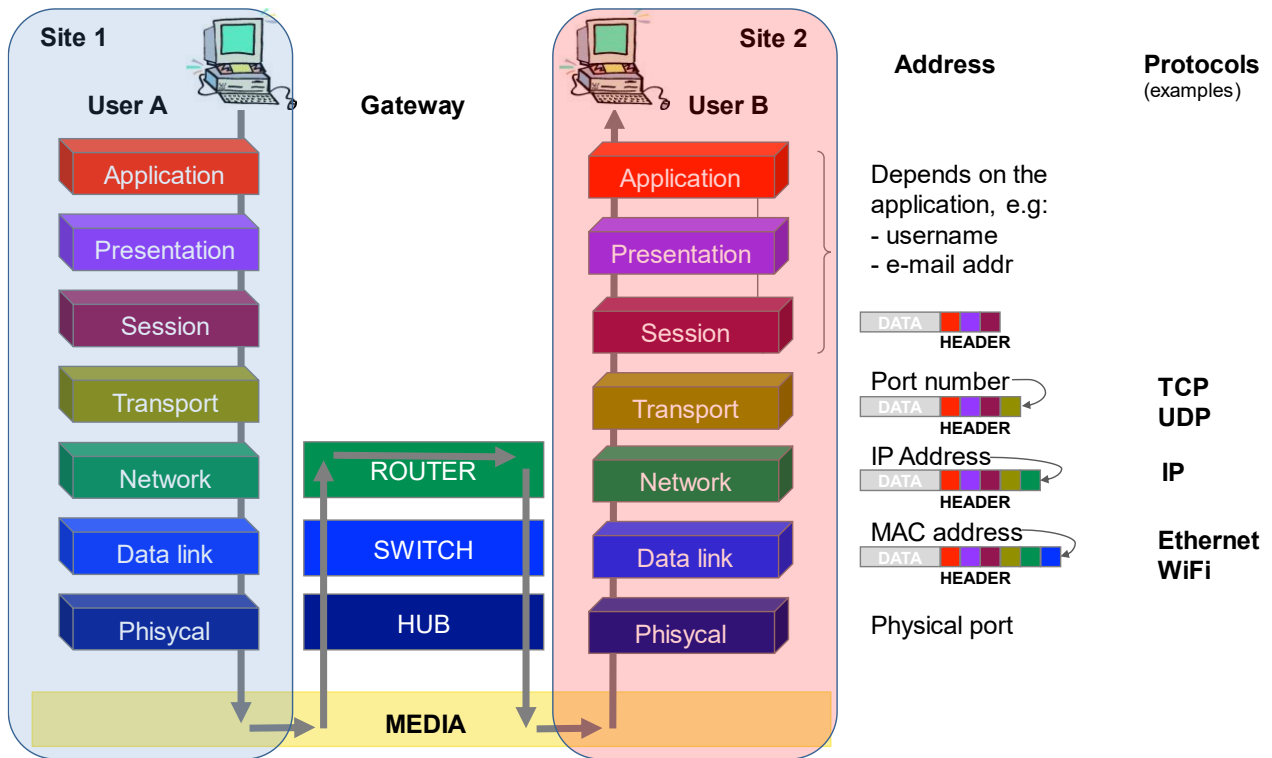
In networking, the lowest layers – the *physical* and *data link* – are similarly responsible for carrying the stack of bits from one device to an other - we can also have choices at this level, we can use either copper or optical cable using *Ethernet protocol* in the data link layer, or we can go mobile using WiFi, which covers both the physical layer (here this is a given frequency, 5 or 2.5 GHz in the air) and in the data link layer. In this layer of networking, we use MAC (media access control) address. Theoretically, each device supporting the Ethernet protocol has a unique MAC address, so all of them can communicate seamlessly with each other. Nowadays, we also have mobile technologies provided by telco companies like 4G / LTE or since 2021 the 5G which has services appropriate for industrial applications. In this layer we have multiple choices, so we always have to collect the requirements and carefully select the appropriate technology.

If we go to the network and transport layers, the function here is to ensure the end-to-end data stream between the two endpoints. These levels are mainly implemented at the operating system level in the computers. In several cases these endpoints (computers) are located far from each other – to connect them together, we need a networking infrastructure. It can be a private network – called WAN, Wide Area Network, but recently we can simply use the Internet.

In modern applications, we almost everywhere use the TCP / IP family of protocols. This is derived from the beginning of the internet.

The addressing at the networking level is the "well-known" IP address, which looks like 152.66.34.82 – this address is the address of the BME Technology Centre in Budapest. But in the near future the possible IP

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addresses are expected to sell out soon – to make it possible to connect more and more devices to the internet, a new addressing mechanism – called IPV6 was implemented, which can work parallel and provide much more addresses.

Question – can we use this address in our web browser?

Yes! But we use much more friendly addressing – so-called domain names. In our case, it is the demo.ipar4.bme.hu. How does it work? Very simply. The internet has a protocol called DNS (Domain Name Service) which translates the ugly IP addresses to a much more readable domain name.

Just turning back for a second to the ISO-OSI model, in most cases, the upper 3 layers are implemented by the applications, like e-mail or WEB browsing (World Wide Web, WWW).

So, what kind of network to implement for our new system?

- In the lower 2 levels, we can mix Ethernet cabling and WiFi where we need mobility, like the tablets of shift managers. But we have to keep in mind that WiFi in an industrial environment is not reliable – it may have longer delays or dropouts.
- In the IT systems network and transport layers, we use the TCP / IP protocol stack.
- To connect our network to the Internet, we use a router in the network layer.
- Connecting the PLC of the CNC machines, in the upper 3 layers, we use the industry standard OPC / UA protocol.

6.5   Data collection

Now we went through the ICT infrastructure part of our industry 4.0 system. The next question is how does the data get from the production line to the IT systems? Simply the data collection is the link between the physical production systems and the cyber world – it connects the OT to the IT.

Let's look at or case study. First, we must decide what data we need to collect to monitor the status of the production, and what data can be used for making smarter decisions and optimizing our production.

To follow how many products are ready in each step of production, we need to analyze the material flow. Assume we have 5 steps: [1] manufacturing the metal parts for the skeleton, [2] assembling the skeleton, [3] cutting out the leather parts, [4] sewing the leather, and [5] assembling the seat.

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Parts production	Parts assembly	Parts ready	Product assembly	Final product ready
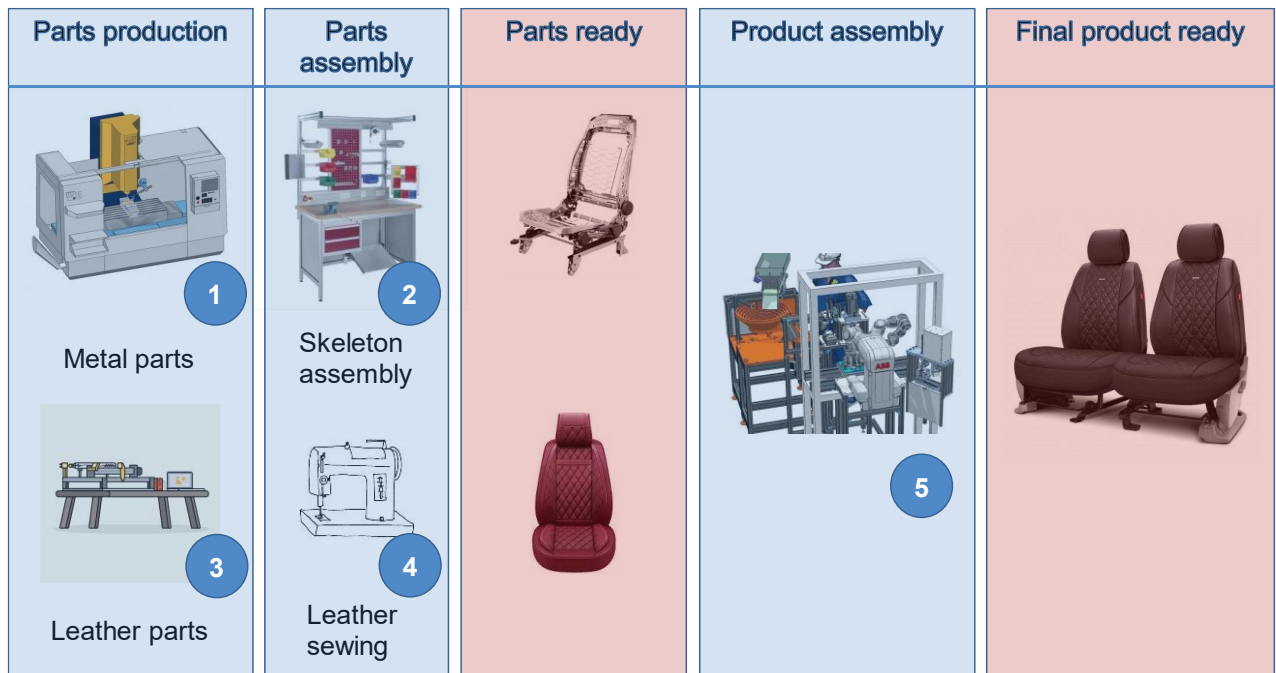
The most important data to be collected at each step are the number of finished parts, the number of waste parts, and the production time of a specific part for later optimization. In the case of manual operations (steps 2, 5) - for the purpose of measuring efficiency - the utilization of the time spent on the production of a part can also be important. How could we get this data from the different machines?

- **The modern CNC machine** can directly communicate with our IT systems, using a standardized protocol, like *OPC UA*. The machine can be connected to our internal network (LAN), using *TCP / IP protocol*. Important to note, that in several cases the vendor of the CNC machine may limit the range of extractable data or the frequency of data query. At some vendors, this feature is not free – a license fee may be applied for the data connection.
- The cutting machines **use PLC** for the operation. Several sensors are connected to the PLC to control the machine. If we can slightly modify the PLC code, we may get access to any data collected by the PLC, and we can even retrieve the actual status of the operation – we only need a special microcomputer, connected to the PLC. The modern PLCs can communicate via industry-standard protocols, we may use Ethernet/IP (eg. Festo PLC), or Profinet (e.g., Siemens PLC). This tiny computer can retrieve the PLC data and sends it to our IT system for further processing. These microcomputers installed next to the machinery are called *edge devices*.
- The traditional sewing machines and even the manual assembling workstations have no sensors and don't collect any data. Connecting this machinery, we need to install sensors, which can detect the actual operation of the machines or any parameter of the production. In this case, we also need an edge device to collect the data from the sensors and send it to the IT systems. What sort of sensors are to be installed? Well, we have several options here. But first, look at how can we get digital data from a sensor.

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Sensors – the digitization process

In the industry, hundreds of sensors are used for sensing something (e.g., whether a working place is there or not) or measuring different physical quantities and transforming these to electrically measurable values - like current or voltage - which are proportional to the original values.
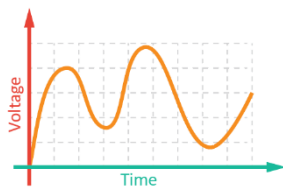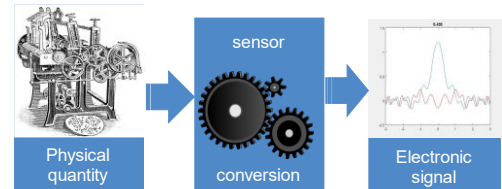
These kinds of sensors are quite spread over in the industry, the automation systems (PLC-s) are mainly using these types of analog sensors. There are standardized interfaces (0-10 V, 4-20mA) so it's quite easy to integrate them. But these values are still analog, not digital – to process the measured data in our IT systems we need to digitize these. How to make an analog value digital? The key difference between the analog and digital is that the analog values are continuous, both in time and in value - meanwhile the digital values are discrete. So what to do?

First, we have to take samples from the analog value - with this process we make discrete samples in time. How frequently should we take samples? Well, there Is a simple rule – If we use 2x higher frequency for sampling than the highest frequency component of the physical value, we don't lose information. It means, if we have an audio frequency between – 20 Hz – 20 kHz, we have to take 40.000 samples in a second.
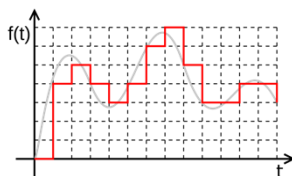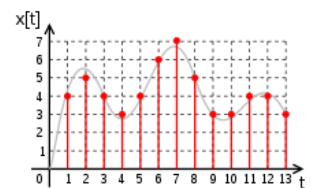
But the discrete values are still analog – the next step is to quantile the samples. The important parameter here is how many steps we use. With this parameter we determine the resolution of our data - usually we represent the data in 10-16 bits. In the case of 10 bits, we can define 2^{10}, i.e. 1024 different values. Thus, in the case of an analog signal between 0-10 V, the smallest difference we can represent in the digital data will be 10/1024, approximately 0.01 V or as we say 10 mV.

Fortunately, we do not have to deal too much with this process – there are integrated circuits (chips) called A/D converters, which do it for us. Also, the PLCs and the microcontrollers usually have integrated A/D converters. Furthermore, there are sensors with integrated A/D converters. These sensors have a digital interface, which can be connected directly to a PLC or to a microcontroller. One of the most popular digital interfaces recently is the I/O link, several sensor manufacturers offer sensors with this.
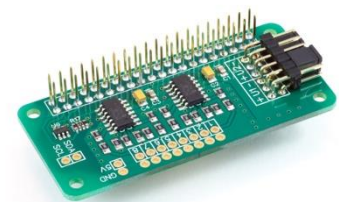
What is important is to remember the 2 parameters – the *sampling frequency* and the *resolution* in bits. These determine the quality of our data collection.

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Sensors to choose.

So, our last step is to finalize planning our new system to choose sensors for the sewing and for the final assembly.

Look at some options:

- To measure when the sewing machine worked and when it did not, the simplest solution is to measure the current consumption of the sewing machine. For this, we use a simple current measuring sensor, the data of which is immediately processed with a microcontroller. The microcontroller can send the data to our edge device or directly to our communication server. Thus, we have already put together a measuring device that we can call an Internet of Thongs, an IoT device.
- to determine when a seat cover is finished, we can use an optical sensor - when the operator puts the finished product into the exposed storage compartment, the optical sensor gives a signal. This sensor can also be interfaced with a microcontroller to form an IoT device.
- We can check the state of the final assembly using computer vision. We place a small camera connected to a microcomputer above the assembly station, and then we process the stream taken by the camera with the help of an AI template matching algorithm - with this we can detect exactly when a new component was installed on the product. The data is sent with a time stamp by the microcomputer directly to the communication server.

6.6 Applications

We are ready to equip our small plant. We collect data and deliver it to the appropriate servers. But what do we do with the data? We must be able to process and analyze the data, and then display relevant data in real-time at various points in production. Thus, operators, group leaders, or even senior managers can make decisions based on appropriate information at all levels of production.

The application areas and possibilities of Ipar4 are reviewed in the next chapter.

Summary / Key Takeaways
First, decide on the necessary application, then plan the appropriate infrastructure!
Plan the software architecture carefully
Have made sizing by the software vendor
Compare the pros and cons of on-premise and cloud implementation

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Self-test tasks/questions

Define whate ICT infrastructure means!

What protocols do you use in the network of your company in the 4 bottom levels?

What are the advantages of the cloud-based IT infra?

What kind of sensor would you use to count the number of products just made?

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7. Digitalization and I4.0

<table>
<tr><td>LEARNING OBJECTIVES IN THIS CHAPTER</td></tr>
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The learner…

…can learn what IT solutions are necessary for a production environment;

…understand the key technologies used in Industry 4.0 solutions;

…get familiar with the key Industry 4.0 application areas.

7.1   Introduction

Can we say that Industry 4.0 is equal to digitalization? From the technology point of view, YES, we can. But Industry 4.0 means not only technology. This means processes, value flow, as Lean defines and the people with digital competencies to use, operate and develop these systems. Before we start to digitalize, first we must understand how the information flows in our company, and what functions and IT systems are necessary to process data. We created a model of IT systems at manufacturing companies. We go through this model and explain where Industry 4.0 takes place.

7.2   Industry 4.0 architecture

In our model, we have two key actors. One is the customer. The reason why we produce any kind of product is to sell it to the customers, be they external or internal customers. She/he is the one who is paying us, so the most important to satisfy her / his requirements. The second is the owner(s) of the company. Why we do this full manufacturing is to make a profit for the investors/owners. So, we always have to keep in mind that all we are doing is for these two people.

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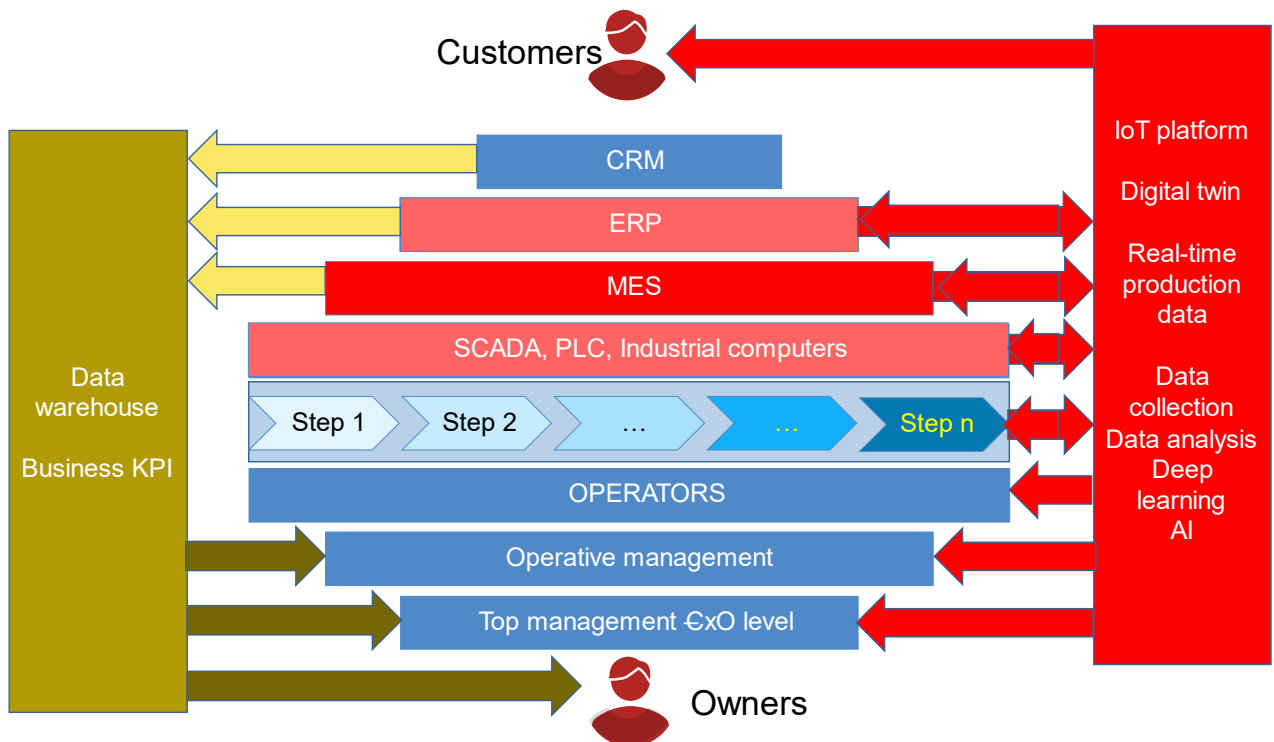
The middle of our model is the production – we may say the value flow itself. The production consists of several steps – the essence of Industry 4.0 is that we collect information in real-time at each and every step of the production.

At the top of the model the customer is sitting – the upper side visualizes how the customer order is processed, how this information is split into production steps, and how it is transferred to the production. In this process, we use several functional layers, which are supported by different IT systems. There are commonly used terms for the groups of these functions such as CRM, ERP, MES, etc.

At the bottom of the model the owners/investors are sitting – the lower half of the model illustrates how the company is managed. It's important to understand what level of management needs what sort of information to work efficiently – actually, the essence of Industry 4.0 is to deliver relevant real-time information to all levels of production.

We split the information processing also to 2 different kinds – the business information (left side) and the production information (right side). Important to make difference between these two kinds of information.

The **business information** is usually retrospective analyses or a kind of business forecast where the information is derived from the operational business systems. But we have a problem here – the operational systems (like order processing, and billing) are designed to handle transactions, not to make reports and analyses. They are called **On-Line Transaction Processing, OLTP** systems. That's why in the 90' a new concept – the **Data Warehouse, DWH** – was developed. These DWH systems are designed especially for running queries and analyses, based on **On-Line Analytical Processing, OLAP** concept. How do the data get to the

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data warehouses? During the night, when the transactional systems are not overloaded, all relevant data is extracted to the Data Warehouse. In fact, a DWH is little more than a copy of the operational database, its data is reorganized with the goal of supporting analytical queries. There are systems called **Electronic Transformation and Load, ETL** which are used to do this extraction, and conversion and/or extension wherever necessary.

So, all is set. We only need some tools to run queries, analysis, and create charts and dashboards from these data – these systems are called **Business Intelligence, BI** tools. These BI tools are frequently used by marketing, sales, and management. With these tools, the users – even without special programming knowledge – can simply create various analytics and can even drill down to the detailed data to find out the causes of given events.

The **information** necessary **in the production** is a bit different. To follow the state of the production, or optimize it in real-time, we need **real-time data**. This needs real-time data collection and analysis – usually whit short latency. To extract or directly collect these data needs different tools and software than the DWH / BI side. But this is not something very new – when automation started in the sixties, controlling systems were developed which were collecting real-time information, processed it, and controlling equipment or a process. But these systems were standalone – the information was used inside, only to assure the process control. These controllers were mainly **Programmable Logical Controllers, PLCs.**

Now we are almost there – we can simply extract tons of data from the PLCs, or we can install new intelligent sensors (so-called IoT devices) if there are other parameters to measure. Recently computer vision using AI has developed enormously, so several kinds of production data can be collected using small cameras and processing the images. All are done in real-time. The systems processing these data form the skeleton of Industry 4.0 applications (see right side).

7.3 Key I4.0 application areas

Business systems – CRM, ERP

CRM and ERP have quite matured terminology in IT. The key functions of CRM and ERP systems are supporting the administrative operation of the companies. These systems track and support the company's business processes. They often have a modular structure, so they can be implemented step by step and expanded with new functions. One of the market's leading ERP software providers is SAP – see below the list of this company's ERP modules.

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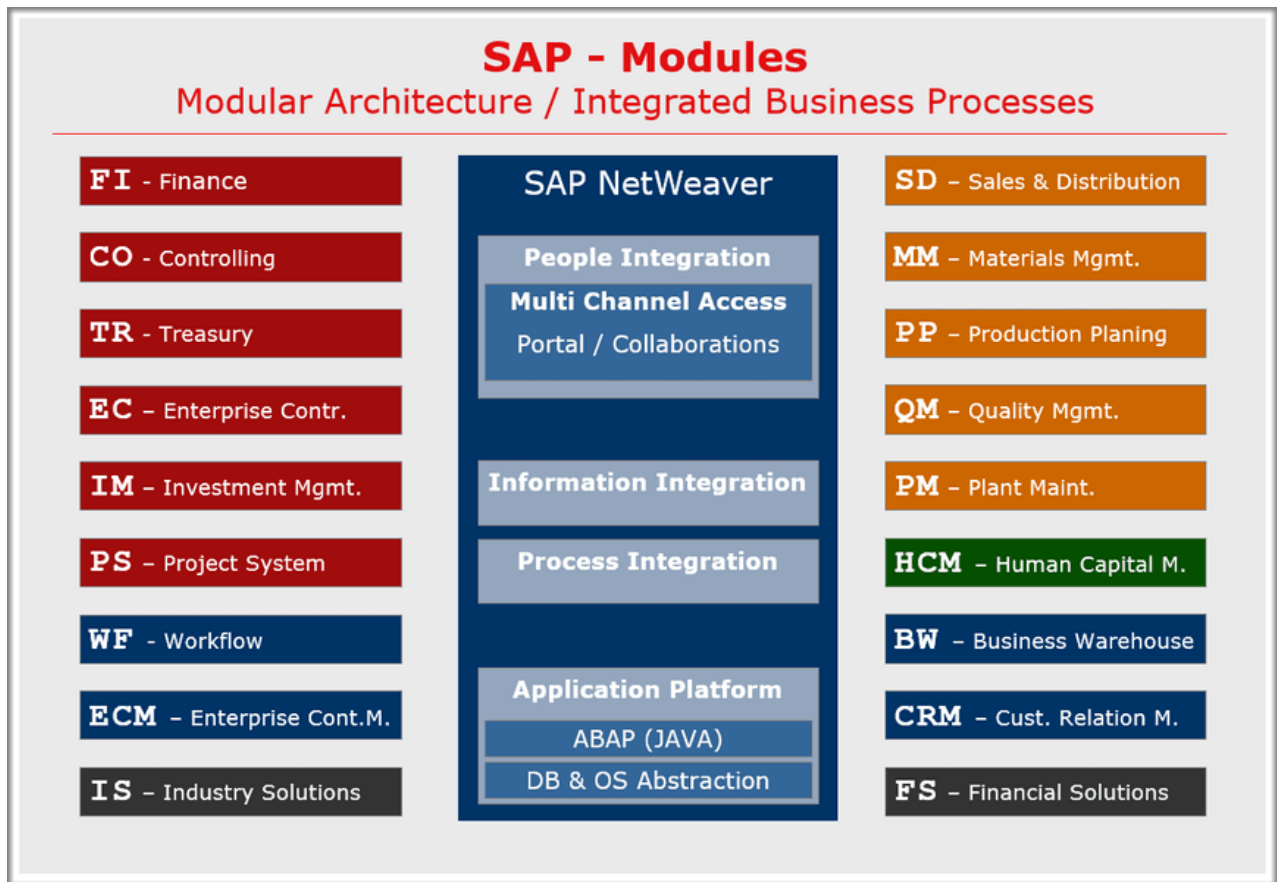
These systems form the basis for all Industry 4.0 solutions. They manage the basic data required for production - such as orders, stock levels, or even human resources.

The borderline between CRM and ERP is narrow – several ERP systems have lots of CRM functions, and usually separate CRM systems are used only in companies with very intensive customer interactions. Similarly, the borderline between ERP and MES also narrows. Companies selling ERP software try to develop their systems in the direction of providing more and more production-related functions, so they often perform many tasks that logically belong to the functions of MES systems.

Manufacturing Execution Systems (MES)

MES is a much less well-defined area than ERP. There are many different definitions for it, each software development company tries to adapt the definition to its own product. However, everyone agrees on one thing - under MES we classify all functions that are not closely part of ERP and are located somewhere between ERP and SCADA systems.

While SCADA is designed to control production in real-time and ERP is designed for management of the company's business processes, MES is designed to track and collect information about each product (semi-product) through all stages of the production process. It is a software (or a set of different software modules)

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capable of operating with data received in real-time (PLC, SCADA), while also exchanging information with the transactional world (ERP, SCM, CRM).

MES's purpose is to analyze and extract important information from production data and forward it to ERP. Also, these software solutions can convert work orders received from ERP to a production schedule and are capable of dispatching this schedule to the shop floor (PLC, SCADA). It is very important to properly correlate process data and product quality and to provide and collect information in different formats from various systems.

MES functions include production management, which is one of the key factors in increasing production efficiency. Its main tasks are production planning, production scheduling, production supervision, and production optimization.

SCADA systems

Supervisory control and data acquisition (SCADA) systems are responsible for monitoring and operating production systems. In practice, they are connected to the computers and PLCs that directly control machines and equipment. They collect data from them, through which the maintenance staff can monitor their operation. In the other direction, if necessary, they provide an opportunity to intervene in production, either to eliminate a defect or to support the transition between products.

The role of SCADA systems should not be confused with Ipar4 solutions. These are usually independent, non-integrated systems, their role is limited to operation, and they usually do not extend to the optimization of production.

At the same time, where SCADA systems exist, they are a good data source for Ipar4 solutions.

Industry 4.0 in the Shopfloor and in Logistics

A lot of new, modern technologies have also appeared on production lines and in logistics, which are usually referred to collectively as Industry4 technology.

Without claiming to be exhaustive, some of these technologies:

- 3d printing – is a collection of several technologies which are able to create unique 3D objects. With the help of this, we can cost-effectively produce unique or small series products.
- Cobots – collaborative robots, which are able to work together with people, sharing some tasks between the person and the machine.
- Indoor positioning - tracking and identifying the exact location of certain logistics objects (forklifts, storage compartments) or larger devices and tools within the plant is not a trivial task. Real-Time Location Services (RTLS) provide a solution for this. We can use optical, image processing-based solutions or even radio frequency systems (UWB).
- Automated Guided Vehicles - the logistics within the factory, and the accurate and precise delivery of the parts to the appropriate points of the production lines are also serious challenges. AGVs are increasingly being used for this task. We can distinguish many different types - simpler solutions

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follow an optical or magnetic strip, while more modern systems are able to map their surroundings and avoid obstacles.

7.4   Key technologies behind Industry 4.0

IoT

The IoT comes from the Internet of Things and is widely associated with Industry 4.0. In some countries, the Industrial IoT – IIoT – is used instead of Industry 4.0. Why is that so?

Definition of IoT (Wikipedia)

The **Internet of things** (**IoT**) describes physical objects (or groups of such objects) with sensors, processing ability, software, and other technologies that connect and exchange data with other devices and systems over the Internet or other communications networks. Internet of things has been considered a misnomer because devices do not need to be connected to the public internet, they only need to be connected to a network and be individually addressable.

Yes, the data collection part of Industry 4.0 is based on IoT in most cases. IoT devices have undergone enormous development in the last couple of decades - the price and size of sensors, microcontrollers, and communication chips have decreased to a fraction, basically, this technological development is the basis of I4.0 - we can say that this development made the spread of Industry 4.0 possible.

IoT platforms

If we have many IoT devices, we may need a system to manage these devices, collect and process the data from the sensors, and make a cyber representation of the physical systems – these are called IoT platforms. Many companies are selling these kinds of systems – like Siemens MindSphere, or PTC ThingWorks. In several cases these systems are cloud-based – our company may have production plants anywhere in the world, and all of our production data is stored in real-time, in one place.

Message Handling

An interesting IT technology is handling the data packets coming from hundreds of sensors / IoT devices / PLCs. In a complex software environment, we may have thousands of data sources and many applications using these data. To make the connections between the data sources and applications flexible, we can use message brokers. These work like the chat boxes – in the broker, we can set up channels. Any data source can send data to specific channels, and any application can subscribe to any channel – this way we can

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centralize the distribution of data. The message broker can handle the speed differences, can buffer data, or even can make filtering.

Data Storage

In transactional systems (like ERP, and CRM) we always have well-structured data. When we collect data from the production, in several cases we can hardly structure the information because it can be very heterogeneous. If we try, we must make schemes, but putting the production data into a fixed scheme we may lose information. A way to avoid losing data the concept of a **data lake** was developed. It can store data in its native format and process any variety of it, ignoring size limits.

Sensor data is usually stored by adding a time stamp to it - the databases created in this way are called **time-series databases**, such as MongoDB or InfluxDB.

It is also worth mentioning the application of **big data**. It is used for data sets that are too large or complex to be dealt with by traditional data-processing application software. Big data technologies use parallel processing of data by several (even more thousand) computers. One of the well-known big data solutions is an Apache open-source project named "Hadoop".

Artificial Intelligence

Definition of AI (Encyclopedia Britannica)

"Artificial intelligence (AI), is the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings. The term is frequently applied to the project of developing systems endowed with the intellectual processes characteristic of humans, such as the ability to reason, discover meaning, generalize, or learn from past experience."

As can be read from the definition above, artificial intelligence is a general, summary definition. The solutions used in practice are mostly machine learning and deep learning technologies, which are a subset of AI. The idea behind machine learning – similarly to the human brain – is to learn patterns, which can then be recognized with high probability even among large amounts of data.
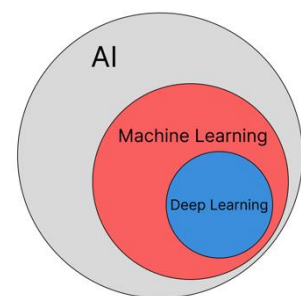
In basic technical terms, machine learning uses algorithms that take empirical or historical data, analyze it, and generate outputs based on that analysis. The algorithms are fed with so-called "training data" first where the expected result also is included, and then they work with real data to predict and find ways to improve their performance/accuracy over time.

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Machine Learning has a sub-field called Deep Learning, it works in the same way, but more special. Deep Learning uses a model called Neural Network, which is based on the neurons like in the human brain. This is basically a network that has layers and neurons in the layers. If the model has two or more layers, it's called deep learning. The idea is that every neuron has its own mathematical calculation, and the incoming data goes through every neuron of every layer, and the output gets calculated this way. During the training, the neurons' weights get updated every time and this way the model develops.

Data Visualization

Following the Lean principles in production, it is very important in every step to visualize the necessary information to all persons involved from the operators to the top management. There are various ways to display information.

In several places on the shop floor, there is no place for displays and the tasks done by the operator dos does not allow watching and reading the information on a monitor. In these places, we use simple tools like **Andon lights**, which we can combine with acoustic signals.

Where we need more detailed information, we can place different sizes of monitors and set up different dashboards, to display all the relevant information in a well-structured, transparent form.

There are situations where the operator needs the information exactly in the place wherever it is necessary. For example, by giving instructions to the operator on what the next step is in the assembling process, it is very useful to show the step projected to the workpiece directly. In this case, we can use modern technologies like Augmented Reality (AR), using a tablet, or even a special AR glass, which enables the operator to use both hands to do the assembling steps. In the picture, we show instructions to the operator using AR on a tablet.

Digital Twin

This is also a fairly general term that we apply to many things in connection with Industry 4.0. We call any IT solution that partially or fully maps a physical object a **digital twin**. The digital twin can be one-way, two-way, or even bi-directional. Look at some practical solutions.

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- A typical one-way solution is when we display the data collected from the machines in our IT system, either graphically, representing the machine in 3D, or simply in dashboards or a tabular form.
Recently, thanks to the rise of augmented reality (AR), the data can be displayed either directly to the physical machine, to the exact place where it is measured using an AR glass, or simply a tablet.
- Also, a one-way solution, but in the other direction when we model and simulate the physical equipment in cyberspace – we can prepare the programs that control the machine and test with different settings in the virtual space, and then we can transfer the finished programs to the physical equipment.
With these kinds of digital twins, we can significantly reduce the time necessary to move from one product to another one, which is a very important element of Lean, by not being necessary to stop production for writing and even testing the new code.
- We can also build bidirectional digital twins, where we collect, process, and visualize the data from the machinery and even can control the system automatically.

Summary / Key Takeaways

We got to know a model for the IT applications of a production plant

If we implement an IT system to solve given business problems we can place it to our model

We lerned what we can chose from the state-of-the-ard technologis to implement a new IT system

Self-test tasks/questions

Wht IT systems do you use in yout company?

What is the difference between a DWH and the industrial data collection?

What IoT means?

List 5 moduls of an ERP system!

List 5 key functions of a MES system!

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CONCLUSION

With a major percentage of organizations embarking on a strategy of digital transformation and disruption being the new norm, digital coaches are becoming even more essential as organizations recognize that digital transformation must be implemented in their businesses. The digital coach should respond to market needs in terms of skills, approaches to the delivery of projects, and the use of digital tools and approaches.

In this self-study module, digital coaches developed their technical skills, project management skills, strategic skills, and business management skills, which are essential for the driver of digital transformation in a company. In addition to this, organizations will need digital coaches to learn and keep pace with existing and emerging technology. In the reality of the "Digital Age," a new digital overlay has been given to the traditional skills to emphasize how digital transformation is impacting every aspect of our work.

The basic technical knowledge, which is essential to drive the digital transformation, has been discussed in this self-study module. However, some digital transformation projects may require specific domain knowledge. This knowledge can be defined by industry group (pharmaceutical, financial), department (accounting, marketing, legal), technology (software development, engineering), or management specialty (procurement, research, and development). These application areas are usually concerned with disciplines, regulations, and the specific needs of the project, the customer, or the industry.

Success in today's digital transformation projects requires a combination of skills, some of which include data science (data management, analytics, and big data), an innovative mindset, security and privacy knowledge, legal and regulatory compliance knowledge, the ability to make data-driven decisions, and collaborative leadership. This creates both challenges and opportunities for digital coaches in management of digital transformation projects.

Digital Coach [2020-1-DE02-KA202-007683]

Corporate strategy for digital transformation and agile project management

Self-study module for Digital Coaches

Editor:
   Prof. Dr. Martin Kröll, Institute for Work Science (IAW), Ruhr-University Bochum. All rights reserved.

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   Autor, Organization

Project Website:
   www.digitalcoaches.eu

Training concept for the module
"Corporate strategy for digital transformation and agile project management"

Erasmus+

Co-funded by the Erasmus+ Programme of the European Union

Agenda

01 ———————— Training concept

02 ———————— Presentation of the individual steps of the training concept

Knowledge transfer structure

Real-world training concept in a learning factory to apply theory knowledge from the self-study modules, in order consolidate the methods.

Self-study module serves as support during the seminar and for effective follow-up work

TRAINING

HANDOUT

VIDEOS

Give a quick **overview** of the topic as an easy **introduction** to the training content.

Erasmus+

Co-funded by the Erasmus+ Programme of the European Union

Video of the self-learning module

- Presentation of the self-study module:
  - What are the objectives of the self-study module?
  - What is the learning objective
  - Short summary of the content

THEORETICAL INPUT

Handout

- Introduction of the self-study module
- Basics on strategic thinking, strategy development and deployment
- Business decision-making structures
- Key project management methodologies
- Basics on ICT
- Including tasks and use cases

THEORETICAL INPUT

Training structure

Introduction
Overview of the module content and learning objectives.

Key Project Management Methodologies

Basic ICT Knowledge

Introduction to Basic ICT Knowledge.
An Overview of a Digital Factory.
The IT Infrastructure.
The Communication Infrastructure (The "C"). Data Collection.
Applications.

Strategic Thinking

Evolution of Strategic Thinking.

Schools of Strategic Thinking.

IT as a Source of Competitive Advantage.

Strategy Deployment

The Goal of Strategy Deployment.

Strategy Deployment Process.

Hoshin Kanri – X-matrix.

Integration of Digital Transformation into Corporate Strategy.

Implementation of Digital Solutions.

Digitalization and I4.0

Introduction to Digitalization and I4.0.
Industry 4.0 Architecture.
Key I4.0 Application Areas.
Key Technologies behind Industry 4.0.

Strategy Development

Strategy Development Process.

Analysis of Internal and External Environment.

Vision, Mission, Goals, Action Planning.

Decision-Making Processes

Introduction to Decision-Making Processes.

Decision-Making Basics in General.

Business Decision-Making Structures.

Decision-Making in Family Businesses (FB).

Conclusion

Summary of key takeaways from the module.

Pre-training and post-training learning material

- Structured learning material for self learning
- Theoretical input before the real-world training in the learning factory
- Exercises included to apply the learned methods

Learning Methodology

- Self-paced online modules with interactive multimedia content (videos, quizzes, case studies).
- Hands-on exercises and activities to apply concepts in real-world scenarios.
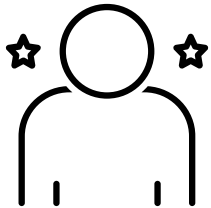- Discussion forums for peer-to-peer learning and sharing best practices

PRACTICAL INPUT

Resources & Assessment
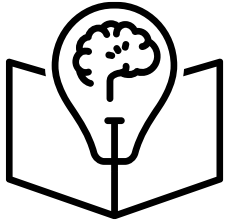
Resources

- Recommended readings, articles, and books on strategic thinking and digital transformation.
- Access to digital tools and resources.

Assessment

- Quizzes and knowledge checks at the end of each module.
- Completion of practical exercises and submission of strategy plans.