Technology Management - Jaish Khan

1. Technology

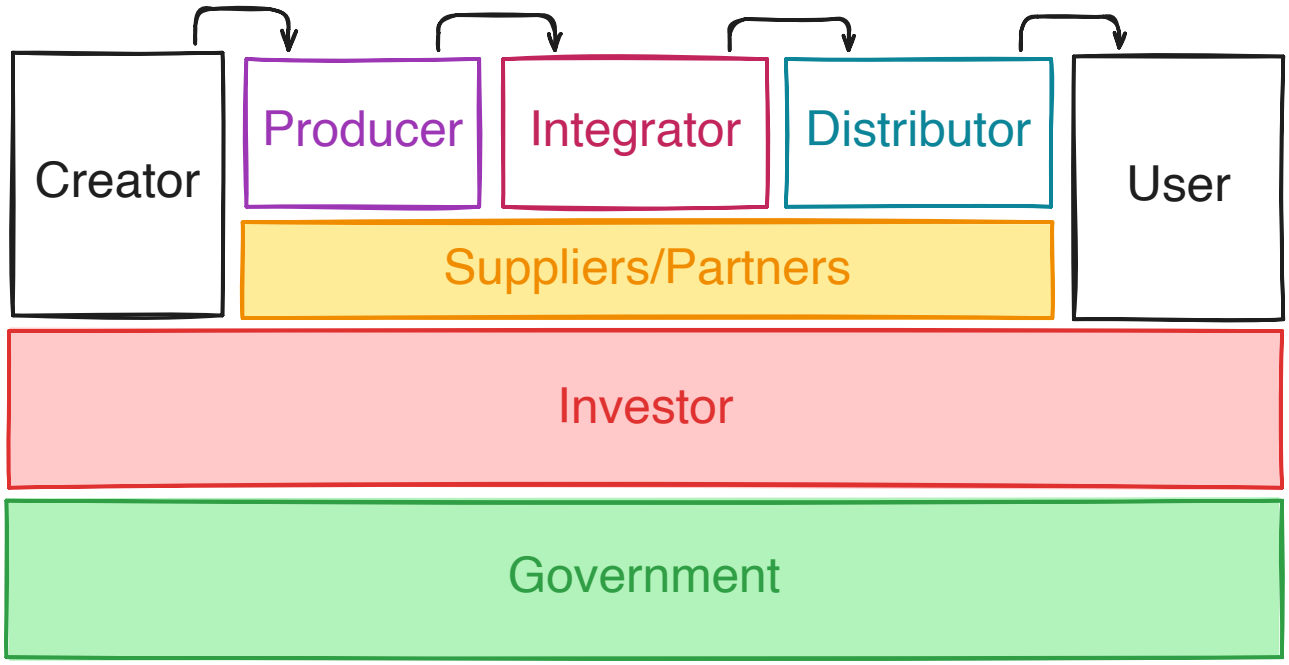
> The knowledge, methods, and processes used to transform resources, often described as applied intelligence or systematized practical knowledge. It encompasses not just equipment (*hardware*) but also the knowledge to use it (*software*), the understanding of its function (*brain ware*), and the practical skills or experience (*know-how*).

Technology is increasingly vital for company value, economic growth, and competitiveness, far exceeding physical assets. It's seen as an engine for development, a strategic resource, and a competitive tool, crucial in a globalized, fast-changing market driven by customer needs. Adopting technology must align with a company's vision and goals for sustainable growth.

1.1. Classification of Technology

- **New Technology** → Recently introduced, impacting products.
- **Emerging Technology** → Potential for future commercialization, high research investment.
- **Low Technology** → Widespread, uses lower-skilled labor, manual operations, low research, stable base, serves basic needs.
- **Medium Technology** → Falls between low and high technology.
- **Appropriate Technology** → Well-matched to available resources.
- **Tacit Technology** → Experience-based, unwritten knowledge held by developers.
- **Codified Technology** → Explains how technology works, but not necessarily why, potentially excluding the developers' underlying knowledge (brain ware).

Roles Relative to Technology



1.2. Technological Change

> The fundamental process by which economies transform over time. This involves alterations in the products and services they create, as well as the methods used to produce them.

`More specifically` It refers to changes in physical processes, materials, machinery, or equipment that impact how work is done and a company's efficiency. Crucially, technological change affects the relationship between labor, capital, and other production factors. While broad socio-economic factors are important, understanding the internal forces driving technological change is key, especially in less developed countries, which can offer insights for industrialized nations.

1.2.1. Measuring Technological Change

Measuring technological change involves looking at several indicators:

- **Economic Indices** → Technological change is measured as the weighted average of the change in factor prices, holding inputs constant.
- **Geometric Index** → Technological change is equal to the change in output not accounted for by the changes in labor and capital.
- **Patents** → The number of patents granted serves as an indicator of technological innovation. Patent data is also used to study how technology spreads across companies, industries, and countries, and to evaluate the output of research activities.

Beyond these indices,

1. **Rate of Improvement** → Measured by tracking a key performance metric (e.g., speed for vehicles, efficiency for lighting).
2. **Rate of Substitution** → Looks at how quickly a new technology takes market share from older ones.
3. **Rate of Diffusion** → Tracks the adoption of new products or processes by users. Interestingly, the growth in improvement, substitution, and diffusion often follows an S-shaped curve, starting slowly, accelerating, and then leveling off.

1.2.2. Theories of Technological Change

Various theories attempt to explain the drivers and mechanisms of technological change:

Theory	What it says
Neo-Classical Theory	Uses the concept of a "production function" relating inputs (like labor and capital) to outputs. Technological change is seen as a shift in this function, allowing more output with the same inputs. However, this theory is criticized for being too simplistic, only considering labor and capital, struggling with improvements beyond cost reduction, and being better suited for analyzing stable economic states rather than dynamic change.
Marxist Theory	Sees technology as a product of human action shaped by historical forces. Technological development is considered a primary driver of historical change, with entrepreneurs innovating for profit or survival. A limitation is its focus primarily on innovations that save labor.
Schumpeter's Theory	Innovation is the main engine of economic development, viewing it as a disruptive force. Innovation is broadly defined to include new products, methods, markets, sources of supply, and organizational structures. The theory focuses on innovation as a distinct, non-routine economic activity but is criticized for its reliance on the elusive psychology of the entrepreneur and lack of empirical evidence on how innovation is generated.
Evolutionary Theory	Technological change happens through a process of "invention" (mutation) and "innovation" (selection). It observes patterns in technological development within industries, moving from initial experimentation to more mature, incremental improvements. A limitation is the lack of quantitative models and the need for more validation of its propositions.

Theory	What it says
Market-Pull Theory	Market demand is the primary driver of innovation. Changes in political, economic, social, and environmental factors influence buyer demand, which in turn signals to technology producers what kinds of innovations are needed. Criticisms include the difficulty in interpreting the innovation process and defining demand, and its inability to fully explain why certain technologies develop over others.
Technology-Push Theory	Technological developments occur autonomously, driven by scientific discoveries, research, and development. These developments then potentially create or meet existing demand. A major limitation is its failure to adequately consider the influence of economic factors on the direction of technological change and the complex feedback loops between the economy and technology.

1.3. Technological Innovation

> The process of turning new ideas into practical tools, devices, or procedures that benefit society. While often thought of as simply creating new products, it also includes improving existing methods, using cheaper materials, or reorganizing processes for better efficiency or lower costs.

While a simple view sees innovation as a straight line from scientific discovery to development and finally to widespread use, the reality is much more complex and non-linear. It often involves revisiting earlier ideas and responding to new needs. The process typically involves several stages:

1. **Basic research:** Exploring fundamental scientific principles without a specific application in mind.
2. **Applied research:** Focusing on solving specific societal problems.
3. **Collaboration:** Bringing diverse minds together to tackle complex challenges.
4. **Technology development:** Converting knowledge into physical or digital forms like hardware, software, or services, often involving testing prototypes.
5. **Technology implementation:** Putting the developed technology into practice in the target market following a plan.
6. **Production:** The actual manufacturing process, which can involve different methods like repetitive, discrete, job shop, or continuous production.
7. **Marketing/Commercialization:** Introducing the new product or service to the market, a phased process that considers production, distribution, sales, and support, and requires a marketing plan and anticipating challenges.
8. **Proliferation:** The widespread adoption and spread of the technology.
9. **Technology enhancement:** Further improving the technology over time.

1.3.1. Innovation Management

> Creating an environment where new ideas, processes, or products can flourish. Senior management support is crucial for successful innovation.

It's not just confined to R&D; it involves encouraging creativity at all levels of an organization. The process can be seen as a cycle of searching for ideas, selecting the best ones, implementing them, and capturing their value. Innovation can be driven by either:

- **Technology-push** → Finding uses for existing or new technology.
- **Market-pull** → Identifying customer needs and developing technology to meet them.

Both approaches require understanding the market and the technical challenges, often best achieved through multi-functional teams. Tools like brainstorming, prototyping, and portfolio management help in this process.

2. Technology Management

> It is essentially about how organizations or even nations handle their technological resources and capabilities to gain an edge and achieve their goals. Think of it as bridging the gap between engineering, science, and business management.

TM covers a wide range of activities, including setting technology policies, predicting and assessing future technologies, developing technology strategies, transferring technology, managing technology projects and R&D, managing the skilled people who work with technology and continuously improving products and processes through technology.

3 levels of technology management tasks

1. **Normative Level** → Dealing with the fundamental, major decisions that define a company's culture and overall policy regarding technology. It's about the core values and long-term direction.
2. **Strategic Level** → A technology strategy is developed based on the normative guidelines. The focus here is on effectiveness – ensuring the right technologies are chosen and implemented to achieve the company's long-term goals and maintain a competitive edge.
3. **Operative Level** → The strategic plans are put into action over the short term. The primary principle here is efficiency – making sure the technological resources and processes are used as effectively as possible in daily operations.

2 scopes of technology management

Both scopes aim to increase efficiency, and they need to be aligned for technology management to be truly effective.

- **Macro (National Level)** → Involves a country's planning for technological development, identifying key technology areas, deciding whether to develop technology domestically or acquire it from abroad, setting up institutions to guide technological growth, and designing policies to regulate it.
- **Micro (Firm/Project Level)** → How individual companies use technology strategically to compete, integrate technology into their overall business plans, evaluate new technologies and innovations, manage their R&D efforts, and deal with technology becoming outdated.

> They also use tools such as S-curves (to track technology adoption), patent analysis, portfolio management, roadmapping (planning future technology development), and value analysis to make informed decisions about technology.

> In short, Technology Management is a systematic approach, operating at normative, strategic, and operative levels, to ensuring technology is used effectively and strategically to drive progress and achieve objectives at both the company and national levels.

5 Steps of Technology Management Framework

1. ***Technology Identification*** → Finding technologies crucial for the company's strategy through activities like scanning, forecasting, understanding customer needs, and benchmarking.
2. ***Technology Selection*** → Choosing the technologies to adopt based on analysis, expert opinions, decision criteria, and financial assessment. This requires considering both tangible and intangible factors for long-term investments.
3. ***Technology Acquisition*** → Obtaining the selected technologies through methods like internal R&D, joint ventures, licensing, mergers, or technology transfer.
4. ***Technology Exploitation*** → Utilizing the technologies to gain benefits, such as improving processes, licensing the technology to others, developing new products, or enhancing the supply chain.
5. ***Technology Protection*** → Safeguarding the company's technological knowledge through patents, contracts, security measures, and retaining skilled staff.

What are the capabilities of technology management?

- The capacity/ability to perform technology identification, selection, acquisition, exploitation and protection.
- The capacity/ability to perform strategic, innovation, project, knowledge and technology management.
- Learn about new technologies.

2.1. Technology Identification

> The process by which organizations pinpoint the right technologies to stay competitive, offer updated services, and produce high-quality goods efficiently. Choosing the appropriate technology is vital for achieving company goals and maintaining a competitive edge.

This process aims to answer key questions about potential technologies:

- Is it physically compatible with existing systems?
- What will its impact be on our current setup?
- How ready or mature is this technology for implementation?

> Addressing these questions requires a thorough analysis from technical, legal (checking intellectual property and freedom to operate), and commercial (assessing market opportunity) viewpoints. It's important to have an open mind during identification, as valuable innovations can come from unexpected areas, even outside a company's specific sector.

What should businesses do for effective TI?

- Actively seek out technology intelligence and market information relevant to their needs.
- Stay informed about technological advancements in their field.
- Develop internal capabilities for systematically identifying and assessing potential technologies.
- Consider external factors like customer needs, competitor activities, scientific advancements, and regulations.

2 Approaches to Technology Identification

1. **Problem-Driven** → Start with a problem that needs solving and then search for available technologies that can provide a solution. Various tools can help in evaluating and choosing among different technological options.

2. **Technology-Driven** → Discover an innovative technology in one sector and then explore potential applications for it in other areas, potentially creating new market opportunities. This often involves scanning literature and conference proceedings.

2 Perspectives of Technology Identification

1. **Business Side** → Focuses on finding new services and technologies in the market that can be adopted and offered to customers.
2. **Technical Side** → Responsible for finding the appropriate and up-to-date technology needed to operate the services identified by the business side.

2.1.1. Technical Identification Factors

Several factors influence the technical side of technology identification.

- **Technology Trends and Developments:** Keeping up with the latest technological changes by monitoring industry trends, vendor roadmaps, and the achievements of other companies.
- **Business Requirements:** Ensuring the identified technology can support the features and functionalities outlined in the service descriptions and align with the service development strategy and customer needs.
- **Internal Technical Needs and Assessment:** Evaluating the organization's current technical capabilities, including the need for modern technology, suitable tools, efficient processes, and skilled personnel, to ensure they can operate and deliver new services effectively.
- **Existing Technology Assessment:** Analyzing the current infrastructure, performance, reliability, and security to determine if it can support new services or if upgrades or new technologies are required.

2.1.2. Technology Identification Process

The main identification process, particularly from the business side, involves several steps:

> **Input** → Gathering external factors like technology trends, customer needs, market competition, and regulations.

Main Process

1. *Scanning & Monitoring* → Continuously watching for new developments in relevant areas.

2. *Technology Intelligence* → Capturing and distributing technological information to inform strategic decisions.
3. *Technology Road-mapping* → Planning the evolution of products or processes by linking business strategy to technology development.
4. *Identify Customer Needs and Requirements* → Understanding what customers want and expect through market research and direct interaction.
5. *Identify the Technology* → Finding the technologies that can deliver the desired services and features, often by engaging with vendors.
6. *Making Preliminary Studies* → Conducting market research and analysis to assess the feasibility and potential success of new services.
7. *Validation and Verification* → Confirming that the new services and technologies meet objectives and customer expectations through studies, analysis, and reporting.

> **Output** → The result of the identification process, typically a *Service Description Documentation (SDD)*. This document details the service, its features, target customers, development strategy, and technical, support, and billing requirements.

Roles and Reccomendations

Different departments play a role in this process. Strategic Planning & Development focuses on future technical plans and strategies, while the Technical Operation Department implements these plans. Technical planning teams assess the organization's readiness and determine the technical requirements for new services, evaluating whether existing technology is sufficient or if new technology is needed.

⚠ Vendors

They are also key players as they provide information on the latest technologies and their future roadmaps. Organizations evaluate vendors based on technical criteria, the quality and specifications of their offerings, and their ability to support future enhancements, in addition to operational and financial factors.

2.2. Technology Selection

> Involves the selection of those technologies that are chosen to help organizations to achieve their ultimate goals.

To make this process effective, several subprocesses are used:

1. **Scenario Analysis** → Estimating the potential value of a technology or a portfolio of technologies under specific hypothetical future conditions or events, including unfavorable ones (like a change in interest rates) to understand potential risks.
2. **Portfolio Analysis** → Analyze an organization's current products, services, or technologies based on measures like market growth rate and relative market share to inform decisions about which technologies to invest in or divest from.
3. **Expert Judgment** → Relying on the knowledge and experience of individuals with specialized expertise in relevant areas to evaluate technologies based on predefined criteria.
4. **Decision Criteria** → Establishing clear definitions of what factors are important and relevant when evaluating options and making a final technology selection.
5. **Financial Analysis** → Evaluating the potential profitability, performance, and overall suitability of technologies, projects, or budgets from a financial standpoint to determine if they are sound investments.

2.2.1. Basis of Technology Selection

Selecting the correct technologies is important, especially for long-term investments. This requires considering a mix of quantitative, qualitative, intangible, and tangible factors.

- **Tangible Factors:** These are easily measurable costs, such as initial investment, ongoing operating and maintenance costs, and the cost of network and support services.
- **Intangible Factors:** These are less easily quantifiable but equally important aspects:
  - *Technical & Operational Aspects:* Features, reliability, performance, capacity, how easy it is to upgrade hardware and software, redundancy (backup systems), security, ease of use, ability to diagnose faults, and potential for future development.
  - *Vendor & Support Factors:* The quality of monitoring and billing flexibility provided by the vendor, compliance with standards, the quality of support, the vendor's ability to solve problems, their expertise, delivery time, experience, and overall reputation.

2.2.2. Technology Selection Criteria

A structured approach is used to define the criteria for selecting technology:

1. **Set criteria:** Establish the specific points that will be used to differentiate between different vendors and technological solutions.
2. **Define project-specific requirements:** Clearly outline the needs specific to the project, including central requirements and IT needs.

3. **Shortlist vendors:** Identify a smaller group of vendors whose offerings appear to meet the high-level needs.
4. **Document requirements:** Create a clear and detailed written record of all requirements to ensure effective communication with vendors.
5. **Evaluate vendors:** Assess the shortlisted vendors systematically using the consistent and meaningful criteria established earlier.
6. **Reach consensus:** Ensure all relevant stakeholders agree on the best vendor and solution.

> Considerations when defining selection criteria include: Ease of use, Delivery and support capability, Platform infrastructure, Application integration, Implementation processes and required resources, Training and knowledge transfer, and After-sale support.

2.2.3. Requirements Document

A structured Requirements Document, often in the form of a formal "Request for Proposal" (RFP), is used to gather targeted information from each vendor. This document is essential for controlling the information received and facilitating direct comparisons between vendor offerings.

It must cover several key aspects:

1. **Functional Requirements** → A list of required functionalities. Vendors are asked to confirm their ability to provide these or note any exceptions. The focus should be on essential items and functionalities. This also includes asking about license types for testing and training, the number of supervisors supported, reporting capabilities, and inbound/outbound resources.
2. **Technical Requirements** → A clear definition of necessary technical specifications related to the platform, software, and hardware. Specific areas of interest like reliability, resiliency, scalability, integration capabilities, and security should be highlighted. Vendors should be asked about their preferred platforms or any special hardware requirements that might impact overall project costs by requiring infrastructure upgrades.
3. **Implementation Approach** → Details on the vendor's proposed approach for discovery, project management, and collaboration. This includes timelines for major phases (design, development, testing, and cutover), defined roles and responsibilities for both the vendor and the organization, and details on testing types, plans, tools, and resources. Information on training types (classroom, on-site, train-the-trainer, knowledge transfer) is also requested.
4. **Support** → Beyond just 24/7 support, this section inquires about service level commitments, warranties, the process for upgrades, and potentially the vendor's release history and future roadmap.

5. **Vendor's Qualifications and Experience** → Requesting important documents and information to assess potential partners' financial stability, contractual terms, relevant experience, overall fit with the organization, and references from previous clients.
6. **Pricing** → Providing a standardized spreadsheet for vendors to complete allows for a direct comparison of costs for hardware, software, implementation, and support services. Asking for base pricing and potential discount levels helps gauge the vendor's seriousness. Pricing should be requested separately for different product categories and locations.

Selecting the right solution and vendor requires starting with suitable candidates and taking the time to find those with the necessary experience.

2.2.4. Gather Information and Compare Vendors

1. *Create a matrix* using the established evaluation criteria and requirements. Include columns to note pros, cons, outstanding issues, and questions for each vendor.
2. *Evaluate vendors* further by checking references and holding structured presentations where vendors can elaborate on their offerings based on a detailed agenda.
3. *Map pricing* back to specific components to ensure an accurate, "apples-to-apples" comparison of costs.
4. *Shortlist vendors*.

2.2.5. Making the Final Selection

1. Determine which vendor's offering most closely meets all the defined requirements.
2. Strictly follow the original selection criteria to guide the decision-making process consistently.
3. Build a scoring template or tool that allows each member of the evaluation team to numerically score vendors based on the key differentiators. This tool helps to minimize emotional bias in the decision.
4. Work towards achieving consensus among all stakeholders so that everyone supports and feels ownership of the final technology selection.

THE END