

Systematic Innovation and Patent Strategy

From Product Development to Commercialization

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CHAPTER 1 CONCEPTUAL FOUNDATIONS OF INNOVATION

Innovation is often described as a “new idea.” Yet the emergence of an idea, its technical feasibility, its adoption within an organization, and its capacity to create value for users are distinct stages. Each depends on different knowledge, resources, and decisions. Explanations that attribute innovation solely to a brilliant idea or R&D expenditure therefore cannot adequately explain why firms achieve different outcomes with similar technologies. This chapter examines innovation as the recombination of knowledge and its transformation into applicable solutions across different actors. Its purpose is to explain the conditions under which products and processes change, and why some changes diffuse while others remain at the prototype stage (Kline & Rosenberg, 1986; Granstrand & Holgersson, 2020).

The extent to which a solution is new to a firm, how it was developed, and what outcomes it produces are separate questions. A technology that is not new to the world may still represent a substantial innovation for a firm using it for the first time. Conversely, a scientifically original invention may remain unused for an extended period because of technical or organizational barriers. This chapter argues that innovation is better understood through the relationships among technical knowledge, organizational learning, complementary assets, and adoption decisions than through a linear “idea to market” sequence. Current policy and research literature likewise places increasing emphasis on the implementation and diffusion of technology as well as the production of inventions (World Intellectual Property Organization [WIPO], 2024e, 2026).

1.1 Scope of the Concept and Levels of Analysis

A first difficulty in the academic study of innovation is that the same term can denote an idea, an activity, an output, or a favorable outcome. A firm reporting that it has “innovated” might mean that it undertook development work, introduced a new product, or increased sales. These claims are not equivalent. At the firm level, the Oslo Manual defines innovation in terms of introducing a product to the market or putting a business process into use when it differs significantly from the firm’s previous products or processes. This operational definition is a starting point for distinguishing innovation from its performance: actual impacts must be assessed separately from sales, profits, or patent counts (OECD & Eurostat, 2018).

The degree of novelty remains unclear unless the comparison point is specified. A firm using software for integrated production planning for the first time may have acquired that technology from another organization. The relevant research question is whether its prior operations have changed significantly, not whether new code has been written for the first time anywhere in the world. Being first in a

market or globally is a separate attribute of novelty. This distinction brings firms that adapt existing technology to their own production and use conditions into the analysis alongside technological pioneers. A routine update or the mere purchase of equipment, however, should not automatically be classified as innovation without a significant change in use or function.

Different questions arise as the unit of analysis expands. At the firm level, the implementation of a new product, coordination among teams, and financial outcomes are salient; at the regional or national level, the distribution of skills, institutional quality, and technology diffusion gain importance. The success of one firm does not establish the innovation capacity of its region. Equally, strong national patent and education indicators do not show that a particular firm has translated ideas into practice. WIPO's 2024 development perspective discusses how innovation pathways may differ according to countries' existing capabilities. The mechanisms linking micro and macro findings must therefore be made explicit (WIPO, 2024e).

An invention concerns a new solution to a technical problem, whereas R&D denotes systematic work with particular characteristics aimed at expanding the stock of knowledge. Product or process innovation may involve either, but cannot be reduced to either. Experimental research on a new material, for example, may not yet have reached practical use. Conversely, a firm may combine existing components and services to deliver a new user experience without producing new scientific knowledge. A patent provides legal protection for an invention, while publication of the patent document also makes technical information available. A patent application, however, demonstrates neither market use nor commercial success. These distinctions establish a common vocabulary for the discussion of product development in Chapter 2 and intellectual property in later chapters (OECD, 2015; WIPO, n.d.-b).

In the first case, the researcher discovers a new heat transfer mechanism but cannot find the necessary material for production; there is a scientific outcome, there is no application. In the second case, the company adapts a method used in another country to its own production line and uses a significantly different process; there is no new invention for the world, there is innovation at the company level. In the third case, the product enters the market but does not reach the expected sales; the realization of the innovation is separated from the positive performance of the product. This comparison illustrates why separate decisions are needed for the selection of ideas, technical verification and evaluation of results.

Determining the boundaries of innovation does not define all of its results at once. The claim of innovation varies when a new product is compared to a previous product (Table 1.1). Similarly, a process that increases the internal

productivity of an enterprise may not be seen by the user; it cannot be inferred that it is ineffective. Academic study must also report on what is new and what is observed at what level. The unconditional transition between product, process, business and industry levels misleads both policy proposal and company strategy. Limiting the concept is therefore not a choice of words, but the beginning of research design (WIPO, 2024e).

Table 1.1 Evidence not to be confused in the innovation process

Stage	Core question	Illustrative evidence
Idea and research	What problem and knowledge gap exist?	Field observation and research findings
Technical validation	Does the proposed solution work under specified conditions?	Controlled tests and prototype measurements
Implementation	Has the product been introduced or the process put into use?	Market records and operational evidence
Impact	Who benefits or is harmed, when, and in what way?	Comparative outcomes and usage data

1.2 Where Innovation Originates The Relationship Between Knowledge and Problems

Technical problems do not always arise from laboratory predictions; a recurring defect in production, a failure pattern detected by the maintenance team, the user running the product under different conditions than expected, or the supplier suggesting new material may trigger a development process. The idea gains importance when it makes the gap between the knowledge of different actors visible. The interactive innovation approach of Kline and Rosenberg (1986) takes into account the feedback between design, production, marketing, and research. This approach questions the assumption that innovation should only advance first in the form of research, then development, and finally marketing.

While it is important for a business to listen to the customer, customer feedback is not always a direct design condition. This device breaks down quickly The user may be talking about durability, maintenance cost, or service interruption. Choosing a technical solution without investigating under what circumstances, how often and with what outcome the problem occurs can optimize the wrong problem. Innovation management requires the ability to re-express the problem until data is collected, so the quality of cross-sectional transmission can be more explanatory than the number of ideas.

The nature of the sources of information also varies from one individual to another. A scientific paper may explain a general mechanism; a patent document may describe a specific technical application; a field survey may show the actual conditions of use of the product; the supplier may provide details of the feasibility of the design. None of these alone can answer all the questions. Which reduces uncertainty in the selection of the source? leads to the question. For example, controlled experimentation may be necessary for the durability of the material while usage observation provides more relevant evidence for the product's adoption by the user. When the context in which the information is generated changes with the context of the new product, the validity of the old finding is questioned again.

Knowledge accretion within an organization affects the ability of information acquired from outside to be evaluated. Cohen and Levinthal (1990), associate the ability to perceive the value of external information, absorb it, and use it with previously relevant information. A small manufacturer can better evaluate the supplier's suggested material when it can regularly keep process records and compare the test results of employees. In contrast, having access to a large number of publications by an organization is not as beneficial when there is no experience or skill to interpret the technical information in these resources.

Problem identification does not just end with writing a better question sentence. The operator must design observations that can distinguish possible explanations. Linking cracking in the product to material selection, the team can compare how the same material behaves at different temperatures and assembly stresses. The number of user complaints is an important caveat, but the total number of products exposed to failure is unknown. The purpose of the experimental plan is not to validate the first thought-provoking solution, but to find which alternative causes can be proven. The same principle can also be applied to marketing and service problems: the cause of low usage could be a lack of functionality, a lack of learning, or access costs. Not narrowing the scope of the solution early helps to make less but more meaningful experimentation.

While the distinction between technological impetus and demand for the source of innovation may be instructive in practice, a new sensor makes a previously unmeasured situation visible; the unexpected behavior of the user suggests a new use of the sensor. Classifying the outcome of this encounter merely as supply or demand hides the feedback that occurs over time, and the researcher's explanatory power increases when he observes when which information changes the design decision rather than who said the first idea. Project recordings, meeting notes, and prototype versions may be conducive to a retrospective review of this process, but later written success stories often leave out the failed options. So just looking at the

final product in the description of the innovation process shows that it is more orderly than the actual search process.

The encounter between technical knowledge and user knowledge sometimes radically changes the definition of the problem. When a field examination shows that the pump is running at an unnecessarily high temperature for most of the day, the real question shifts to the control and usage pattern instead of the engine. The re-establishment of the problem not as energy efficiency, but as functional adaptation to changing demand creates more solutions. Adhering to the first design question can produce a product that is technically more advanced but with limited benefits in total use.

An experienced operator may detect defects from a particular sound or vibration early; the written procedure may not convey exactly under what conditions these signals are meaningful. When new measurement technology is installed, the loss of this experiment can lead to misinterpretation of the sensor data. On the contrary, contentment with existing expertise alone can limit the detection of new phenomena. Cohen and Levinthal's (1990) approach to assimilation explains the importance of the relationship between externally acquired knowledge and existing accumulation, while the interactive model shows that information can move between institutional functions (Kline & Rosenberg, 1986).

1.3 Organizational Learning and the Reconfiguration of Capabilities

Businesses constantly decide between maintaining their current business efficiently and exploring options that might work in the future. March's (1991) research and business breakdown allows comparing the uncertain outcomes of experimenting with new options with the short-term outcomes of improving existing routines. It is not right to fund both at the same rate in each case, but because the results of the current product are strong, stopping all search activity can narrow the options when technical and market conditions change. On the contrary, only turning to new opportunities and lowering the quality of existing production processes weakens the foundation for future investments.

In order for learning to be valuable, information from experiments needs to return to decisions. When a prototype fails to work, simply shutting it down as fail may not indicate which technical assumption is wrong. When the test condition, design version, and measurement limit are recorded, the same error may not be repeated in another project. Such recordings improve an organization's ability to respond to changing environments. Teece, Pisano, and Shuenin (1997) emphasize the dynamic ability approach to reintegrate and organize resources. This insight helps to understand why the decision to purchase new equipment should be addressed in conjunction with working skills, data flow and supply relationships.

It is not enough to have the capacity to innovate as a single unit in an organizational schema; it is necessary to specify how the problem proposal will be selected, by whom the evidence to be used will be evaluated, and when resources will be redistributed to an uncertain project. ISO 56001:2024 provides an up-to-date management system framework that is structured in the context of leadership, resource, operation and evaluation without reducing innovation management to a single project list. The standard does not promise that a particular idea of innovation will achieve definite success; it helps to define roles and learning cycles for a functioning system (International Organization for Standardization [ISO], 2024).

While a company's existing technical know-how can facilitate some innovations, it can make other innovations invisible. Henderson and Clark (1990), showed that even if the components of a product remain the same, changing the connections between the components can create significant difficulties for established companies. For example, a device's sensor, software, and user interface may be separate familiar components, whose rearrangement of data flows can change the operating boundaries of teams, so it is not enough to measure the degree of innovation only by the number of new parts or cost increases. Change at the architectural level requires coordination and information sharing.

In the management of an innovation portfolio, it seems easy to rank projects by a single score, but it can hide types of uncertainty. A small improvement in an existing product may lower the technical risk, and the sales expectation may be more predictable. The continuity of user demand may not be known even if the technical demonstration is successful in a project entering a new scope of use. In the face of this uncertainty, ignoring the promise of magnitude can also deplete resources altogether. Clearly writing down the decision threshold reduces the pressure of defending a failed project or hurrying to enlarge a successful attempt.

Low-performance knowledge can be lost in an environment where problems are presented only as positive outcomes to top management; on the other hand, binding each failed experiment to a detailed and heavy verification process can discourage small and safe trials. The teams shall determine together which errors are acceptable learning costs and which are unacceptable in terms of user safety or production continuity. Instead of the number of meetings to measure information sharing, it can be observed whether or not a previously learned finding is used in a new design or discontinuation decision. This measure shows both organizational memory and the traceability of decisions.

The relationship between experiments also determines the nature of learning, and a team can only repeat the same design assumption without realizing it if they use different materials after each failed prototype. The knowledge value of

experiments increases when the mechanism on which the alternatives are based is predicted and what measurements will distinguish them. The availability of experimental reports and the participation of partners transforms learning from individual memory into an institutional opportunity.

Complementarity between talents can enhance the ability of a successful technology to be copied to another company. One of the two companies that set up the same software may have standardized the data, trained maintenance personnel, and redefined decision-making responsibility; the other may have added software to the old workflow. The first can be a meaningful process change, while the second can be an increase in costs and the operation stays the same, and counting two firms in the name of technology as equivalent cases of innovation hides the difference. Teece and colleagues' (1997) approach to restructuring is a useful framework for explaining the importance of the connections between them to the single existence of resources.

1.4 Knowledge Beyond Firm Boundaries and the Innovation Ecosystem

Just as businesses do not innovate on their own, external information does not automatically become usable. Suppliers can develop the component, the research institute can explain the underlying mechanism, another firm can provide software infrastructure, and the user can shape the day-to-day operation of the solution. The combination of these is not sufficient for effective cooperation; technical interfaces, information rights, investment order and responsibilities need to be aligned. Granstrand and Holgersson (2020) conceptualize the innovation ecosystem not only as cooperative actors, but as a changing blend of actors, activities, technical objects, and corporate relationships.

For example, the success of a new electric mobility solution does not depend solely on the capacity of the battery. However, these complementarities do not mean that all players in the ecosystem have the same interest. The cost-cutting goal of the battery supplier may conflict with the manufacturer's sustainability goal; the decision to share data by the organization that manages the platform may limit the product development options of small partners. The analytical value of the ecosystem approach is that it allows for research into interdependencies and power relations rather than positively labeling collaboration (Granstrand & Holgersson, 2020).

Open innovation is not merely the acquisition of knowledge across borders. Joint research, learning from user developments, licensing, co-prototyping, and allowing a developed technology to be used by other actors are different flows of knowledge. Ebersberger and colleagues (2021) examined the model selection sensitivity of the relationships between outsourcing practices and innovation

performance with innovation research data from three European countries. The strength of the study is that instead of a one-way benefit such as working with an outsider always yields better results, relationships depend on measurement and modeling preferences.

As the structure of cooperation grows, the task of coordination becomes more obvious. Shen and colleagues' work (2024), which combines qualitative research on industrial firms, examines ecosystem orchestration practices in dimensions such as strategic design, relationship building, resource integration, and the direction of technological activities. These practices do not necessarily mean that every company should have a centralized router. Some companies may specialize in a particular component and take an important place in the network that others build. The appropriate form of management depends on the depth of technical dependence, the replaceable nature of the partners, and who has the data in their hands (Shen et al., 2024).

The legal and technical requirements for the flow of information must be considered together. An explicit patent document makes it possible to examine a technical idea, while the right to use its contents may depend on conditions such as the duration of protection, country and scope of application. In contrast, the research paper can be read freely but may not provide access to the coverage information necessary for production. When the joint development agreements do not define what background knowledge is put into the project and how the resulting solution will be used, inconsistencies may arise as cooperation progresses. Regulations protecting the freedom necessary for the business itself and the contribution of partners are important for the sustainability of technical information sharing (WIPO, n.d.-b; Granstrand & Holgersson, 2020).

In ecosystem research, drawing actors is the beginning, not the explanation. The diagram does not specify the nature of the flow of information between a university, producer, enterprise, and public institution. When a university wants to publish a scientific result, the firm may worry that early disclosure will affect the patent strategy, which does not indicate that one of the tense parties is opposed to collaboration; it indicates that different task and time horizons need to be aligned. Measuring the number of successful partnerships only with signed protocols provides weak evidence about the knowledge actually acquired and the products implemented (Shen et al., 2024).

The boundaries of the ecosystem also depend on the research question. Material, software, and manufacturing partners may have priority to understand the technical performance of a product; service organizations and distribution channels may have priority to understand its distribution. The same actor may be complementary in one innovation and rival in another. Granstrand and

Holgersson's (2020) conceptualization of competition and substitution relationships takes this variability into account, whereas the widespread use of the form everything is an ecosystem reduces the ability to explain why a particular decision is made. The output that the study wants to explain should guide the choice of actors and the boundary of the system.

1.5 Adoption of Innovation and Uneven Diffusion

It is not the same when a solution is developed for the first time and adopted by different users. Innovation may require new adaptations when it is transferred to other companies, regions and institutions than the company that produced it. Rogers' (2003) diffusion approach shows that relative superiority is useful in understanding the processes of adoption of perceived characteristics such as adaptability, complexity, testability, and observability to existing practices. These characteristics are not the product's unchanging labels; they are reinterpreted according to the decision maker's skill, investment potential, and use conditions. Even a technically superior solution can spread slowly without maintenance network or training.

For example, a new production technology that reduces energy consumption may not fit into the existing machine park if it provides high efficiency in the laboratory. The same technology can yield different results due to the time taken to install it in a different facility, the nature of the workforce, or the quality of the raw material. Implementing an externally developed solution may require reorganizing local processes and skills. Mining itself is not synonymous with technical invention, but can be decisive in shaping the economic and social impact of innovation (WIPO, 2026).

WIPO's 2026 World Intellectual Property Report emphasizes that the dissemination of technology is not automatic and everywhere equal, that access to information should be evaluated alongside local capacity. Even if an article or patent on technology reaches everyone, there may not be the equipment, education, and production connections to test it, and as much as differences in income and skills between countries, the scale of firms within a country can affect how it is distributed. The fact that a policy only increases the number of research outputs therefore does not guarantee the results of implementation (WIPO, 2026).

It is also part of the dissemination process for users to adapt their innovation to their own conditions. The placement of the same digital system by a hospital, manufacturing facility, or home user into different workflows can reveal problems not present in the developer's design. This feedback can lead to new product or process versions; considering each adaptation as a separate innovation inflates the measurement. Distribution is not only the replication of the first solution, but also

the source of the occasional redesign so that the user experience returns to the product development cycle (Rogers, 2003; Kline & Rosenberg, 1986).

A technology can be used first in large enterprises; a version later transferred to small enterprises can be cheaper but more limited in functionality. Although products in different institutions are referred to by the same name, the technical structure and use may have changed. These differences are covered up when the researcher draws a single adoption curve, and the process is better understood when the installation date, active use, version change, and discontinuation decisions are monitored separately. Furthermore, when maintenance, public infrastructure, or educational services provided by the supplier collapse, the preference of the business may change, so the spread of technology is more a consequence of interdependent decisions over time than of a permanent trend. Nor does the widespread acceptance of a solution prove that it is the best option in all contexts.

Local customization can replicate the knowledge base. A company that changes production tolerances to use lower-cost materials not only copies another solution, but also conducts a process of testing and skill development. However, counting each small setup as an innovation exaggerates the appearance of progress in the industry. It should be asked whether adaptation for separation makes a significant difference to function, process order, or performance, and whether it is actually used. This evaluation also reduces the risk of undervaluation because of technology from another region. Origin and practice should be interlinked, but not the same variable, and it should be clearly defined from a policy-making point of view which investment in research capacity and which investment in practical capacity will compensate for the shortfall.

A pilot application may provide visibility in the press, but long-term maintenance and operating costs may not be disclosed. The later abandonment of an early-adopted system indicates that the initial use does not ensure the economic and social outcome, so the number of new installations and the rate of continued active use over the years are different measures. WIPO's 2026 dissemination focus is a reminder that access to technology in different places alone does not mean equal use (WIPO, 2026).

The role of public policy is also not limited to financing initial research alone. Skill development, interoperability standards, testing infrastructures and the adoption of technical knowledge by small businesses can change the conditions. However, it is necessary to investigate which obstacles are really binding in the design of support programmes. For a technology in which there is no demand, education alone may not be sufficient; the lack of funding or infrastructure in an area with sufficient technical knowledge may be decisive. When the WIPO's 2024

country-based policy approach is read together with the 2026 dissemination analysis, it appears that a single policy tool cannot be applied to all sectors and regions with the same result (WIPO, 2024e, 2026).

1.6 Changing Boundaries with Digital Technologies and Artificial Intelligence

In digital products, the change in components may not be as noticeable as in physical products. While the interface of a service remains the same, the mechanism of recommendation, the process of data processing, or the way the user accesses may change. To understand where innovation occurs, the function and business process within an organization that is presented to the user instead of the name of the software must be studied. The scope of the innovation claim remains limited if an enterprise's refurbishment of the storage infrastructure does not create significant changes to the previous presentation or working order. Conversely, if the new data stream changes order decision, delivery time, and user communication together, product and process dimensions can be interconnected. This distinction distinguishes innovation from technological updates without underestimating non-physical changes.

Research by Rammer and colleagues (2022), based on German company data, examined the links between the use of artificial intelligence and innovation outcomes. This study shows that the use of technology can be investigated empirically; it does not prove that the relationship in a particular country and data period is of the same size for each sector. Companies using artificial intelligence become innovative a benefit in the form of disregarding the previous capabilities and application goals of companies choosing the technology.

Data preparation, employee skills, and management's determination of appropriate use areas can be critical in the application of AI in an enterprise. A study by the OECD, Boston Consulting Group, and INSEAD (2025), based on firm discussions, shows that adoption decisions depend on organizational conditions beyond access to technical tools. The production of a text or image by the model does not indicate that the output is accurate, legally usable, or physically applicable. Productive AI proposals in technical design require separate validation; the integrated use of TRIZ in the second section is precisely why it distinguishes conceptual thinking from engineering evidence (OECD et al., 2025).

The dissemination of digital innovations also depends on infrastructure and complementary investments. While small businesses can easily access cloud services, they may find it difficult to cover the cost of gathering reliable data, integrating it with existing workflows, and empowering new employees. Issues such as the dependence of the software system on an external vendor, interoperability, and data portability influence subsequent innovation decisions, so

a tool that initially appears inexpensive can narrow down the long-term options of the business. The assessment of innovation should take into account not only the rate of initial deployment, but also the ability to build capacity and make changes in the future (Granstrand & Holgersson, 2020; OECD et al., 2025).

The technology itself developed in the explanations of artificial intelligence must be separated from its use as a means of operation. A software firm may be developing a new model architecture; a logistics business may include routing an existing model; another firm may have provided its employees with a general purpose chat app. These activities do not indicate the same technical and organizational change. In the third case, it is not correct to present the acquisition of a vehicle as an innovation output if there is no significant change in the business process; in the first two cases, where the performance has changed and the significance of the change in relation to the previous application must also be shown. Rammer and his colleagues' (2022) analysis at the company level also supports the importance of differentiating use areas.

Algorithmic recommendations should examine the appropriateness of the data source and on whom the error resulted. If the past failure records used for maintenance estimation cover certain machine types, the accuracy may not be the same on other machines. Reporting only the average performance of a business can overlook the rare but costly types of errors. The organizational benefits of automation cannot be fully assessed without the employees who will oversee the model's recommendation and the option to return to old operations if necessary. The learning that digital innovation requires includes the ability to recognize the limits of output, from the ability to use new software, so the impact of technology should not be measured just by reducing costs.

1.7 Value Creation and Responsible Assessment

It is a multi-dimensional claim that innovation generates value. The business may aim to increase revenue with new products; the user may gain time savings or accessibility; the production process may consume less energy. These benefits do not always progress in the same direction. A cost-cutting scheme can increase the workload, while a new service that facilitates product use may require more personal data. In such cases, it is not correct to assume positive social outcomes based solely on the nature of innovation. After use with predetermined targets, the effects observed should be separated, and the negative effects on whom should be asked.

Objectives such as transformation, sustainability and technological convergence are discussed together in current science and technology policies. However, a country-wide conversion target does not automatically indicate that a single

product is sustainable. Effects on material, energy, life and use at the product level; training, supply, and working conditions at the business level require separate evidence. The meaning of an innovation claim is reinforced when the measurement threshold is clearly stated. Two levels should not be confused unless mechanisms are identified that relate national targets to the day-to-day decisions of firms (OECD, 2025).

The business model is also part of the value creation debate. The same technical product can be offered via a one-time sale, pay-per-use, or service subscription. Teece (2010) examines the business model in relation to value creation, presentation, and capture to the user. However, a change in the method of income does not make it unnecessary to ask which product or business process actually differs. The appeal of strategic narration does not replace the evidence of change taking place. Also, an option that appears to be affordable to the user may result in a higher total cost in the long run; the value proposition must be evaluated over a given period of use.

The change in value over time is also important. The implementation of a new process can increase training costs and error rates in the first few months and provide stability later on. Therefore, only observing first-year income or first-pilot productivity may reflect a long-term result deficit. Conversely, long-term benefit expectations should not be a reason to ignore today's negative impacts. The fact that the result that the researcher is measuring differs from the result that the director intends can lead directly to a method error.

Social outcomes should also be questioned in terms of distribution. A digital health service can reduce the average access time while making it difficult for those with poor internet access to access the service. A manufacturing innovation can strengthen the recovery of used material while reducing total energy consumption. Identifying such potential impacts is not an assumption that every innovation is harmful; it allows for a more accurate statement of the conditions under which and for which groups value is produced. When different user groups and lifecycle stages are studied in the early stages of design, problems that would require expensive later correction can be seen earlier.

Responsible evaluation does not mean automatic caution against technology. Writing the uncertainty clearly does not prevent the experiment from being done; rather, it shows what experiment is needed. A stronger verification may be required when it comes to user security or access to a basic service. Applying the same checklist to different project risks can both slow down low-risk learning and be inadequate in high-risk applications. ISO 56001:2024's place in the institutional context and evaluation cycle contributes to the regulation of these decisions according to project specifications (ISO, 2024).

1.8 Possibilities and Limits of Measuring Innovation

Measurement should be based on which side of the concept is being studied: R&D budget and employee training revenues; joint research and testing activities; products put into use and processes put into operation; sales, productivity, user benefit and environmental outcomes are indicators of impacts. When a single indicator is used instead of these four areas, the research question becomes ambiguous. For example, not every project of a high-tech enterprise with R&D spending may turn into innovation. But to exclude these indicators altogether is also a loss of knowledge; strengths and blind spots must be evaluated together.

Patent documents are particularly useful for tracking technical trends, actors, and accumulation of information in certain fields. However, not all product and service innovations can be patented; firms may choose to keep certain technical solutions secret. The number of applications, the number of patent families, and the number of inventions used are also not the same sizes. Patent review is more explicit when combined with research into market data and business processes. The availability of published technical information depends on the conditions of absorption and dissemination discussed above (WIPO, n.d.-b; WIPO, 2026).

Firm surveys can capture product and process changes on a broader scale, but respondents are not expected to interpret the "significant difference" threshold the same way. The Oslo Guidelines are a useful operational framework for this type of comparable data collection; they should not replace all theoretical explanations of research. In particular, when evaluating result variables, the existence of a new product, the expected commercial or social benefit of that product, and the actual observed change should be questioned separately so that negative or delayed results are not excluded from the data simply because they do not meet the definition of success (OECD & Eurostat, 2018).

The European Commission's 2026 European Innovation Scoreboard examines the performance of countries with 32 indicators of different dimensions. Such a framework makes it possible to see the strong and weak areas together, but the creation of total scores depends on the selection of indicators and the data period. Regional and sectoral inequalities can also be found below high average performance. Ranking should be a starting question, not a substitute for analyses that explain the mechanisms (European Commission, Directorate-General for Research and Innovation, 2026).

The researcher's cause-and-effect claim also demands attention: a business may have grown because it invests in innovation; it may have been able to invest in innovation because it is bigger and more efficient. Ebersberger and his colleagues' examination of model sensitivity in open innovation studies (2021) reminds us that different variable choices can influence interpretation. Therefore, it should not be

concluded that a single programme or method has produced success without taking into account sector structure, age of the firm, previous capacity and time lag. The mechanism of neutral case studies, the prevalence of surveys, experimental and semi-experimental designs can contribute to understanding the causal effect under certain conditions.

A new production line may look better than the average energy consumption of the old line; the difference may be much smaller than the best-adjusted period of the old line. Similarly, in order to link the difference in sales between the two firms to the practice of innovation, the initial customer volume and product quality must be taken into account. The failure of an experiment in an operational measurement should also not be excluded from the report; merely counting successful pilots hides the actual learning cost of the portfolio.

The use of multiple indicators together does not mean that they measure the same concept. Innovation income may indicate the market value of the new product, labor productivity the process result, and patent data may explain some technical knowledge. It does not have to be a contradiction that increases do not happen together: the company has developed a new product, but it may have reduced productivity in the short term as it reorganised its existing production. The duration of the data used to interpret the relationship between the displays, the unit of observation, and the comparison group must be consistent with each other. So the reporting level should be selected from the research query, not derived backwards from the lines that the existing database provides.

The behaviour encouraged by the measurement system should also be considered. It is possible for a manager to target low applicability applications only when the number of patents is targeted; long-term processes and capability work may fall backwards only when short-term new product sales are targeted. Using a large number of indicators does not solve this problem alone, because it is important how the indicators are weighted and monitored for what decision. A good measurement framework should show the learning of the project portfolio and the results of the implementation together; it should explain the interpretation limits of individual indicators. The goal is not to increase the sum of the indicators, but to find reliable answers to a particular question.

Comparison time is particularly decisive in policy evaluation. The outcome of a research program may come into use in other sectors years later; short-term firm research may not see this effect. Interim observations may provide evidence for technical learning, shared skills, and experimental infrastructure, not to be confused with the ultimate economic impact. This approach makes it possible to evaluate the theoretical argument of the first chapter, that learning and practice are interconnected but separate processes.

1.9 Chapter Synthesis and the Transition to Product Development

This section describes innovation at four interconnected levels: identification of the technical or user problem, learning of knowledge within the organization, implementation with complementary actors, and dissemination of innovation to different conditions. Scientific work may be valuable, but it may not turn into product innovation; an enterprise may exert original knowledge and organizational effort when implementing an outsourced solution; the product offered to the market may not deliver the expected benefit. The narrow definition does not diminish the importance of these facts; it makes it possible to examine each with appropriate concepts and evidence.

The second section will take this framework to product development decisions, examining how an opportunity is selected, how requirements are written, how TRIZ tools can be used for conflicting technical objectives, and what experiments are needed to validate generative AI-enabled proposals. Thus, this section's view of information, organization and dissemination forms the basis for explaining the link between the formation of a technical solution and the value it generates in its use.

CHAPTER 2 SYSTEMATIC INNOVATION AND TRIZ IN PRODUCT DEVELOPMENT

In the first section, innovation was not associated with the idea or technical invention itself, but with the introduction to the market or use in business of a solution that differed significantly from the previous product or business process. This definition raises the question of the conditions under which a creative proposal in product development can be implemented. The design team can develop a concept that enhances technical performance, but a concept that does not meet user requirements, is not reliably produced or provides economic conditions cannot be expected to result in innovation. This section examines TRIZ's technical contradictions and generative AI approaches in the product development stream, ranging from opportunity selection to engineering verification (OECD & Eurostat, 2018; International Organization for Standardization [ISO], 2023).

Product development is not a linear and one-way list of tasks; user requirements, technical possibilities, cost targets, and safety conditions can be reinterpreted during development. Clearly identifying the problem being studied, creating solution options, reducing uncertainties experimentally, and using the results are distinct decision areas. TRIZ offers a useful toolset of this flow, particularly in the phases of re-expression of the technical problem and search for conceptual solutions; it does not stand alone as a substitute for customer verification, detailed design, or performance experiments (Ilevbare et al., 2013; Mohammadi & Zeng, 2025).

The argument of this section is that systematic innovation is not about applying a specific method name to every project, but about making the link between representing the problem, producing alternatives and collecting evidence decisions visible. First the choice of opportunity and need is discussed, then the basic concepts and choice of tools of TRIZ are discussed. In the next section, a representative design problem related to the heat management of smartphones is solved step by step; finally, the contribution of artificial intelligence, its limitations and the evaluation of application results are examined. The subject of patents is here confined to the freedom of access to technical information and resolution; legal protection and commercialization are covered by the section on progress.

2.1 Selecting Opportunities and Defining the Product Development Problem

Opportunity must be identified before a solution can be determined, such as the difficulty encountered by the user, a repeated error in the production process, the technical possibility provided by a new material, or the introduction of a performance condition based on legislation. All of these cannot be evaluated with

the same kind of evidence: user observation can reveal the existence of a need; laboratory testing tests the feasibility of a predicted technical mechanism. ISO 56007:2023 recommends that the activities of identifying opportunities, generating ideas, and validating concepts be interconnected but treated separately in front-end innovation. This distinction helps to prevent the initiation of design as if it were solving a problem that has not yet been identified (ISO, 2023).

When determining the extent of the problem, at least five questions should be recorded: in whose use and under what conditions is the problem being monitored, what function is the existing solution performing at what level, what measurable characteristic will development change, and what characteristics must be preserved? For example, the expression 'better cooling' does not decide on its own. The technical content of the problem becomes apparent when conditions such as lowering the component temperature in a given processing load, maintaining the surface at the specified range and not increasing the product thickness are written separately. Thus stresses that worsen one performance property while improving the other can be evaluated (Altshuller, 1984; Sheu et al., 2020).

It is not enough to consider only the estimated size of the market or the most attractive idea in the selection decision. The user benefit, technical feasibility, production capacity, cost, delivery time, sustainability and available knowledge must be assessed together. Giving these metrics a number does not mean that the decision is objective; weights and uncertainty ranges must be justified. Therefore, preference criteria comparable to indispensable thresholds should be kept separate; uncertain claims should be converted into appropriate experimental and research tasks. The management system approach of ISO 56001:2024 also addresses innovation in a way that is related to the context, resources, processes and evaluation of the organization (ISO, 2024).

The difference between choosing an opportunity and choosing an idea is particularly important. Lowering the temperature is a goal, adding a steam room can be a candidate solution. The early attachment of the team to the initial proposal narrows down the options that the requirements can be met in different forms. Writing the problem at the functional level allows the solution to be investigated in different ways, such as changing the material, rearranging the heat flow, controlling the software, or changing the product architecture. The abstraction stage of TRIZ also focuses on identifying a contradiction independent of the technical field and considering solution patterns in other fields; however, the suitability of the chosen pattern for the relevant product must also be shown (Ilevbare et al., 2013).

Front-end evaluation is not just about listening to the external market. Failure records from existing products, call center data, observations of usage conditions,

and repeated postures at the production station present different types of problem signals. The experience of users who have not complained is not recorded; fault data does not always indicate the conditions under which the product was used; and expert consultation may be overly dependent on existing technical solutions. So instead of looking for a source for a solution idea, we can understand the frequency and severity of the real problem (ISO, 2023).

When preparing a portfolio of opportunities, projects should not be ranked solely by expected revenue. The proximity of a project to the existing competence of the organization, the possibility of using shared infrastructure with other projects, and the learning to be provided if it fails are also part of the decision. Competition on a single scale of uncertain studies with easily verifiable improvements in the short term that can create long-term value may systematically discount the second group. However, the reason for strategic importance cannot be a reason to support every project forever. The management system view requires the regular linking of technical work with resource allocation decisions (ISO, 2024).

2.2 The Relationship Between Innovation Management and Technical Problem Solving

In the first section, invention, R&D and innovation were separated, and in this section, the same separation applies to decision-making. R&D can systematically reduce technical uncertainty; TRIZ can expand the scope of the design solution; product development ensures that the resulting solution is embodied according to requirements. Innovation can be recorded as a result of these activities by the introduction of a significantly different product into the market or the use of the process. Producing a successful prototype is a valuable breakthrough in the development process, but does not result in product innovation taking place on its own (OECD & Eurostat, 2018).

Uncertainty in product development is not unique: misunderstanding of demand is market and usage uncertainty; the proposed mechanism is not working is technical uncertainty; the working order in the laboratory is inconsistent in serial production is manufacturing uncertainty. Supply conditions, maintenance needs and cost fluctuations also create separate risks, so interviews, patent scanning, numerical analogy, material testing, prototype and user testing within the same project answer different questions. For example, the existence of a solution described in a patent document offers a technical option; it does not prove that the product will work in a specific size, cost, and conditions of use (World Intellectual Property Organization [WIPO], t.y.; ISO, 2023).

At the institutional level, method selection must also be linked; the same detailed process cannot be applied to enterprises with different product architecture, team experience and development budgets. However, leaving an appropriate decision mark is useful on all scales: it records the source of the requirements, why the alternative was chosen, what risk remained open, and what experimental outcome was reached. ISO 56000:2025 regulates the basic concepts of innovation management so that they can be applied to different types of organizations and innovation; ISO 56001:2024 provides requirements for the establishment and improvement of the system. These standards do not say that a particular TRIZ principle will necessarily be used in a project; they help to consider the place of the technical method within a broader decision-making system (ISO, 2024, 2025).

The relationship between functions within the business can change the outcome of the technical selection. The material proposed by the design team to improve surface temperature can create a supply risk in terms of purchase, an assembly failure in terms of production, a repair difficulty in terms of service. Gathering these objections only in the final stage can lead to a redesign of the solution. The combination of engineering, manufacturing, quality, marketing and intellectual property expertise at appropriate decision points makes the problem visible early. Contrast assessments should not be assumed to be resistant to the idea of innovation; they should be studied as information showing which conditions are not met. The purpose of the process is not to average all opinions, but to find an option that can meet critical requirements together (ISO, 2023; Spreafico & Russo, 2016).

2.3 Theoretical Foundations and Limits of TRIZ

TRIZ is an abbreviation of the Russian expression Theory Resheniya Izobretatelskikh Zadach; it is mostly encountered in Turkish in the form of Theory of Inventive Problem Solving (TRIZ) Historically, the examination of patent documents is important in the formation of this approach, but it is not correct to accept the alleged numbers and lists of principles that have been excluded from the patent pool as experimental law under all circumstances. Current reviews treat TRIZ more than as a single algorithm, as a family of methods that combines the principles of contradiction analysis, function representation, resource analysis, and solution (Altshuller, 1984; Chechurin & Borgianni, 2016; Sheu et al., 2020).

A distinctive feature of TRIZ is that it changes the representation of the problem before the solution-seeking process. Let's make the part thicker suggests only one solution candidate; The expression parts should be more durable at a given load, but total mass and volume should not increase indicates the relationship between

the variables. The second expression is conducive to exploring different options such as locally reinforcing the material, changing the load path, transferring the required strength to a different component, or temporarily reducing the load. The method may distance the designer from the first usual answer, but it does not alone determine which answer is correct.

Technical contradiction means that when one property is improved, another property is likely to deteriorate, while physical contradiction means that the same compound must have opposite properties under different functions or conditions. For example, the heat exchanger area should be wide to reduce the heating point and narrow in terms of the volume it covers in the product. Although the physical contradiction may seem to occur at the same time and place, the separation of conditions can facilitate the search for a solution: separate characteristics can be provided at different times, in different regions or in different working conditions. The purpose of these expressions is not to put all engineering problems into a single template; it is to question whether a compromise assumption is really inevitable (Altshuller, 1984; Sheu et al., 2020).

The idea of an ideal end result should be read as a goal aimed at achieving the necessary function without creating an additional burden. The mass may decrease when a piece is removed, but the total result may not improve if maintenance costs or the likelihood of error increase. It is necessary to identify the operation, indicate where the adverse effects occurred, and specify which evaluation limit is used. Among the criticisms directed at the TRIZ literature are the complexity of tools, the need to learn, and the fact that studies on effectiveness are often based on sample events (Chechurin & Borgianni, 2016; Ilevbare et al., 2013).

The fact that TRIZ was born out of a historical patent examination tradition does not mean that every principle of the method corresponds to a patented solution. When a design team detects the same functional pattern in another area, instead of directly copying the document, they re-examine the physical mechanism, the conditions of the material used, and the boundaries within their own product. Patent scanning can help to show known options and prioritize; the described example does not alone indicate that it has been marketed or can be freely used. Therefore, the acquisition of technical knowledge, the protection of invention and the freedom of enterprise resolution should be considered as separate issues (WIPO, n.d.a.).

The evolutionary trends in the TRIZ text should also not be interpreted as a definitive prediction of the future. The emergence of a more flexible, smaller-scale, or less fragmented system may be explanatory for some technologies; however, reliability, maintenance, user habits, and manufacturing infrastructure influence the direction of development. Describing technological change as a one-way law of

conservation can hide the conditions under which old and new solutions are used together. Tools like the nine windows should therefore be used to ask what new constraints a change in the subsystem creates in the upper system, rather than to draw a compelling picture of the future. Literature reviews reveal that there are different tools and interpretations of TRIZ; claims of the method should be tested separately with measurable performance in practice (Chechurin & Borgianni, 2016; Sheu et al., 2020).

2.4 Selecting and Combining TRIZ Tools

The contradiction matrix and 40 creative principles are among the best-known tools of TRIZ. The characteristic to be improved on the classical matrix is matched with the deteriorating characteristic with general engineering parameters; the principles at the intersection provide clues for finding a solution. The matching here is open to interpretation: when it is not explained how a linkage-specific requirement, such as cooling performance, becomes a general parameter, different teams can arrive at different principles. It is also not necessary to use all 40 principles sequentially for each project; what is important is that the principle is associated with actual function and constraints (Altshuller, 1984; Ilevbare et al., 2013).

The idea of separation for physical contradictions focuses on where, at what time, or under what conditions properties are necessary. Only if high cooling is required at the peak processing load can a load-shifting arrangement be investigated instead of a continuously working arrangement. If the heat is concentrated in a particular compound, only the relevant area of the heat pathway can be changed instead of thickening the entire enclosure. Any of these options may meet basic requirements or create new problems. The advantage of separation is that it produces testable alternatives by converting the expression must be widened and narrow into measurable subconditions.

Functional analysis tries to show what kind of effect a component in a system has on which object. The effect can be beneficial, inadequate, excessive, or harmful. This representation helps to study the interactions of the parts rather than just ranking them by name. In the example of a smartphone, the processor generates heat; the intermediate surface material tries to convey this heat; the emitter moves the heat to a different area; the casing warms the environment and contacts the user. The scheme of a function is more explicit if it is associated with measurement points and energy flow (Ilevbare et al., 2013; Sojka & Lepsik, 2025).

Substance field analysis abstracts interaction over two substances and the space between them, which determines what kind of change can be investigated when a particular relationship is lacking, inadequate, or harmful. In classical TRIZ writing

it is used in conjunction with standard solution sets; however, the reduction of a physical phenomenon to this simple model does not mean that all thermal, electrical, and mechanical effects in the real system are solved simultaneously. In cases where the problem is not collected in a single interaction, the model boundary can be reconstructed with functional analysis and experimental data (Sheu et al., 2020).

Resource analysis examines the possibility of exploiting existing material, space, motion, heat flow, software control, or unused functions before adding new parts and energy from outside to the system. Functional simplification, called Trimming, also asks which component will perform its mandatory function when removing a component. The nine-window approach allows the problem to be studied in the past, present and future timescale with the subsystem, system and upper system scale. These methods can be used in the same project, but each must contribute to the concrete question (Ilevbare et al., 2013; Sheu et al., 2020).

ARIZ is a more detailed problem-solving algorithm developed to step-by-step re-express unsolvable invention problems. It may not always be suitable for generating general ideas in a short team meeting. It is more appropriate where the problem is embedded in a narrow and significant technical conflict, where initial scans fail and detailed system knowledge is available. The 2025 systematic review on process improvement shows that technical contradictions and creative principles are frequently used, application contexts and tool combinations differ; hence it cannot be concluded that there is only one good TRIZ tool in all sectors (Sojka & Lepsik, 2025).

2.5 Concept Development and the Engineering Validation Cycle

The first output of systematic work is a traceable problem file rather than a solution. The file contains user status, the success of the existing product, requirements, limitations, uncertainties, and acceptance criteria. Expressions such as sufficiently light or not warming are not sufficient to interpret the experimental result unless the numerical limit and conditions are specified. Patent analysis can be used to understand technology trends and technical options; the level of disclosure and legal status of documents are also assessed (WIPO, n.d.; ISO, 2023).

In the second stage, meaningfully different concepts are created. Only two dimensions of the same heat exchanger can produce diversity unless a different physical mechanism is explored. Concepts are compared in terms of functionality, expected benefit, potential harmful effect, new component requirement, and verification cost. An uncertainty-high option does not have to be eliminated at first, but it should be recorded which simple experiment will determine the outcome. A concept that appears to be theoretically favorable can be exploited due to

ergonomic grip, electromagnetic compatibility, battery life, or assembly tolerance. When reasons for decisions change, problem identification can also be updated (ISO, 2023; Mohammadi & Zeng, 2025).

The third stage is experimentation and modeling. The calculation model depends on the characteristics of the material, boundary conditions and accuracy of the load profile, while the prototype can be affected by defects caused by the manufacturing method. Experimental design helps to distinguish the effects of alternative factors, sensitivity analysis helps to demonstrate the dependence of the results on uncertain inputs. The fact that the result can be interpreted and replicated by another team provides stronger evidence than just a good-looking visual. Verification of the numerical model and its validation in real use are separate questions (American Society of Mechanical Engineers [ASME], 2022).

Decision points in the development cycle should not be seen as rigid and irreversible doors. The experiment may show that the initial requirement is misidentified or that the user is concerned with a different feature. In this case, returning to the previous stage with new information is not a failure of the project, but an early abandonment of the wrong assumption. However, repetitions have a cost and schedule. The concept validation approach of ISO 56007:2023 supports traceability between opportunity, concept, and evaluation beyond focusing on the number of ideas (ISO, 2023).

A product's suitability includes conditions of reliability, availability, maintenance, availability and distribution in the use environment, while innovation in the production process is assessed along with operator training and process control. If the product is currently only used in a pilot operation, it should not be confused with the final product offered to the market. The realisation of the expected commercial, environmental or user benefit with the presence of a new product is a separate measurement issue (OECD & Eurostat, 2018).

Requirements such as safety of operation, legal fitness, certain mechanical strength, or an upper temperature limit on the surface contacting the user should not be reduced to a low weight component of the total score. Flexible targets, such as mass, cost and production time, can then be compared between options, which prevents a candidate from appearing to compensate for not meeting the safety threshold with a low cost advantage. The dependence between measurements must also be controlled: with a decrease in mass, the increase in the cost of the material is a separate effect; double scoring of the same benefit creates a choice error.

The stages of prototype development must also be distinguished. A simple benchtop experiment may test a particular physical mechanism; an engineering prototype shows the arrangement and interaction of components; and pilot production tests whether the selected design can be produced consistently. A

positive result from the first prototype does not establish the cost or defect rate of mass production. Similarly, a favorable comment during a prototype presentation does not demonstrate long-term use. After each experiment, the development record should answer explicitly which proposition has been validated and at what level. Preserving the boundaries of the problem and its measurement prevents subsequent teams from interpreting the same data differently (ASME, 2022; ISO, 2023). As summarized in Table 2.1, different product development decisions require different forms of evidence, and no single type of evidence is sufficient across all stages of the development process.

Table 2.1 Product development decisions and types of evidence

Decision	Information required	Evidence that is insufficient
Select an opportunity	User problem and current situation	Attractiveness of one solution idea
Select a concept	Comparison of functions, constraints, and alternatives	A proposed inventive principle alone
Validate the technology	Model, prototype, and measurements	A simulation image alone
Deploy the solution	Production, user, and field data	Laboratory success alone

2.6 Illustrative Application Thermal Management in a Smartphone

Smartphone thermal management provides an illustrative design problem involving competing technical requirements. The alternatives discussed here do not represent measured performance for any particular device. Under sustained high processing loads, the hypothetical product must control chip temperature while keeping the hand-held surface temperature and case thickness within acceptable limits. Processing stability and surface comfort matter to the user; volume, mass, cost, and component placement matter to the manufacturer. Under the definition of product innovation discussed in the preceding chapter, a conceptual thermal solution would have to become a tangible product and be introduced to the market before it could be counted as an innovation (OECD & Eurostat, 2018).

The technical contradiction can be stated as follows: increasing the heat removed from the processor should not increase the cooling system’s volume, weight, or energy consumption. The physical contradiction is that the heat-spreading area should be large for heat transfer but small enough to fit within a thin enclosure. These statements identify different problems. The former concerns a trade-off between performance attributes; the latter concerns opposing requirements imposed on the same physical element. Before analysis, the duration

and processing load at which this tension arises should be measured. A solution that is unnecessarily heavy for a brief, low-load problem may be unsuitable (Altshuller, 1984; Sheu et al., 2020).

In a simplified functional model, the chip generates heat, an interface material transfers it, a spreader distributes it laterally, and heat is exchanged between the enclosure and its surroundings. The battery, antenna, display, and user's hand impose constraints at the system level. Adding a component without locating the interface at which the largest temperature drop occurs may leave the bottleneck unresolved. Thermal imaging, embedded sensors, and comparative simulations can support the measurement plan, provided that the resolution and boundary conditions of each method are assessed separately. Functional analysis should identify the interaction to be changed rather than merely attach short labels to the technical description (Ilevbare et al., 2013).

One concept uses a thin heat spreader to distribute energy from a hot spot across a larger surface; another adjusts control in response to changes in processing load. A material capable of thermal storage may temporarily limit peak loads, but its storage capacity is finite, after which heat must be released to the surroundings. Merely invoking a phase-change principle is therefore not evidence that the concept works. The material's phase-transition range, stability across cycles, assembly method, and electrical compatibility must be tested. Separation principles clarify that continuous cooling and short-term peak-load management address different operating conditions (Sheu et al., 2020).

A further concept changes only one part of the heat path or gives an existing enclosure component an additional function. This may simplify the system and use existing resources, but a rise in the temperature of a surface touched by the user could introduce a harmful effect. Evaluation must therefore extend beyond chip temperature. Chip and surface temperatures, sustained processing speed under load, enclosure thickness, mass, energy consumption, production cost, repairability, and reliability should be measured together. A reduction in chip temperature cannot be treated as a complete success if another essential requirement deteriorates.

The proposed validation sequence is to measure the existing product, model alternatives, build a physical prototype, conduct comparable load tests, and evaluate durability. Unless ambient temperature, software version, battery state of charge, and processing load are held constant, the source of temperature differences cannot be identified. The observed improvement should also be compared with measurement uncertainty. If a concept fails a required threshold, it should be revised or rejected. This illustrative exercise shows how TRIZ principles can generate technical concepts; because no device measurements are provided, it does not claim that any of these alternatives has been validated.

A decision matrix can be used to compare the alternatives in this example. Its columns should record the conceptual mechanism, the functional deficiency it addresses, a property that could worsen, and the least costly discriminating experiment. For the thin spreader, thermal resistance and assembly thickness would be measured together; for temporary storage, the rate of temperature rise after a specified peak load; and for software control, processing performance and energy consumption. Numerical success values should not be inserted because the example contains no measurements from a real device. The matrix instead specifies which evidence would support or refute each concept.

It is also not necessary to select a single solution. Local improvement of the heat path may be beneficial in conjunction with software load regulation; however, the contribution of one component may vary in the presence of another. In this case, a series of variables that are tested individually may miss out on interactions. In the comparative experiment, the current design only helps to separate the effects by examining the material change, only the control change, and the conditions under which the two changes are applied together. A solution that meets the design conditions is retested with longer-term questions, such as whether the material's properties change during repair and cycle ageing. Representative thermal-management concepts, their intended functions, and the critical conditions to be tested are presented in Table 2.2.

Table 2.2 Representative heat management options and test questions

Concept option	Intended function	Critical condition to test
Thin heat spreader	Distribute the hot spot	Surface temperature and assembly thickness
Temporary thermal storage	Limit peak load	Storage duration and cycling stability
Load responsive control	Regulate heat generation	Processing performance and energy consumption

2.7 TRIZ in Relation to Other Design and Quality Methods

Determining requirements, resolving conflicts, and making a solution reliable are different tasks. User interviews and quality function dissemination can be used to associate demand with technical specifications; TRIZ can suggest different solution principles when requirements conflict with each other; and error types and impact analysis can help assess in which ways the chosen design may fail. When root cause analysis searches for the cause of the current malfunction, TRIZ may focus on the opposite conditions created by the desired healing after the root cause

is identified. Critical examination of industrial cases suggests that there are numerous examples where TRIZ is combined with other methods, but the effect of these combinations should not be read as a causal consequence independent of context (Spreafico & Russo, 2016).

The transition point between methods should not be arbitrary. For example, if the user says phone is heating up uncomfortably in the hand, the environment and conditions of use should first be monitored; before starting thermal simulation, it should be determined in which use scenario the discomfort occurs. If the cause of the problem is heat resistance on the intermediate surface, different transmission materials can be experimented with. If expanding the material increases the mass and thickness, the technical contradiction is clearly written and the TRIZ tools are selected. This arrangement allows each study to respond to the results of a previous one; using the method is not an outcome on its own (ISO, 2023; Ilevbare et al., 2013).

The depth of validation required varies by industry, while surface temperature and battery performance can be critical in consumer electronics, bioavailability and traceability in medical devices, occupational safety and continuity on the production line can gain weight. The ability to transfer the abstract principle of TRIZ to different fields does not eliminate the need for industry-specific evidence. Sojka and Lepsik (2025), who have studied the process improvement literature, reveal that the tools and solution combinations used vary according to the application purpose. Thus, case studies are conducive to generating new research questions; they are not a guarantee that the same profits will be made in another business.

The sustainability claim should also be a separate consideration in method integration. If a solution that reduces the number of parts requires more energy in the production of new material, environmental success cannot be declared only by mass of product. Similarly, if lower operating temperatures are provided at the expense of higher electricity consumption, the total use effect should be calculated. Addressing the ideal poses a question to the design team; it requires appropriate lifecycle data to determine the actual environmental and economic impact.

The problem in interdisciplinary teamwork is often caused by the different use of terms such as lack of method. The unit of production can mean being manufacturable on existing machines, the unit of marketing can mean customer acceptance, and the unit of design can mean working on a physical principle. When different thresholds are discussed under the same word, uncertainty persists even if the decision meeting appears to have reached a conclusion. Such a record is consistent both with the breakdown of innovation activity and output in the first

section and with the inter-method business section (OECD & Eurostat, 2018; ISO, 2023).

In small teams, it may not be possible for all methods to be performed by individual experts. Instead, some minor questions may remain: What is the user's verified problem; what function will actually be changed; what critical hardening risk the proposal poses; what test can show this risk early; who is responsible for the selection? The same questions require more detailed recording and independent verification in large and modifiable projects. Although the scale of the process varies, the distinction between the choice of the TRIZ principle and the approval of the design should not be lost. Thus the learning cost of the method can be directed to better problem identification and measurable trials rather than unnecessary form filling (Ilevbare et al., 2013; ISO, 2024).

2.8 Systematic Problem Solving Supported by Generative AI

Productive artificial intelligence is being investigated in TRIZ studies due to its ability to summarize technical texts, generate problem expressions, mark possible contradictions, and develop proposals for alternative principles. Jiang and his colleagues' refereed AutoTRIZ study (2025) evaluated the production of a solution report structured with a large language model, textbook examples, and an application for battery heat management. This evidence shows how automated text production can be used in the design process; it should not be extended in the form in which technical accuracy, patentability, or market presentation success is achieved in every field.

Combining environmental-based design with TRIZ, Mohammadi and Zeng (2025) studied an interactive approach ranging from problem definition to function analysis and idea generation. Researchers have reported that high scope in AI outputs is not the same as accuracy; there is wide variation in functional analysis errors and quality of thought. This observation supports the need for assumptions, constituent relationships, and contradictions to be controlled by an expert rather than saying "find a solution" to the model. Maturing the problem statement together is a more fundamental contribution than merely extending the list of suggestions (Mohammadi & Zeng, 2025).

Ghane and his colleagues' systematic review of semantic TRIZ (2024) evaluates text processing work through patents and other technical documents. Text mining can help to find functional and solution relationships that repeat in different sectors, but the similarity of keywords does not mean that physical conditions are the same. The suggestion of similarity produced in a source text may be misleading if the name of the material, working temperature, stress condition, or production method are lacking. Therefore, ideas derived from patent documents or AI

derivatives should be traced back to their original sources, separating which information was obtained directly and which technical commentary was made by the team (Ghane et al., 2024; WIPO, n.d.-a).

In an AI-enabled operating system, the problem text and constraints can be saved first by the version number, and then the model is asked to list the functions, uncertain parameters, and possible contradictions separately. The engineer marks the correspondence and origin of each term in the list in the actual system; he corrects erroneous expressions. However, after this stage, concepts are created according to alternative principles. The output is classified not by the unique number of ideas, but by the likelihood of meeting the requirements, different physical mechanisms, testability, and expected harms. A second expert review may catch the model repeating the same prefixes in different words. These steps are a proposed practice derived from limitations in research; they are not a standard procedure guaranteeing the success of a particular model (Jiang et al., 2025; Mohammadi & Zeng, 2025).

The transfer of confidential design data to external services, the use of copyright or trade secret documents and the reliance on patent information provided by the model should also be governed. The labelling of a model solution as patentable does not replace legal evaluation; the prior art, country, and application scope are investigated separately. Similarly, a real patent number and claim of technical characteristics should not be used until the source document is returned. Establishing rules for data access, storage, and accountability makes the application of artificial intelligence a broader organizational decision than the production of technical ideas. The system approach of ISO 56001:2024 provides a general framework for regulating powers and evaluation responsibilities; it does not eliminate the need for legal review (ISO, 2024; WIPO, n.d.-a).

A chain of evidence for AI outputs is required, separating the name of the principle proposed by the model, the relevant technical explanation, the proposed physical mechanism, and the source for whether this mechanism will work under design conditions. When a proposal says "storage the material", it also calculates how long the material will be stored at what temperature range. The standard number, patent, DOI and performance percentage of the model can be checked in the source records. In the case of insufficient information, accepting the expression informal is more valuable than an unrealistic definite result. This practice leaves the epistemic responsibility to the team while using the machine's ability to quickly create choices (Ghane et al., 2024; Mohammadi & Zeng, 2025).

For experimental research, it is possible to compare a human team with a single human team and a human and an AI team on the same design tasks, so the task difficulty and time should be equated, so that the evaluating experts do not know as

much as possible how the choice was generated. Since ideas are not at first glance interesting, feasible in a laboratory setting, or economically viable, multiple criteria are needed. Repeated tasks can also make the impact of usability learning visible. Without establishing such a system, an overall sentence in the form of artificial intelligence makes TRIZ more effective, blending the potential of the method with an empirical result (Jiang et al., 2025).

2.9 Evaluating Success and Research Limitations

It is easy to measure how many ideas are generated in the evaluation of the TRIZ application, but it does not alone explain the nature of the ideas. The number of options approaching the problem with different mechanisms, the rate of meeting the requirements, the transition time from the first idea to the prototype, the assumptions taken as a result of the experiment and the measured change in the final product are individual indicators. Comparative design is required to evaluate the utility of a method: problems of similar complexity, without similar resources and common acceptance criteria, cannot reasonably compare the results of a team that does not use TRIZ with a team using TRIZ. The intensity of sample events in the research literature may limit the power of generalization, although it makes application potential visible (Chechurin & Borgianni, 2016; Ilevbare et al., 2013).

Similar distinctions are needed in the assessment of artificial intelligence. The fluency of the text does not indicate that a correct technical relationship has been established. The consistency of the definition of contradiction with experts, the originality of the alternatives produced, physical feasibility, and the cost of testing differ from one another. Comparisons made by Jiang and colleagues (2025) and Mohammadi and Zengin (2025) using limited samples provide a concrete starting point for research; it is not appropriate to directly transfer the results of these studies to the entire product portfolio of an enterprise. For the same problem, output may change when the model version or command is changed. The version used in terms of reproducibility, date, input, evaluation parameters, and expert interventions must be recorded.

The gap between technical success and innovation success is particularly apparent after implementation. The launch of a new design that lowers the heat is relevant in terms of product innovation; the change in user comfort, warranty failures, or energy consumption is the next measure of results. The fact that a product has been placed on the market does not automatically indicate that the expected benefit is being realized. In contrast, a limited accepted solution on the market can be considered an innovation if it is significantly differentiated by definition and put to use. Assessing success with only a patent application, prototype number or short-term sales involves different stages. The separation of

activity, output and impact established in Section 1 here becomes a concrete measurement plan (OECD & Eurostat, 2018).

The adoption of a product for the first time on the market is not the same as the adoption by different businesses and regions. WIPO's 2026 report examines whether the impact of technical progress depends on the conditions of distribution and local adaptation. In the example of a smartphone, the adoption of a hot design by different manufacturers may require re-validation when the location, material supply, and usage profile change. Well-documented functionality and test information can facilitate transfer, but the test result on the first product cannot be transferred directly to the reliability of another product. Thus the institutional learning value of systematic innovation also includes adaptation processes after the first solution is found (WIPO, 2026).

When broadening, industry, scale and time differences must also be specified. In a product open to fast software updates, field feedback can quickly return to design; in a product that requires long-lasting equipment and security, verification and manufacturing investment are much heavier. The suggestion of 'shortening product life cycles' does not apply equally to all sectors. Targeting the pace of development alone can impair the quality of measurement or safety of use. The cost of the shortened market presentation period should be explained together with learning, error, cost and sustainability indicators. The value of systematic innovation lies not in denying time pressure, but in being able to show which evidence is indispensable under pressure (ISO, 2024; OECD & Eurostat, 2018).

If a solution is found not because of the supply of materials, but because the measured temperature effect is insufficient, these two reasons will be used differently in future projects. The problem, the TRIZ tool used, the alternative that emerged, the experimental order and the reason for the decision must be included in the solution logs. However, a comprehensive documentation arrangement does not mean that a better decision is made on its own; teams need to access records, re-interrogate old assumptions, and adapt the information to the new conditions. The repeatability of systematic innovation depends on the preservation of essential learning rather than the re-implementation of the same principle (ISO, 2024; Ilievare et al., 2013).

2.10 Conclusion

This section relates technical contradiction, TRIZ tools, and the place of generative artificial intelligence in product development to the first section's definition of innovation. Opportunity selection, explicit writing of requirements, function and contradiction analysis, production of alternatives, engineering verification, and measurement of application results are mutually supportive but

requiring different evidence. The strength of TRIZ is that it expands the field of conceptual solutions by questioning specific technical commitments. The method alone does not determine the market suitability, environmental benefit or operational value of the product. These are also assessed under actual conditions of use and production (Ilevbare et al., 2013; OECD & Eurostat, 2018).

Current research suggests that large language models can make TRIZ knowledge accessible and can rapidly manipulate different ideas. However, errors in problem expression, omissions of physical conditions, and unproven technical suggestions make experimental evidence with human expertise more important. In the following sections, the use of patent documents as a source of information for technical solutions, the protection of the resulting invention and the commercialization of the product will also be discussed. Thus the expressions creative principle, corrected technical solution, adapted product and measured benefit can be used throughout the book without confusion (Jiang et al., 2025; WIPO, n.d.-a).

CHAPTER 3 PATENT INFORMATION AND INTELLECTUAL PROPERTY STRATEGY

Product development work does not end with a working prototype. The design team's solution requires separate decisions about how the product was previously described, what elements of the product could be protected, how third-party rights could affect the implementation, and how the acquired information would be retained in the company. The second section discussed the definition of conflict, the development of solution options, and engineering testing, which examines how the technical and strategic knowledge gained from patent documents would be incorporated in the process, and then how the protection choice would be justified. A patent is not the document of the innovation itself or its automatic achievement; at the same time, it can be a technical explanation, a legal right, and research data under certain conditions. When these three functions are mixed together, both design decisions and research results become misleading (World Intellectual Property Organization [WIPO], 2022).

The approach here is broader than looking for a few keywords in a patent database and reporting the number of results. It covers the phases of limiting the technical problem, creating the search set, reading the relevant documents, cleaning up the data, interpreting the indicators and further examining the legal outcomes. A recent literature review on patent research shows that patent data are used in different areas of research such as indicators, analytical methods, and intellectual property management; the same data source answers a different question in each of these areas (Mejia & Kajikawa, 2025). The purpose of the section is not to replace the examination of the patent expert, but to clearly show what the engineering and management teams are investigating, what conclusions they can reach with what evidence.

3.1 From Technical Solutions to Information and Rights Decisions

There are different suggestions that a prototype can be patented by lowering the temperature; a new cooling element may have provided the target temperature under laboratory conditions; the same structure may not have been previously described in a public patent or paper. Furthermore, a positive appraisal in terms of patentability does not mean that all parts of the product can be freely manufactured against the rights of others. The technical success of the product, the claim that it is new, the scope of the elements to be protected, and the freedom to practice examine different objects. Therefore, the phrases tested, no identical explanation or no true obstacle detected in the project record should not be used as if they were stating the same result.

The information value of the patent document is related to the applicant's obligation to explain the technical solution in particular detail. The title and summary provide a

quick start, while the forms of application of the designation, the drawings, the structural relationships, and the claims indicate the limits of the protection requested. In the study, these sections are given different weightings depending on the research question. The engineer seeking a technical alternative may focus on the description and drawings; the expert evaluating the potential legal barrier must study together the legal situation in the country regarding the current text of the claims. The European Patent Office's 2026 review guideline defines conditions separately, such as technical characteristics, innovation, invention stage and industrial applicability, in terms of the European system. This framework makes clear that the technical utility alone does not imply patenting (European Patent Office [EPO], 2026a).

These distinctions must be reflected in organizational responsibilities. The engineering team records the problem and the distinguishing features of the solution; the researcher searches prior disclosures; product management identifies the relevant markets and fields of use; and the intellectual property specialist assesses claim scope, ownership, and term. Separate responsibilities do not require a breakdown in communication. A technical alternative identified during a patent search may change the design, and a design change calls for updating the earlier search query. A one-way sequence of designing first and examining patents later limits the use of invention information during development. A transparent decision record preserves who interpreted a finding, when, and for what purpose.

The protection decision should also not be seen as an administrative process added to technology. The value of rapid market entry in a short-lived product is different from the value of a production method that can be maintained for years. On the contrary, it may not be sustainable to try to keep a structure that can be easily seen with re-engineering a secret. The timing of the patent application, public disclosure, collaboration and the country in which the product will be used must be considered together. The difference between the implementation and dissemination of innovation in the first chapter is tangible here: where the invention was made and where conservation has economic significance is not always the same place. Linking the protection decision to the technical lifecycle provides a more explicit approach than automatic preferences such as patent for every idea or confidentiality of every information.

3.2 The Structure and Purpose of Reading Patent Documents

The publication number in a patent filing, the application number, and the filing information refer to different dates and documents. The application for the same invention, the published text, and the patent subsequently granted may be with different document codes; claims may vary in the process. This change is omitted when the researcher makes a definite determination about the scope of rights only

through the first available PDF. First, it is necessary to determine when and where the document was published, and then to monitor subsequent processes of the same file. A published application may not yet be a documentary right; it is also examined whether a patent granted is in force in the country concerned. The EPO makes it clear that the accuracy and timeliness of the legal case data may vary depending on the speed at which national offices provide data (EPO, p.

Technical reading must first determine which function the problem is set up with. The passage of the expression *telefon cooling* in both documents does not indicate that they are based on the same mechanism. One explanation may address the order of layering that transmits heat from the processor to the body, the other the control logic that sets the workload. Both can affect the temperature of the product, but the engineering variables, the properties to be preserved, and the application costs are different, so it is useful to read the document with the function, effect, physical tool, and application condition columns instead of just matching the keywords. These are the researcher's own conclusions; an effect that is not explicitly contained in the document should not be conveyed as a validated result of the patent holder.

Interpreting patent claims requires particular care. The description of a broad technical objective in the specification does not mean that every possible implementation is protected. The first independent claim identifies the features claimed in combination, while dependent claims may impose further limitations. Replacing a claimed feature with synonymous wording does not in itself establish that a product falls outside the scope of the claim. Article 69 of the European Patent Convention and its Protocol on Interpretation explain that the extent of protection is determined by the claims, with the description and drawings used to interpret them. These are legal texts specific to the European context; the same procedure or outcome should not be assumed for other jurisdictions (European Patent Organisation, 2020).

References in a patent document can also be evaluated for two different purposes: references to previous documents help to search for the relevant technical history; and later references to previous applications show a trace of information. However, the formation of a reference depends on the application of the study institution, the age of the document, and the publication density of the field. A reference is not proof that the technology has reached commercial value or that it has been used verbally by other teams. Reading patents together with scientific papers, standards and field data expands the technical context. Geissler and his colleagues' research (2024), which examines the relationship between patent knowledge and scientific literature, provides an example of how these two

sources complement each other; interpreting the relationship as a direct causal one again depends on research design.

3.3 Developing a Reproducible Search Strategy

The search starts with a decision question, not a database selection. Is there a similar hot solution before?, Which subfields have had application density in certain years? and What rights can the product meet in the planned countries? questions do not require the same query and the same data fields. The first question requires a thorough examination of the technical explanations, the second a set of comparable data, and the third a legal examination at the country and demand level. When the search intent, date, language, technical function, and product class are rewritten, a set of results can be checked later to see why it is selected. WIPO's guidance on the use of patent knowledge addresses trends such as patentability, avoidance of potential infringements, evaluation, and technology as separate uses of information (WIPO, 2022).

Keyword research does not consist of synonyms. It may be relevant to solutions such as heat exchanger, thermal interface, vapor chamber, and load control, but may be exclusive to some. The different spellings of English terms, industry jargon, chemical or mechanical naming and translation differences should be taken into account. It is best to first identify a few clearly relevant and a few clearly irrelevant documents and test how the survey captures them. Increasing the number of results alone is not helpful if irrelevant records are increasing; too narrow a query leaves out important alternatives. So the team can show why they're expanding or narrowing their scope in the later stages of the research.

Public databases offer different scope. WIPO's PATENTSCOPE system provides access to the full text of published international PCT applications and to the participating national office documents; searching is possible in the word, classification and number fields (WIPO, n.d.-c). TÜRKPATENT directs its own records to the EPO and WIPO tools. No single source should be assumed to be complete for all languages, all document types and the most current legal events. Database selection is also related to the researcher's access and data extraction conditions. The explanation of the coverage used in the research makes it easier for other teams to evaluate finding different numbers for the same question.

The quality of a result set can be tested by sampling. Two researchers can independently encode documents in a defined subset as related, limited, and not relevant. When a dispute arises, the question is whether the function of the document, the context of the product, or the classification limit has been interpreted differently. This work does not guarantee a thorough review of all patents with the available resources, but it does make the conceptual limitation visible. Thus the

negative result, i.e. arama is not found in the set, is not a general and timeless nowhere claim.

It is also a limitation for the search approach to rely solely on patent documents for prior arts. Scientific papers, standard documents, product use guides, theses, and exhibition descriptions may show that some inventions have a public record. These sources have different search interfaces and historical records; they do not indicate that they do not appear in a patent database. In a patent landscape, however, the concept of collecting non-patent publications as a single number of inventions on the same graph with patent families violates. In combined analysis, the source types are treated as separate layers; it is examined whether the same solution may have appeared at different stages in article, patent, and product documents.

The sensitivity of search results is assessed differently when the goal changes. It may be acceptable to read some irrelevant results in early opportunity discovery, because unexpected technical areas can expand the solution area. The result of missing a small number of critical documents in a free activity scan may be different, so a context-independent formula as en good query should not be sought. The rate of sampling of relevant documents and the actual relevance of the selected documents may be reported together, and the manner in which the evaluated sample was selected shall be explained. When an expert in the technical field and an expert in information access work together, the relationship between search terms and actual function becomes more reliable. Table 3.1 distinguishes the evidence required for prior-art searches, patent-landscape analysis, and freedom-to-operate assessments, while also indicating the conclusions that cannot be derived from each type of investigation.

Table 3.1 Different decision questions in a patent investigation

Research objective	Evidence examined	Conclusion that cannot be drawn
Prior art	Published technical disclosures	The product may be sold without restriction
Patent landscape	Family, technology field, and applicant data for a defined set	The market value of every application
Freedom to operate	Product features, jurisdictions, claims, and legal status	All future products are free of risk

3.4 Classification Patent Families and Units of Analysis

Patent research can overlook forms of technical communication written in different languages and with different terminology when only the word is used. International Patent Classification provides hierarchical codes for technical fields; the use of codes as a common search point in different texts partially reduces this problem. According to TÜRKPATENT, classification functions in the investigation of the known state of the technique and in the production of statistics according to the fields of technology (Turkish Patent and Trademark Office [TÜRKPATENT], t.y.). However, a code is not entirely equivalent to a specific product or functional mechanism. As there can be many different structures within the same class, a solution can occur in more than one class, so keyword and code-based queries must be tested interchangeably.

The level of detail of classification changes the result of the research. A broad class can indicate the general movement of a technology; a more acute question about a particular component of the product can be answered when lowered to the subgroup. But overly narrow codes can leave out solutions that are not yet well-integrated into the classification system or compounds that have been developed in border regions. Perez-Molina and Loizides (2023) show that technological proximity maps can be generated from classification codes; they also state that two-dimensional visualization simplifies the original multidimensional relationships. Without proper documentation and engineering knowledge, visual clusters cannot be made into a design proposal.

A patent family allows related documents filed in different countries or published at different stages of an invention to be examined together. If publications are counted, application and grant publications for the same invention may create several records; a family-based count can reduce some duplication. The definitions of simple and extended families nevertheless capture different relationships. The methodology annex of WIPO's 2024 patent landscape report on generative AI explains that it uses simple families as an approximate indicator of inventions, assigns years by the first family publication, and selects different data when examining legal status (WIPO, 2024c). Reading the same figures as applications, publications, or families can fundamentally alter a comparison.

The name of the applicant is a secondary problem in data cleanup. The old and new names of a company may appear to be separate actors in their affiliates, mergers, or correspondence in different writing systems. Therefore, the researcher must clearly document institutional normalization in the data set. The location of the inventor, the applicant's headquarters and the country of protection sought are three different geographical indicators. In particular, in the development of

multinational products, the design, ownership and commercialization of an invention can be separated.

The decline in the number of applications in new fields in recent years does not necessarily indicate that research is declining. Patent applications may remain closed for a period of time before publication; countries and document types reflect different delays in the database. It is wrong to compare past years to last year as if it were the same level of maturity. The 2026 technology panel of the European Patent Office, containing 2025 application statistics, shows the distribution of applications to its own institution by technological fields; this is not a count covering all inventions in the world (EPO, 2026b). The scope and latency range of a data series should be added to the heading or footnote of the graph, otherwise the change in the scope of the organization's task may be interpreted as a general technological development.

Recent research has identified technological clusters in the field of electric vehicle charging using Collaborative Patent Classification (CPC) codes. Lee and colleagues (2026) use code patterns in documents in specific years and selected databases. The work demonstrates the contribution of patent classification to systematic technology monitoring; it does not prove that the groups produced by a set algorithm are identical to actual market segments or technically applicable product families. Furthermore, when the classification codes are updated by patent offices, the backward comparison may vary, so the researcher must document the code version and analytical sampling used, accepting that the method should be retested for other products and countries.

3.5 Designing and Auditing a Patent Landscape

Patent landscape study is a structured examination of what solutions, actors, and time relationships make up a particular field. Before creating a map, the purpose of use must be explained: tracking the investment direction of competitors, discussing research gaps, searching for a licensing partner, or assessing technical capacity in public policy require different limits. The classification of academic patent research by Mejia and Kajikawa (2025) shows that analytical studies distinguish between the fundamental problems, indicators, methods, and uses of the patent system. The technology, geography, period, and counting units involved in the study must be written from scratch.

The core of the approach is the combination of query development and document selection. First, the main functions and possible technical tools performed by the product are identified. Words and classifications are extracted from the relevant known documents, and documents that solve another problem are recorded if they contain counterexamples, i.e. similar words, followed by

questioning, examining a random or layered result sample, and updating the exclusion criteria for unnecessary records. In each change, the previous query is stored. The question what records were made during the development of the query? is more useful than the question how many results were obtained?. The detailed presentation of technical terms, classifications and additional verification steps in WIPO's report on artificial intelligence is a current example of the verifiability of research (WIPO, 2024c).

Once the data cleanup is complete, even the simplest analysis can be useful: the number of families by year, the main technical functions, the leading applicants, and the countries requesting protection. But these views do not have to support each other. A company with a large number of applications may not have developed the most technically efficient solution; commercial potential may be high in a less-requested area; technology clusters may be manually coded according to functional characteristics or created using text-based methods. Regardless of the method, the coding scheme must explain consistency control and the researcher's boundary decisions in at least one sample set.

The change in time should not be limited to a single curve: the first year of publication reflects patent visibility, the year of the patent application, and the year of filing the completion of the review process. Similarly, the new classification code added to a set can cause previous records to be assigned differently; the working version, the date of data extraction, the version of the code system used, and the cleaning rules must be stored. Geissler and his colleagues' association of research literature with patent data (2024) makes it possible to compare it with alternative data; it should not be assumed that every change in the patent graph is equal to a change in the speed of scientific discovery.

The final output of the landscape requires caution in naming white space. A technical option that is rarely seen in the search set may be an unresolved opportunity in the real world; it may also be technically unproductive, unclaimed, protected by trade secret, or not included in the definition of the search. The alternative from the analysis of contradictions in Section 2 is to look at these explanations in the landscape map. Identifying the patent gap with the market opportunity hides the lack of evidence of practice and value. Comparisons made with net expert opinions, open publications and user data strengthen the basis of inference.

Particular attention should be paid to the comparability of visualizations in a landscape report, for example, if the circle area of two periods shows a different number of households, scaling the radius rather than the surface of the apartment may mislead perception. A hundred percent growth in a small technology area in the oral graph can only correspond to a few applications as an absolute number. In

the annual series, last year's missing publications must be visually marked separately. When the analyst does not write down in the graph which years have what data maturity, the reader cannot distinguish between actual decline and delay in visibility. A one-page summary of the unit in which the numbers are collected may be more useful than a fancy grid diagram.

The company that uses the available clusters to look for opportunities must match them with the product plan before converting them into a single resource allocation list. A region that is technically close but far from the need for organization, maintenance, or distribution seems attractive at first glance. On the contrary, a small subset that can be combined with existing capabilities may be more applicable. Hirose's (2023) examination of the information composition from different technical fields over patent data in the NetZero field shows that the empirical result of how technological distance is defined can be influenced. The answer to this in the product decision is not to replace the proximity of classification with ability and market consistency. The team must re-examine the candidates they get from the map with engineering experiments and user questions.

3.6 Strengths and Limits of Patent Indicators

The number of applications represents part of the technical activity, not the whole innovation performance. A manufacturer may not want to disclose the secret of the process; a service innovation may not be covered by a patent; another firm may apply for the same solution in multiple countries. An advanced reference to a patent, on the other hand, is the observation that subsequent documents are associated with it. Additional assumptions are needed to equate this relationship with economic value, technological influence, or the power of demand. If the applicant is younger, there has been less time to collect references, and the reference habits between classes are different, so making only a total reference ranking without a comparison of years and spaces can create a systematic error.

Protecting a patent in more than one country can increase the size of the family; paying annual fees indicates the owner's decision to retain the right. Each of these indicators reflects a costly preference but does not measure the same economic return. Cativelli, Pinto, and Lascrain-Sanchez (2023) have combined family size, renewal, and forward references as indirect value indicators. The relationship between demonstration and value can only be explained by the research universe, time, and survival conditions. It is logically possible to find a valuable local solution for a small family or technology that has not been implemented despite a large family.

Svensson's (2022) empirical research with inventor and small business data in Sweden has linked indicators such as innovation and family scope to

commercialization. The sample selection, the actual cost and market size in the country may not be the same in other contexts. The model used by Og and colleagues (2020) for renewal decisions also shows that the information value of different indicators can vary over time. The fact that a new application has not yet accumulated advanced references does not render it invalid; nor does the fact that an older document receives a large number of references indicate that it is still valid.

Exhibits must be selected according to the purpose of the decision. Functional similarity, technical elements of the claim, and application conditions may be highlighted for the design team. Public policy analysis can be concerned with the number of individuals or firms, the results of distribution and adoption into fields. Giving a single patent quality score to all these questions confuses the evaluation object. The input, output, and effect distinction in the first section also applies to patent data: publication is the output in relation to the disclosure of the invention; use, income, or social benefit are also shown.

3.7 Distinguishing Novelty Searches from Freedom to Operate

Innovation research asks whether the developed invention is distinguishable from previous technical explanations, while the free-of-activity evaluation examines how the intended product meets the requirements of specific countries and the scope of relevant rights. In the first case, older technical texts published in different parts of the world may be important; in the second, the country where the product will be sold or produced, the duration of protection, the right holder and the valid text of the applications are also important. If a team finds an explanation too close to its own design in a previous publication, it can make it difficult to claim patentability, but the expiration of the explanation can have a different effect on the use of that solution. On the contrary, having a new improvement of its own development may not be independent of the current demands of a broader fundamental invention (Figure 1). The WIPO's patent information guide aims to reduce the risk of infringement by patentability research (WIPO, 2022).



Figure 1. Intellectual Property and Commercialization Flow

Free-of-activity is a systematic but link-specific review that defines the components of the product, the method of production, the function of the software, the geography of sales, and the time horizon. claims for risky documents, file and record records, continuing applications, and the conditions of the country concerned are examined. It requires direct record checking of legal status data, especially for records remaining at the border that may involve delays. If the product changes, it must be reassessed whether it falls within the same scope as the previously examined solution. This process is not completed by a few competing names at the end of the broad patent landscape; specific claims must be compared with specific product characteristics. Making the final legal comment with competent experts in the relevant country does not diminish the technical contribution of the research team; the comparison he made clarifies the basis of the comment.

The choice of country for protection is also different from the question of innovation: the first place of application, the market on which the product is sold, the country where the production chain is located, and the scope of activity of potential licensing partners may not match. An international PCT application is not a worldwide patent automatically granted; the application undergoes a specific international process and is evaluated at the national or regional stages of final protection (WIPO, n.d.-d). In a strategic decision, these periods should be considered in conjunction with a technical development calendar; this section does not recommend a country-specific fees or definite application calendar.

This distinction also does not imply the suspension of a new product project; it may be the option of developing an original alternative that is outside the scope of the relevant claim, obtaining permission from the rightholder, or changing the time

of entry of the product into certain markets. The impact of each option on technical performance, cost, and implementation time is tested separately. Judging not to browse through a document is not reliable only if the word resemblance is maintained. The TRIZ principles in the second section may make it easier to find alternatives; it cannot be concluded that the application of these principles provides an automatic waiver from existing rights.

A claim comparison cannot be made from the title of the document or the external appearance of the drawing. The technical team can separate the product feature into its elements and prepare a worksheet comparing each mandatory feature of the relevant claim. The table is kept for the purpose of recording new, different, informal and related to the version of the product. This is not the final legal opinion; it specifies which technical feature the expert should review. The existence of a right in a particular country does not alone determine which of the actions of the product fall within the scope of that right, thus safeguarding the limits of technical data order and legal interpretation.

Innovation and freedom of action are also distinguished in terms of time, and comparing the final components of the product with the rights a few months before sale by looking for similar technical solutions to be kept confidential when preparing the first application does not require the same level of detail. Early research can open up more design space; late-stage evaluation should be based on the country and actual product version to be applied; newly published documents and changing claims may not be up to date on the previous risk list as project duration extends. Instead of collecting all the data from scratch at each decision gate, a difference record showing the new release and changing product characteristics can be kept, which reduces the sense of false certainty when checking costs.

3.8 Protection Mechanisms and Knowledge Management in Collaboration

Patents, designs, copyrights, trademarks, contracts and trade secrets do not protect the same object in the same way. The technical heat transfer structure in the product body and the external appearance, the technical function performed by the software code and the code, the mark on the market and the coating method used in production must be evaluated separately. An innovation does not have to fit into just one type of right, but trying to protect all information with every possible right can blur the strategic goal while increasing the cost. The selection is subject to conditions such as easy imitation, the possibility of independent discovery, the need for disclosure, the product life and the need for sharing. WIPO's 2024 trade secret guide recommends that the legal and business reasons for the forms of protection be addressed together (WIPO, 2024d).

When a trade secret is selected, the information is not only protected by being labeled as "privacy", it determines who can access what information, the boundaries of employees and partners, the security of records, the separation of employees, and the order of sharing with the outside supplier. The absence of separation between previous knowledge in research collaboration and the results emerging during the project can create ownership inconsistencies in licensing negotiations. Rimmer's (2022) case study of metal three-dimensional printing shows that patent, trade secret, and contract claims can be embedded in the same technological competition. A single disagreement cannot be deduced for the success rate of the sector as a whole; the case makes clear how different types of rights should be managed together.

In a partnership between the university and the business, there may be tension between the publication requirement and the timing of the patent application, and the researcher may ask to postpone the sharing of the result and the business to postpone the early disclosure of technical details. The solution is not to devalue the publication of science, but to determine which explanation will be made on what date and with whose approval at the beginning of the collaboration. EPO's 2024 survey of European universities reveals that there have also been instances when the university does not appear to be the applicant at academic meetings, reminding that the inventor, the applicant and the institution financing the research should not automatically be considered the same person or institution (EPO, 2024). Contributions and previous information used in the in-house invention report shall be clearly recorded.

A 2023 joint investigation by the EPO and the European Union's Office for Intellectual Property (EUIPO) examines the relationship between patent and trademark ownership and funding of enterprises (EPO & EUIPO, 2023). The observation of this relationship is not merely a causal guarantee that the application will convince the investor or increase financing. Better organized or high-potential firms may already be more prone to both entitlement and access to finance. The right portfolio, technical verification, customer needs, business model and regulatory compliance must be assessed together in a business meeting so that protection does not become an indicator of technical success or performance that replaces the market.

The selection of protective devices can also be divided according to which information of the product life cycle is disclosed, while a mechanism that is visible to the user can be understood by re-engineering while the calibration parameter used in production may not be observed externally. In the first item, it may make sense to seek temporary rights in return for disclosure; in the second, information management limited to specific employees may be more applicable; however, if the

supplier is to access confidential settings during production, the cost of storage and the possibility of leakage should be reassessed. WIPO's trade secret guide (2024d) addresses the choice between patent and secrecy along with conditions such as product lifespan and ease of imitation.

In co-development, the ability of the parties to use the invention in their own activities is just as important as who the patent application belongs to. When deciding on the right-sharing of the emerging new solution, research data, prototype, code, and test infrastructure may be separate entities. This initial distinction also provides clarity on how other partners use the information after the patent document is published. The management goal is not to close every possibility with long contracts, but to determine in advance the ways of use that are really necessary for the development and commercialization of the product.

3.9 Opportunities and Risks of AI Assisted Patent Searches

Text mining and generative artificial intelligence can be used to search, cluster, translate, and first summarize patent documents, suggesting search terms, marking technical items in long claims, and finding similar functions in different classes can save time. However, the flow summary of a model does not replace the document text or record record. Single-word restrictions in claims can affect the scope; machine translation can erroneously convey technical terms and negatives. The training data of the AI device, the legal systems it covers, the date of data update and the identity of the document must be evaluated, and verification steps must be designed so that the wrong document number or fake citation can be caught early in the expert review.

In particular, legal matching is not the same as similarity score. The summaries of the two documents may show high semantic similarity, but one layer of the claims that is mandatory may not be present in the other. On the contrary, the fact that the product performs the same technical elements in claims written with different words can create controversy. The 2025 scanning of the patent research area together highlights the increase in AI-based methods and the need for methodological precision (Mejia & Kajikawa, 2025). Sensitivity and mismatch rates can be traced through human-labelled samples for technical analysis; the same success should not be expected in different product classes.

When used in the development of artificial intelligence in production, use as a tool should also be distinguished from invention. The current guidance, published at the end of 2025 by the United States Patent and Trademark Office, withdraws all of the previous text dated 2024, stating that the current legal standard applied to human inventors in artificial intelligence-enabled inventions is in effect (United States Patent and Trademark Office [USPTO], 2025). This relates to the U.S.

agency's practice; no direct single conclusion can be drawn between countries. The design team must write separately in the project log what technical understanding is made with human input, what the model proposes, and what the experiment confirms. Such a record is useful not only for a legal dispute but also for the technical decision to be reviewed later.

Confidentiality also poses a different risk: when details of an invention that has not yet been disclosed to the public are released to the outside world, the conditions for data retention, sharing with third parties and use for educational purposes should be checked. It may be unnecessary to upload full technical drawings when preparing a query if only a general problem description is sufficient; however, excessive extraction of details may impair the quality of the search; the organization must make a measured decision as to which data will be processed in which tool. The principle of distinguishing between the production of ideas and engineering verification adopted by the second section for generative artificial intelligence takes the form of separating document and legal examination from automatic matching.

3.10 Illustrative Application Smartphone Thermal Management

The smartphone example used in the second section can be maintained to show how patent knowledge would be tied to a product decision. The problem is not to increase body thickness and energy consumption while lowering surface temperature in intensive use. First, the sub-functions of the solution are separated: removing heat from the processor, spreading it within the body, limiting the surface to which the user is in contact, and adjusting the load according to time. Different technical terms and possible classification codes are specified for each subfunction; the actual suitability of the codes is tested with sample documents.

The search file keeps the date, language, database, search area, and query for each search in full. From the first set of results, functionally clearly related documents are separated from irrelevant documents that only include general electronic cooling. The first group helps to expand the word and classification, while the second group narrows down the overly broad queries. The selected documents are marked repeatedly in the same family; it is noted that the application and document publication are not considered as two separate inventions. Documents are read using functional codes such as structure that directs the process, temporary storage, load management. These codes are the analytical preference of the researcher, not the official patent class.

The thin heat exchanger described in one example may look similar to a TRIZ alternative in the second section. This similarity raises three different questions. Secondly, whether or not the technical performance is the same in our product size

and usage profile, and thirdly, which elements will meet the relevant requirements in the planned production and sales countries in the current scope. The first two often advance with engineering and previous technical research; the third requires up-to-date record and expert legal evaluation as product characteristics become established.

In this example, a concept map, the number of patents and the technical measurement can be presented in separate columns, where the map shows the current direction of the solution, the visibility of the application in the set of data that determines the number of families, and the measurement shows the temperature and thickness results of our design. The recovery in one of these is not an automatic increase in the others. The customer use for the product's market potential, the service network and cost; the material and energy lifecycle for the environmental benefit are also examined. Predicting sales with a patent indicator or removing protection from prototype temperature is a methodological error.

In the case of a sample decision, the team may record the idea of a heat exchanger as an option that has been tested successfully, is close to previous technical documentation and requires due diligence in specific countries. Alternatively, the load-varying control strategy may still be weak in engineering terms, but offers different design possibilities. Which one to choose is not determined solely by the number of patents. The different levels of maturity of design, testing, rights, production and market evidence must appear together at the time of decision. This framework enables the ideas produced by TRIZin to be enriched with patent knowledge, weak options to be released early, and strong options to be directed to the necessary expert review.

The research report of the representative study may also indicate the reason for the selection of sample documents. One document may indicate the function of the heat transfer layer, another its relationship to load control, and a third mismatch that is outside the product context despite the use of the same word. The fact that the third document is reported is not a wrong result; it is a readable explanation of the search limit. Such a counterexample shows which documents the researcher has left out. In a real project, the sample set must also be updated as the documents change; it should not be written as if a few pre-selected typical patents represent the entire field.

The results presented to executives can be grouped into four decision headings: whether a redesign is necessary, whether more technical experiments are needed, whether an expert review is needed in a particular country, and whether the option is still valid as a market rationale. For an idea with critical demand matching, even if the sales plan progresses quickly, detailed pre-production research may be required; for a technically weak concept, it may be ineffective to initiate expensive

right analysis early. Patent research is one of the data sources of this comparison; it is not the entire investment decision. The separate decision areas involved in the thermal-management example, together with the required records and responsible parties, are summarized in Table 3.2.

Table 3.2 Separate decisions in the example of heat management

Decision	Record required	Responsible party
Technical option	Function and experimental outcome	Design and test team
Prior disclosure	Document and claim mapping	Patent researcher
Right to implement	Jurisdiction, register, and final product features	Intellectual property specialist
Value proposition	Usage, cost, and supply data	Product and market team

3.11 Organizational Governance and Research Ethics

Decision-making using patent data is not a process independent of the raw files held by the research team; the research version, data clearance records, the date the legal status was verified, and analytical decisions should be archived together. An updated claim or a new publication only allows an explanation as to why the previous result has changed. Combining the names of uncertain actors in one study, keeping them separate in another study, changes some comparisons; the same analytical decision should be aimed at consistent implementation over years. However, sticking to the old coding scheme merely for the sake of consistency can also prevent new technologies from being seen.

Negative findings in terms of scientific integrity should also be preserved. The absence of relevant records in the search set is reported according to the survey and coverage used; it is explained that this is not evidence of a global and definite absence. If there is a disagreement among experts as to whether a document is relevant, the report should not present the majority opinion as a single outcome. The resulting table should show which cell is based on the document and which is based on the analyst's inference, although scientific publications and strategic company reports address different readers, both use controllable methods.

The ethical use of patent data includes not only the analysis of the applicants' legitimate information, but also the avoidance of unnecessary circulation of inventor and employee data. Patents can be public; this does not imply that any personal information can be used for the purpose of creating an unlimited profile. If a study wants to rank individual inventors, name similarities, institutional change, and the impact on private life must also be evaluated. The clear separation of

concrete findings from strategic commentary in the management report ensures both fairness and analytical reliability.

A functioning corporate process produces three distinct records: the development file of a technical solution, the methodology and findings file of patent research, the reasoning file of protection and enforcement decisions. This distinction does not mean establishing three separate bureaucracies. Separating different types of evidence under the same project identity can indicate which decision an update affects. A new prototype results in an updated technical file, a newly published previous technical document research file, a copyright term, or a requested change protection file. The value of patent intelligence lies not only in producing reports, but in being able to correct design and investment decisions in a timely manner when new information emerges.

3.12 Conclusion and Transition to the Next Chapter

This section evaluates patent information in three distinct planes: technical research, analytical indicators, and legal rights. The first requirement from the point of view of product development is to write the question openly; the second requirement is to make search and document selections reproducible; the third requirement is to separate different units such as patent family, application, publication and documentation. Displays gain explanatory power only when the limit of the data set and the purpose of the interpretation are specified. The mode of protection does not automatically depart from the technical specification; it is a management decision based on use space, sharing, simulation, and time conditions.

When read in conjunction with previous chapters of the book, the conceptual line becomes more pronounced. The first section distinguished innovation between idea, practice, and effect. The second section developed and directed alternative solutions to a specific engineering problem with TRIZ and artificial intelligence. The third section examined the relationship of these alternatives to past technical knowledge and pointed out the limits of legal decision making. Thus the terms creative idea, working prototype, preserved invention, freely applicable product and value-creating innovation are not used as different names for the same success. Each requires separate evidence, history, and geography.

The next stage is the way the chosen solution is scaled and created value. Methods such as licensing, co-production, entrepreneurship, open use, or direct product sales require market, financing, and organizational capacity, as well as technical and legal evaluation. The patent portfolio is one of the inputs to this decision; it does not produce commercial results on its own. Thus, as the options for commercialization are discussed in the next section, the conditions necessary for the conversion of technical knowledge into value have a clear starting point.

CHAPTER 4 TECHNOLOGY COMMERCIALIZATION AND SCALING DECISIONS

Working on a technical solution does not mean that it will produce value in the market or in public use. A laboratory-verified prototype may not sufficiently reduce the user's problem; even if the problem is actually solved, production costs, supply reliability, service obligations, or incompatibility with existing products may prevent widespread use. This section examines the introduction of the solution developed in previous sections to the market and use as interrelated evidence and resource decisions. The first section explained the relationship of innovation between knowledge and use, the second section explained the creation of engineering alternatives, and the third section explained the boundaries of patent knowledge and jurisdiction. The question here is who will use the chosen solution, under what conditions, through what production and distribution system.

Commercialization is not a linear end stage that begins with the addition of a price tag to the research output. It is an organizational process that requires feedback between technology, product, market and institution. The same technical knowledge can be licensed to an existing manufacturer's product family, developed in an initiative set up by a research team, subject to a joint development contract, or some components can be publicly shared while others can be kept in business. Each route's time requirement, complementary assets, level of control and risk distribution are different. Compilation on the commercialization of emerging technologies shows how technological characteristics affect who will enter the market by which route; therefore, a single entrepreneurial recipe cannot be applied to all inventions (Haessler et al., 2023). The framework proposed in this section shows the evidence on which the decision is based and the missing assumptions, rather than the superiority of a particular method.

4.1 Distinguishing Value Creation from Value Capture

An innovation can reduce the cost or risk of a user, but the organization that develops it may not be able to generate all of that value as revenue. The opposite is possible: a product that generates short-term sales revenue may not provide the expected benefit to the user or environmental performance. In the analysis, value creation is the measurable contribution to a particular problem, while value capture should be kept separate as the contribution's response to the organization in the form of price, license cost, service revenue, or other corporate benefit. It must also be stated to whom the value belongs: the end user, the purchasing unit, the manufacturer, the distributor and the public actor evaluate the same result by different measures.

The success of an academic technology transfer cannot be measured solely by the patent period or licensing income. Research partnerships, education, consultancy, open information flow, and the development of regional production capacity can also contribute in different forms. Abreu and Grinevich (2024), in the entrepreneurial university debate, emphasize that commercial and social goals require different resources and metrics within the same institution. This observation does not neglect financial performance; it also requires measuring which user benefits in addition to performance.

Five distinct propositions are useful in analyzing commercialization. Technical feasibility concerns whether a solution works under defined conditions; user validation tests the relationship between the problem and the solution in actual use; production feasibility concerns repeatable quality and unit cost; legal and institutional feasibility concerns the necessary permissions and chain of rights; and economic sustainability concerns returns relative to investment and operating cash flows. Although these dimensions may appear to yield a single maturity score, strong evidence for one does not remedy a lack of evidence for another. A temperature improvement in one device proves neither equivalent performance in mass production nor customers' willingness to pay more. This distinction prevents a laboratory result from becoming an unsupported market claim (Kruachottikul et al., 2024).

The time limit for the analysis must also be clear. The sales revenue generated in the year the product was launched is different from the service and redesign costs that may occur years later. In such cases, the cash table prepared for a single project does not measure the total social value of the transmission of information. The commercialization evaluation therefore records the results of appropriateness from the investor's point of view, sustainability from the producer's point of view and benefit from the user's point of view. Conciliating different levels can be a decision about policy and institutional strategy; engineering experience alone does not determine this preference.

4.2 Studying the Context of Use and Market Opportunity

The first unit of market research is not a broad sector name, but a specific use case. For example, the "smartphone market" for a heat management solution does not define a decision-making target. The gamer who uses processors for a long time, the manufacturer who uses field applications at high ambient temperatures, the manufacturer who designs a compact body, and the corporate buyer who prioritizes battery life carry different requirements. When the user, the buyer and the integrator are not the same person, the positive opinion of one party cannot explain the supply decision alone.

Nitel interviews can reveal the language of the problem, the chain of use of the product, and unexpected drawbacks, depending on the choice of sampling and the nature of the problem. A participant may say that they found the recommended feature useful, but they may never have discussed changing preferences over price, battery consumption, or device thickness. So instead of asking "did you like it?" we need to look at when the problem arose in the past, how it was solved, how much time or resources were spent on the current solution, and how the real choice between alternatives was made. Interview findings provide a stronger decision basis when compared to other data such as limited product testing, usage record or payment behaviour. Current research examining customer segmentation, value recommendation, and quantitative evaluation of the minimum function set in environmental technologies shows that positive feedback alone is not sufficient for product preparation (Meyer et al., 2024).

Early market research should also examine the total cost of the solution at the time of use. The unit price paid by the manufacturer may differ from the energy consumption, maintenance, software update, or repair loss incurred by the end user. An evaluation that only competes with the initial selling price may not capture the value of a low failure rate or longer service life; instead, assuming that the technical gain measured in the lab is important in the purchase decision, the erroneous market size emerges. The value proposition, the target segment, the measurable outcome, the available alternatives and the excluded characteristics must be clearly written.

Overall population dividends starting from above for market size do not provide access to the target supply chain. A more defensible first estimate is based on attainable customer groups, purchasing cycle, possible design acceptance, and production capacity. The account separates the total size of the target market, the subset that can actually be served and the demand that can be gained over a given period of time. Generating a single impressive sales figure without keeping track of the sources of the variables and the uncertainty ranges does not provide even reliable evidence for a financing interview.

Negative market findings should be distinguished in particular. The customer's failure to purchase today may be based on three different reasons: the problem is not important enough, the proposed solution is not suitable for the problem, or the budget and authority for product integration are not yet available. The first finding may require a re-selection of the target segment, the second a design change, and the third a different purchase calendar or partnership. The views of several employees from the same firm should not be regarded as independent market observations.

The company adopting the first pilot may have a higher technical tolerance or more trial budget than the large-scale customer base, in which case the satisfaction of early adopters is not a direct prediction of widespread demand. The sales channel, setup time, and support needs are also tested in different customer classes, as in the patent view of the previous section, and in the market research, the sample is written into a report on how the sample was selected, which groups were left out, and when the find was produced. The limit of evidence is not only related to the statistical sample size, but also to the variability of the decision environment.

4.3 Multidimensional Validation and Staged Learning

Technical maturity indicators can provide a useful language for the environment in which a technology is displayed, but they do not measure market consistency and operational readiness on their own. Similarly, there may be no supply capacity for critical material for an advanced working prototype. The test environment, sample number, comparison measurement, measurement uncertainty, and the conditions of use to which the results can be transported should be kept open in the verification file. In particular, safety and durability claims require data on extremes and faultforms as much as average performance.

Instead of turning decision doors into a rigid linear scheme, the most valuable uncertainty to be tested at each stage can be chosen. If the customer's needs are unclear while the technical mechanism is in operation, the use interview instead of a new prototype can provide more information. This approach combines the cost of the experiment with the potential loss of the wrong decision. The proof-of-concept study of university-origin inventions has shown that conditions such as the intent and technical maturity of the research team are related in different ways to licensing, new ventures, and further research results; it cannot be said that a single proof-of-concept output is sufficient for all pathways (Battaglia et al., 2021).

Technical and commercial hypotheses must be written differently in the verification report. The new layer reduces heat is a technical claim; the load profile, ambient temperature, time, and comparison device are measured. If the manufacturer adopts this layer it is a behavioural claim that depends on the supply price, physical volume, change of assembly, reliability and purchase calendar. Each claim must have a predefined acceptance criterion, data owner, repeat date, and rejection condition, and archiving negative results prevents the same assumption from being costlily tested again by a different team.

The goal of early verification is not to eliminate all uncertainty; ideally it produces the minimum information needed for the next irreversible decision. How much technical explanation will be shared before consultation with a licensing partner; the reliability of the estimated order before mold investment; repair and

service obligations before market entry require a different threshold of information. The identification of these thresholds at the beginning of a project reduces the tendency to change the measure of success once results are seen. Studies that together examine transitions between technology, product and market indicate that activities are running in a backward and overlapping structure (Haessler et al., 2023; Sanasi, 2023).

When the technical team replaces the material tested, the commercial team describes the cost and performance of the old sample, the basis of the investment decision becomes uncertain. The description of the material for each version, the method of application, the test protocol, the production estimate, the history of the patent investigation and the explanation presented to the customer must be matched with the same identity, so that the characteristic that the market rejects and the characteristic that engineering improves are actually related to the same product version. Version management is not a bureaucratic supplement, it is a research infrastructure that makes claims traceable.

Some technical risks interact unexpectedly: increased heat dissipation success may increase the thickness or weight of the device; a lower temperature should be considered along with a possible change in battery performance. Therefore, the experiment not only tracks the primary purpose variable, but also the secondary constraints. The contradiction established with TRIZ in the second part does not seem to have disappeared during commercialization. A design change made for the work of a product can affect both the cost structure and the request assessment in the third section.

4.4 Selecting a Technology Transfer Pathway

Internal development, licensing to an outside organization, new venture, co-production, and open use are different options for transferring technology into practice. The company's sales channel, ability to invest in production, responsibility for quality, ability to provide technical support to the customer, and ability to develop technology within a given period of time should be compared. Licensing may provide the existing manufacturer with access to broad distribution possibilities; in return, control over product design and use may be limited; the new venture may provide more decision-making autonomy; however, it requires the team to build production, sales, finance, and service capabilities together. Joint development, allowing for expertise and cost sharing, requires detailed agreement on knowledge, ownership of outcomes and decision-making. The principal technology-transfer pathways are compared in Table 4.1 in terms of the capabilities required, early validation questions, and typical decision risks.

Table 4.1 Methods of transferring technology to an application

Transfer pathway	Main capability required	Early validation question	Typical decision risk
In house product development	Production, distribution, and service	Can the existing system support the solution?	Fixed investment and loss of focus
Licensing	Clear rights and technical transfer	Can the licensee carry out further development?	Incomplete implementation and loss of control
New venture	Multidisciplinary team and financing	Can the team scale implementation?	Gaps in capital and management
Joint development	Division of tasks and knowledge sharing	Are the parties' objectives aligned?	Dispute over ownership of results
Open use	Maintenance and governance arrangements	Who will sustain use?	Unsupported diffusion or conflict over rights

Table 4.1 presents transfer formats as a summary of decision questions rather than a definite success ranking. Open use is also not an invaluable option because it is free; sharing of compatible components, standards, or software interfaces can create demand for complementary products. However, the licensing conditions of the sharing, the rights of third parties and the responsibility for sustainable maintenance should also be taken into account. The study on the role of university technology transfer units discusses these units not only as instruments for document preparation, but as actors with the functions of finding partners and transferring information between institutions (Chen et al., 2025). However, no intermediary can make a weak technical or market proposal strong by contract.

The prioritization of a transmission route can be initiated by conversations that can be reversed. Talking about technical conditions with several potential manufacturers does not require long-term exclusion of a single company. At the same time, the presence of founding team candidates does not necessarily require the immediate establishment of a technology-based company. The evaluation records together the minimum investment required for each alternative, the initial implementation time, decision control, expected usage impact, and the cost of leaving the option. Rather than a single "good road" announcement, it can be a conditional decision about which road to take, whichever threshold is provided. Davey and colleagues (2025), who covered the formation of academic ventures with research data from 33 European countries, show the role of an attitude of

cooperation with industry and an institutional culture; it cannot be assumed that such a relationship produces the same result in every context.

Capacity matching in an export decision is not measured only by the size of the enterprise. A large manufacturer's sales channel may be widespread, but it may not prioritize adapting new material to multiple device architectures. A small venture may focus on a technical problem, which may result in difficulties in establishing a quality laboratory, a guarantee reserve, or an international sales network. It is also possible to track different paths in different markets for the same technology, but if the scope of the different licenses conflicts, the expected flexibility is lost.

Differences of opinion should be recorded in the decision-making body that selects the method of transfer. The patent expert can highlight the legal risk, the customer access of the sales unit, the technical possibility of the researcher, the cash burden of the financial unit. The task of management is not just to collect points, but to determine which data will change the decision by making critical assumptions visible. For example, the buyer's claim for exclusivity requires previous interviews with alternative partners and new information about existing capacity.

4.5 Contract Economics in Licensing and Collaboration

In a licensing interview, there is patent information, which does not determine exactly what the opposing party will receive. The scope of the patent family, the technical knowledge, the software and the experimental record, the country and field of application in which the right of use is granted, whether the patent is exclusive and how the development obligations will be monitored should be explained. Since the technical solution requires additional engineering for commercial use at an early stage, the fixed input cost, pay per use, phase payment, and minimum operational obligation creates a different risk sharing. The structure of the price is related to when and by whom the product will be developed; assuming an excess licence share based on high future earnings may weaken the practice. Doran and his colleagues' analysis (2025), which focuses on early technology contracts, notes that under some circumstances, postgraduate earnings may be a barrier to transfer.

Exclusivity should also not be given as a one-sentence privilege. Exclusivity, limited by field, geography, time, and performance objectives, can reduce the risk of technology being kept completely unused while maintaining the investment incentive of the licensing area. In the absence of the relevant capabilities and resources, the extensive exclusivity also prevents the invention from being evaluated by others. It can be linked to verifiable milestones such as development plan, prototype integration, serial production preparation, and initial market launch.

This regulation is a decision-making architecture rather than legal advice for the parties; the applicability of the actual contract requires expert examination according to the country, rights and conditions of non-compliance. WIPO explains that corporate resources related to technology transfer, licensing, research collaboration and entrepreneurial pathways carry different ownership and incentive issues (World Intellectual Property Organization [WIPO], p.

The nature of technical assistance is as important as the sharing of income. A patent document describes a protected invention; the process window required for serial production, the reasons for failed experiments, or the integration skill may not be contained in the document. This information must be transmitted within an appropriate confidentiality and collaborative framework. The file submitted to the licensed entity contains material characteristics, tolerances, test methods, and change records, and the third-party software, data, and patents used must be clearly stated as they may also remain out of date. The date on which a prototype is shown differs from the date on which it becomes commercially available; the contractual obligations must reflect this difference.

4.6 Business Models and Economic Feasibility

The business model is not the assumption that the right to technology will automatically turn into a cash flow. The function presented to the target user, the customer access channel, the delivery format, the frequency of payment, the service obligation, and the partners performing the work are defined together. The same technology can be sold as a hardware component, licensed in an integrated solution, or supported by design and testing services. While the production and warranty costs are decisive in the one-off component sale, the licensing model emphasizes the speed of implementation and contract scope; the service model emphasizes expert hours and the after-use support network. Industry (2023) discusses entrepreneurial experiments separately in the context of business model validation, scaling, and reorientation; it does not equate early customer satisfaction with a sustainable business model.

In unit economic analysis, the unit of measurement must first be fixed. In the contribution per product account there is a difference between the selling price and the variable production, logistics, warranty costs and sales channel costs. In a simple conditional example, the unit contribution $m = p - v$, the fixed period line F and the unit sales amount q are written as the activity contribution $qm - F$; the prime amount is F/m only when m is positive and assumptions apply. This algebraic expression does not give a decision result: if the price decline, waste, low capacity use, term and rate of return are changed, the result also changes.

The cost approach is based on past or reproductive costs, the market approach is based on comparable transactions, and the income approach is based on possible future economic benefits. Comparable licensing transactions at an early stage may be few and incomes may be uncertain, in which case a single monetary real value is not suggested. WIPO's Early Stage Intellectual Property Assessment Guide (2024b) recommends that the approach used be reported along with data and assumptions constraints. Assessment is a decision support tool; it is not evidence that the offered price will be accepted by any buyer.

In assessing the business model, the opportunity cost of options must also be taken into account. Developing a product within an organization links capital, engineering time, and sales capacity; the same resources can be used in another product family. The license can reduce the flow of data directly from the market for future improvement while offering a faster dissemination opportunity. The new initiative can lead to the early founding team spending excessive time seeking funding while creating the opportunity to adapt to multiple markets. The analytical power of comparison depends on using the same units, the same time horizon, and the same uncertainty ranges in each scenario.

Even if the customer agrees that the total cost of the new feature will be reduced, he must allocate additional resources for device redesign, certification, supplier approval and warranty risks. If price negotiations leave out these complementary spending, positive feedback may not turn into sales. Particularly if the technical benefit of a product appears to the final consumer and the purchasing burden to the manufacturer, value sharing should be reconsidered. The licence or part price shall be negotiated with the development cost to be borne by the manufacturer.

The learning curve is also used with caution in sales volume scenarios. As production increases, labor and poverty may fall, but the price of materials, the cost of special equipment, or the cost of recall may also increase. The management evaluating the scenarios should see which input comes from the direct supplier offer, which comes from the pilot party, which comes from the assumption. This makes cash demand more visible in the short product lifecycle.

4.7 Transition to Production and Scaling

Market verification answers the question of finding the buyer, while production scaling answers the question of reproducing the same result. The prototype may have been carefully crafted by a small number of specialists; serial production involves wider tolerances, different supply batches, and operator conditions. Which critical characteristic of the design is sensitive to process variability should be studied in conjunction with component and assembly error forms. For example, the

effect of a heat coating in the laboratory, small changes in material thickness, or mechanical pressure in the body of the device may vary in the production line. Therefore, there must be an independent verification program between worked in the laboratory and produced in the field of the same quality.

Parts list in production preparation, design change records, acceptance criteria, alternative suppliers, traceability and process adequacy are interrelated. The waste rate obtained in the first pilot batch may not be equal to the waste rate of the future automatic line, but the classification of fault causes determines the checkpoints of the new line. Early investment in overcapacity equipment can create cash pressures when demand is uncertain; otherwise, insufficient line orders may not be met. Schäfer and colleagues (2024) exemplify the assessment of capacity and different ways of scaling for the production system by a separate event analogy. This method can narrow the decision area; it does not guarantee the accuracy of the model inputs and future demand.

The corporate side of scaling is the growth of the distribution and support system. Intensive engineering support given to the first customer may not be offered at the same cost to every new customer. Returns, warranties and field failure processes must provide feedback to the design team; otherwise the increase in sales will also exacerbate unmeasured reliability issues. In a comparative study of four technology-based initiatives, Industry and Friends (2023) shows that new experiments are underway on customer segmentation, distribution channel, and relationship management after market verification, so the first customer or first sale does not indicate that the uncertainty regarding scaling is over.

The first appropriate indicator for the production manager is not just the total production. The first time the appropriate product ratio, delivery time distribution, field error ratio, performance according to use conditions, reprocessing cost and supply interruption time must be monitored together. It should be clear on whose account the error cost is seen: the high performance of the component vendor can hide the customer's losses on the assembly line.

As manufacturing processes progress, the cost of engineering changes may increase. A change in connection detail in the first drawing may be less expensive; once the mold is completed, the same change may require re-testing, stock separation, and customer approval. Therefore, the decision to freeze the design should not only consist of the technical team's announcement of the latest version. Supply, quality and customer approval requirements are tied to the same date. The appropriate decision shall be made by distinguishing which characteristics are deemed to be unchanging and for which characteristics the control trial takes place.

If the scaling analogy is applied, the result is sensitive to the probability distributions selected for demand and processing times. Early investment of new

automation in a scenario can increase the fixed expense burden on low demand while reducing unit cost. The same model must also compare alternatives, such as the shift arrangement or the use of external resources. The visual clarity of the simulation does not eliminate unmodelled supply cuts or a rare security incident.

Capacity gains are not limited to purchasing equipment. Test infrastructure, quality personnel, spare parts, and after-sales support must also adapt to the increase in demand. If critical component acceptance tests are not performed at the same speed while the final assembly line accelerates, stock increases or control steps are skipped. This is why the dashboard is searched not only at the station with the longest processing time, but also in the process of technical approval and customer feedback. Especially in products with rapid model renewal, the recovery time of the capacity investment is assessed along with the model's remaining on the market.

4.8 Financing and the Timing of Decisions

Research, prototype, pilot line and market entry do not require the same form of financing. Early research grants may reduce technical uncertainty; customization for the client may be financed by a joint development contract; pilot production equipment may require borrowing or self-investment. The choice of financing should be compared not only in terms of the amount, but also in terms of the repayment schedule, the impact on ownership and decision-making, the limits of use and the time it takes to generate income. The European Innovation Council's 2026 impact report shows different capital sources and follow-up investments for the scale-up of deep tech companies; program data does not mean that all enterprises can access the same funding (European Innovation Council, 2026).

In a phased investment approach, a large-scale decision is made after a small trial. The pilot party allows the design and process to be tested together; the client agreement can make some of the expected demand more reliable. However, every waiting option is not invaluable. If the product has a short life cycle, the delay may narrow the competition window; the price of the material or the time of supply may vary. The decision file must show the expected learning for each investment language, the avoidable loss, the opportunity cost of delay, and the condition that the project can be stopped. The closing of a funding round is not a measure of technical or social success; it is an investor's decision to take risks under certain conditions.

Cash planning is especially important in fast-growing orders. When revenue is accounted for, cash may not have been collected; payments for materials and personnel occur earlier. In different growth scenarios, gross margin, the need for venture capital and the funding gap must be calculated together, and should not be

easily concealed under the assumption that the loss of menstrual growth could increase in a product where the unit contribution is not positive, and that fixed expenses would decrease. In this analysis, the price, the quantity of production and the figures used for collection must be clearly indicated in the representative or actual file.

Public support may change the decision horizon, but the needs of the product may not be the same as the objectives of the program. A support call may not cover marketing, stock and service expenses while it is conducive to research output or technical demonstration. The current OECD assessment on Turkey highlights the importance of more interactive and long-term forms of cooperation for university-industrial knowledge transfer (Organisation for Economic Co-operation and Development [OECD], 2025). This determination should not be translated into the conclusion that a specific incentive or incentive is appropriate for each project.

When seeking financing, the level of evidence of the shared presentation should be the same as the level of evidence of the in-house decision file. These statements not only create an ethical problem, but also misdirect the planned cash and investment sequence. The document suitable for the early investor shows uncertainty as to technical progress, the budget needed for the next turning point, and what oversight the budget will generate. When capital is provided, the success assumption is re-measured; changing conditions can change the target market and transfer mode if necessary.

4.9 Institutional Collaboration and Complementary Capabilities

Commercialization often requires a broader skill set than a person's technical competence. The researcher can prepare experimental design and technical explanation; the production engineer assesses process repeatability, the sales manager assesses the buyer's decision, the financial expert assesses cash horizon, the intellectual property expert assesses contract and chain of rights. The specification of functions does not mean that the entire responsibility is transferred to one unit. The researcher who knows the technical data must be in a licensing interview, and the commercial team must be able to translate customer feedback into a design contract. Denoo and colleagues (2024), who study consultants in science-based ventures, show that the roles of business and technology consultants can be different; they do not replace an external expert team with a permanent management capacity.

The university's ownership of rights, the publishing goal of the researcher, and the role of the founder in a possible initiative may conflict with each other. WIPO's Guide to incentives (2024a) emphasizes that the motivations of researchers and technology transfer workers can be different and the importance of non-financial

incentives. However, copying the distribution rate from one institution to another may not be appropriate due to contractual and legislative differences. The basic principle is to co-manage the production of public information and the task of commercialization with recognition of the contribution of the research team.

A successful pilot study in a private sector partnership must be clear about who will make the next investment decision. The joint venture can provide a test environment and modify technical requirements, recording the results of the research and what these changes mean in the scope of the right. Even well-intentioned collaboration may be delayed if the frequency of interviews, the level of data sharing, the conditions for stopping the test, and the reporting of negative results are not determined. Belitski and Sikorski (2024), who study entrepreneurship in a university context, associate the creation, validation, financing, and scaling of ideas with the corporate ecosystem.

Supplier relationships are also a part of technology transfer, and if critical material is sourced from a single source, performance knowledge and quality control capabilities are concentrated at a single point, as is cost risk. The existence of the alternative supplier must be indicated not at the catalogue level, but at the tested material and approved process level. Signing a large number of cooperation protocols without answering these questions does not measure actual transmission capacity.

Corporate capacity is not just the sum of experts, a team needs to collect test results every month, turn a customer's technical complaint into a design change, and recalculate the cost of that change. If the meeting calendar, common file structure, and decision-making authority do not support such a feedback loop, information transfer between experts is disrupted. The success of cooperation should be measured by how early inconsistent findings enter the decision-making mechanism, rather than the meeting rate.

It is important for academic partnerships to discuss the calendar between the publication of the findings and the prior protection and confidentiality of the business partner. The solution should not be pushed to extremes such as indefinite retention of research results or immediate unlimited disclosure of all data. A reasonable review period for the publication, the necessary application steps and which data set will be publicly shared are negotiated in advance, taking into account the student's thesis requirement and the contributions of partners to data production. Corporate policy, which does not reduce the transfer of information to a single patent license, can together strengthen the integrity of research and the predictability of partnership.

4.10 Responsible Product Development and Life Cycle Impacts

If the commercialization decision is limited only to the cost and technical performance prior to the initial sale, the use and post-use effects of the product remain outside the design. Durability, reparability, energy consumption, material consumption, data security, and accessibility can carry different weight in different user groups for the same product. An improvement, such as a new layer that reduces temperature, can shorten the service life if it makes the device easier to disassemble. Therefore, technical advantage should not be used as an optimization goal alone, which eliminates other requirements. The United Nations Environment Programme's 2024 resource report combines the environmental consequences of material flows and consumption patterns; the overall impact of a company-level solution can only be tested with its own lifecycle data (United Nations Environment Programme, 2024).

In the example of a smartphone, the extraction of the material required for heat management, the production of the component, the energy consumption of the phone, the maintenance capability and the lifetime separation can be examined together. In this review, the functional unit should be clear: a single device produces different comparisons of specific service life or equivalent service performance. A solution that extends the life of the device may reduce total material use; however, this result depends on the assumption that all devices are actually used longer. The 2026 Communication of the Joint Research Centre of the European Commission stresses the importance of reliability and durability for electronic products in product design (European Commission, Joint Research Centre [JRC], 2026). This information should not be interpreted as the automatic application of European rules to a design example; the current obligations of the target market are controlled in the product specific.

Safety and conformity requirements should affect market decision from the outset. Testing by the product component supplier is not the same as the ultimate device manufacturer's obligations to the system. The standard of evidence may also change as the industry in which the technology is used changes. A 2024 study on the development of medical technology suggests that regulatory, clinical, production and quality requirements should be addressed together with market strategy (Kruachottikul et al., 2024). This result does not imply that medical device methods apply to telephone components; it indicates that the sectoral obligation in technology transfer is a decision entry that changes the business model.

When measuring societal benefits, it should not be based solely on the announcement of entry into the market, but also on availability, the service network, security events and the actual impact of the product on different user groups. The right to protection may be one of the incentives for the investment

needed for wider dissemination; the outcome varies if the licensing area delays implementation or excludes specific uses. WIPO's 2026 Technology Dissemination Report shows that the dissemination of innovations does not occur spontaneously and equally, so the distinction established between the invention that can be preserved throughout the book and the innovation that is widely used should also be preserved in the assessment of commercialization success (WIPO, 2026).

Environmental assessments are also part of commercial statements, and just because the product works colder, it is not automatically going to consume less electricity or have a lower carbon footprint. Actual energy consumption may increase if the design allows for different processing power use; the production load of the additional material may exceed the utility gain. For a defensible claim, the comparative devices, use scenario, lifetime assumption, system limit and data source must be written open. An environmental statement that selectively focuses on positive conditions prevents the decision maker from seeing real commitment. The lifecycle view also opens up the debate about repair and end-of-life separation as well as technical performance in product strategy.

4.11 Illustrative Application Smartphone Thermal Management Solution

The heat management example discussed in the previous sections is not a real corporate case where the data is claimed to have been obtained. In the second section, the problem was expressed as the need to reduce the thickness of the device body, battery consumption, and user touch comfort when the surface temperature increases at high processing load. Multiple solution alternatives were conceptualized with TRIZ tools and directed to engineering testing. In the third section, similar technical explanations were examined to establish separate questions for past knowledge, possible scope of rights and freedom of action. Here, a new assumption is added to this: whether the experimental heat dissipation layer has been selected, and since no digital market size, patent scope, temperature drop, or return on investment have been fabricated, the following decisions are just an example of the method.

The first decision is which buyer benefits from the product change. The component manufacturer can buy an intermediate product; the phone brand can make the design decision; and the end user feels the temperature and battery life. These three stakeholders are not expected to give the same value to the same technical feature. The research team, in consultation with manufacturers, records integrated constraints such as which product classes of existing heat distribution solutions are inadequate, how early in the design cycle the new material is selected, body thickness and antenna performance. The product demo measures not only the

maximum temperature, but also the long-term performance, different ambient temperatures, repeatability, and battery consumption.

The second decision is the method of production. Is it possible to cover the layer by a sample method in serial production; how much material variability affects performance; does it increase the processing time of the phone on the assembly line? The first pilot batch measures material waste, adhesive errors, recyclability, and part-head variable shear along with technical performance. When the solution is improved, patent research is also reviewed; assuming it is not the same as the previously studied technical regulation. Keeping the release dates in the test and search files together keeps the link between the changing design of the product and the validation.

The third decision is the method of transmission. If the team does not have production and sales capacity, a licensing interview can be held with the existing component manufacturer for a limited application area. If the first partner only wants to purchase a prototype, there is no need to grant an indefinite exclusion for all future uses. The decision records the development capacity of the licensing area, the expected verification calendar, the number of alternative partners, and the share limit of technical knowledge. Table 4.2 shows the data with which different claims can be tested in the example; table rows are not a realised finding.

Table 4.2 Claims for decisions in heat management solutions

Decision claim	Evidence required	Risk of a false positive conclusion
The layer lowers temperature	Repeated comparative measurements under the same conditions	Generalizing from one prototype
Production is repeatable	Conformity across batches and process conditions	Overlooking manual work by the pilot team
The manufacturer seeks adaptation	Specific discussions with design and procurement decision makers	Treating user preference as a purchasing decision
Rights permit the intended use	Current expert review by jurisdiction and claim	Treating an old patent search as definitive clearance
The solution creates economic value	Cost, volume, and payment scenarios	Treating technical success as a revenue forecast

At the decision meeting, the status of each row in this table is not limited to the binary proven or failed. The measurement may be positive under well-defined temperature conditions and not result in a high humidity environment. When the boundaries of such findings are kept open, the licensing interview becomes more convincing: the technical gain is not exaggerated, it is specified what uncertainty

the joint investment will alleviate. End user benefit is assessed by the experience measured throughout the phone; the material sample is not kept on par with the laboratory success.

4.12 Performance Monitoring and Chapter Conclusion

In the commercialisation report, activity, breakdown, usage and impact indicators must be separated. The number of interviews represents the activity; the working prototype breakdown; the adoption of the product being purchased and used; the verified change in reliability, cost or comfort. Sales figures alone are not proof of user advantage either: marketing, distribution power, and price impact can change sales volume. The third section, which discusses that the number of patents and the number of licenses are limited indicators, requires the same interpretation discipline for the production number and the circulation.

At each stage, the decision record must answer five questions: What claims were tested, what methods and data were used, under what circumstances were the findings applicable, what uncertainty remained, and what was the next source decision? Keeping successful and failed experiments together reduces selective memory in subsequent assessments. ISO 56001:2024 provides an institutional framework for the management of innovation along with its objectives, responsibilities, evaluation and improvement; the existence of the standard is not a guarantee of the success of a single product (International Organization for Standardization [ISO], 2024). The framework should be used for the traceability of those responsible and the decisions, not to assert the non-measured value in the language of the certificate.

The main conclusion of this section is that commercialization is not the activity of a single threshold or a single entity. For a technical solution to be put to real use, consistent decisions must be made between customer problem, product integration, production repeatability, rights, contracts, financing and after-use effect. The application dimension of the innovation described in the first section is embodied at this stage; the technical alternatives in the second section are retested under actual conditions of use; the patent and protection decisions in the third section are replaced only as an input of transmission. A well-designed process does not guarantee success; instead, it makes it possible to explain what claims are supported by what evidence, what investments will reduce uncertainty, and under what conditions a different path will be taken.

CHAPTER 5 GENERAL ASSESSMENT AND CONCLUSION

This book has advanced an account of innovation that is not confined to the emergence of a new idea or the acquisition of a patent right. Defining the problem, using technical knowledge, developing a solution, examining its relationship to prior art, managing rights, and generating value in use are interconnected activities. Each nevertheless raises different questions and requires different evidence. This is the book's central conclusion. A creative proposal does not automatically become a functioning product; a functioning product does not automatically become a protectable invention; and a protectable invention does not automatically become a successful innovation. Repeated inquiry and decision making connect these stages. Innovation outcomes should therefore be assessed through the relationships that produce technical and social effects, rather than inferred from a single application, prototype, sale, or investment indicator.

The theoretical discussion of the first chapter revealed that innovation depends as much on learning as individual creativity, on the ability to apply and on the flow of knowledge between different actors. Within this framework, scientific knowledge, user experience, manufacturing skills and organizational regulation do not interchange; they perform different functions in the development of the solution. However, it cannot be assumed that the first problem definition remains constant throughout the process. Experiments and user feedback may indicate that a feature that was initially considered important has limited value or that a limitation that was ignored is determinative. So the systematic approach relies more on explaining why assumptions are reinstated than on keeping track of pre-defined steps.

In the second part, this view was transferred to the solution of the engineering problem. TRIZ tools can help develop alternatives by making conflicting objectives visible; while generative AI can increase the speed of research into information processing and possible solutions. However, generating an idea by a vehicle does not imply that the proposed mechanism is physically working. Function, conditions, comparison parameters, and acceptance thresholds must be predetermined to test the solution. While speed is particularly important in short product life cycles, when the basis for rapid decision-making remains unclear, the development process transfers technical debt to subsequent stages. Well-documented failed experiments are not worthless, either: which option shows under what circumstances it does not work and where the new work should start.

In the third section, patent information is assessed both as a source of information enabling the investigation of published technical statements and as a legal system capable of providing legal protection under certain circumstances. Just

as the existence of similar documents does not mean that a solution cannot be implemented automatically, the absence of documentation in the search does not prove the Freedom To Operate of the product. When the history of the research, the countries covered and the search method used are kept open, the patent data contributes to design decisions, while the protection decision does not depend solely on the level of technical innovation; it depends on conditions such as explanation, simulation, collaboration, cost, and duration of use.

The fourth section examines the impact of these decisions in the context of use and market: laboratory success of a technology does not replace evidence of customer demand, reproducibility of production and economic sustainability. Licensing, co-development, intra-agency product development and new venture pathways create different resource and control patterns for the same technical solution. Evaluation does not end when the product goes on the market: field performance, repair, cost, access and environmental impact must be monitored. Just as the emergence of commercial revenue does not demonstrate real user benefit alone, a strong user benefit does not guarantee that the developer has a revenue and organizational model that can sustain it.

When the chapters are read together, a more complex structure emerges from a linear idea to a market scheme. A new technical document found in a patent examination may change the product design; the variability seen in the production trial may limit the initial technical superiority; the customer's actual use form may reprint the first list of requirements. These feedback should not be viewed as a process failure, the important thing is that it can be traced back to what data the previous decision was based on and why it was changed by the new data. When technical research, copyright management, and market learning are conducted without each other's knowledge, conflicting claims about different versions of the same product can arise.

The example of hot management on a smartphone used throughout the book is a representative application designed to make these relationships visible. The example does not show the empirical success of a particular company, patent or prototype. Even if successful heat dissipation is assumed, user comfort, battery performance, body thickness, manufacturing tolerance, coverage and possible repair failure must also be examined. For example, the value of the method lies not in the fact that the numbers that are not actually obtained appear to be accurate, but in the fact that it explains what kind of data is needed for which questions. When the conceptual framework in the book is applied to a real project, the measurement protocol, patent and patent examination, customer research, and economic analysis must be reconstructed with data specific to that project.

The research team must be able to explain the technical assumptions and experimental boundaries, the scope and timeliness of the document, the product team the user and production conditions, and the management what evidence the investment is based on. When artificial intelligence systems are used in research and design, the source of the suggestion produced, the technical validity, and the extent of the shared knowledge are also monitored. Involving human expertise in the process does not only mean approving the final outcome; it also involves understanding where the wrong assumption was generated and re-establishing the experiment or search.

Similarly, extending protection does not increase benefits in all cases. Protection of the invention may allow for development investment; however, widespread use may not occur in the absence of an application partner, high integration costs, or limited user needs. Institutions must evaluate together with the purpose of researching which information will be properly protected, which will be shared in collaboration, and which outcomes will be disclosed to the public. This view only takes patent strategy out of the application calendar and relates it to the learning, application and impact dimensions of innovation.

The limitations of this study are that while the sections provide a systematic way of evaluating, they do not prove the superiority of a new product in a particular industry or the overall success of any commercialization model. Patent indicators are as informative as the data they use for AI-enabled proposals and market forecasts. It will be useful in future research to monitor the same framework across different sectors; to compare decision records from technical testing to market entry; to evaluate licensing and in-house development pathways with long-term use results. Such study should include not only successfully completed projects, but also abandoned options, delays, and negative outcomes.

The relationship between patents and innovation cannot be expressed as a simple claim that more patents necessarily produce more innovation. A patent may serve as a document for examining prior knowledge, a right protected within a defined scope, and an asset in partnership negotiations. Innovation, in turn, requires the implementation and adoption of a solution and the assessment of its benefits. A sound strategy connects these two domains while recognizing their distinct functions. Patent information becomes a valuable decision resource for organizations that define problems clearly, test alternatives on reasoned grounds, assess rights using current information, and measure outcomes in use. The purpose of the approach developed in this book is to show what evidence supports the path to innovation and which questions remain open, rather than to prescribe a guaranteed formula for success.

Statement on the Use of Generative AI

In preparing this book, the authors used OpenAI as an assistive tool for the English translation of the original Turkish manuscript, language editing, consistency checking, and document formatting. The authors reviewed and revised the resulting text and take full responsibility for the accuracy, interpretation, and final content of the book.

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