Bacheloropdracht TBK

Technology-based Appropriation for Starting Entrepreneurs.

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Dutch summary.

Ondernemers staan voor tal van beslissingen, waarvan een aantal belangrijke zich snel na oprichting voordoen. Een van deze beslissingen is hoe zij hun technologieën gaan beschermen. Hoe zorgen wij er voor dat wij anderen kunnen laten betalen voor het gebruik van onze technologie als wij dat willen en als wij dat niet willen, hoe gaan we dat tegen? In het Engels heten deze praktijken *appropriation*, maar in het Nederlands hebben we er geen term voor. Hoewel toe-eigening en inbezitneming letterlijke vertalingen zijn, dekt dit niet de lading aangezien het impliceert dat je iets neemt wat niet van jou is, terwijl je juist uitbaat wat wel van jou is.

In dit onderzoek worden technologieën van elkaar onderscheiden op basis van karakteristieken van hun innovatie en op basis daarvan wordt gekeken welke technieken van *appropriation* het beste daarbij passen. Hoewel er geen normatieve uitspraken worden gedaan, levert dit onderzoek tal van redenen en motieven wanneer welke mechanismes op hun plaats zijn en kan zo waardevol zijn voor elke ondernemer.

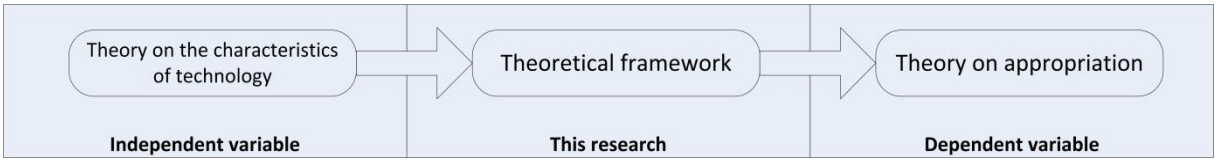
1. Appropriating your technology

When starting your own company, a lot of issues regarding strategy, both long- and short-term, come along at a rapid pace. Because starting entrepreneurs have to make a lot of decisions on a short-term base and these decisions have to be first-time-right, the decision-making-process becomes a point of interest. Important questions are for instance: “what kind of information or processes do entrepreneurs take into account?” and “how does this information influence their decisions?” How businesses protect the fruits of their own research is a big issue nowadays. This can be illustrated by the patent wars between Apple and Samsung or the big secret behind Coca-Cola’s recipe after all these years.

This last example has been around for over a century. Robert W. Woodruff started the strategy of keeping Coca-Cola’s recipe a trade secret and since the 1920s, there have only been a few executives that completely knew the recipe. Since then, umpteen companies have tried to find and copy the recipe, but no one has discovered it yet. If Coca-Cola can pull this off, why are several other drinks successfully copied over the years? Choosing the right way of protecting your intellectual assets is important and can make or break your business, even after a hundred years.

This research aims to use several distinguishing factors between different technologies throughout different industries and scales to define the applicability of several ways to exploit and protect intellectual assets. This practice is called appropriation. Which methods of appropriation are applicable for different technologies and which characteristics determine which ones should be used?

At first, different ways of appropriation, the dependent variable, that are available to entrepreneurs will be explored. Identifying these methods is key in this research, but extremely important in real life as well. At second, the characteristics on which the methods will be distinguished will be decided. Hereafter, a theoretical link between the characteristics and the methods will be deducted. In other words: the link between the independent variable, the characteristics of technology, and the dependent variable, the appropriation strategy, will be examined. Then, we will regard interviews with several entrepreneurs and try to reason with them, trying to extract and grade their motives and reasoning on their practices regarding appropriation Finally, interviews with several entrepreneurs will be regarded, their motives behind their choices will be extracted and graded, and their practices regarding appropriation will be explored. Throughout this research, other factors that contribute to the decision regarding a company’s appropriation strategy and the way risk influences this decision are discussed.



1.1 The research model and goal

This research is designed to complete the research goal: “*To give valuable recommendations to start-up-entrepreneurs regarding their appropriation strategy.”* Following the research design method of Verschuren and Doorewaard (2000), the research model looks like this:

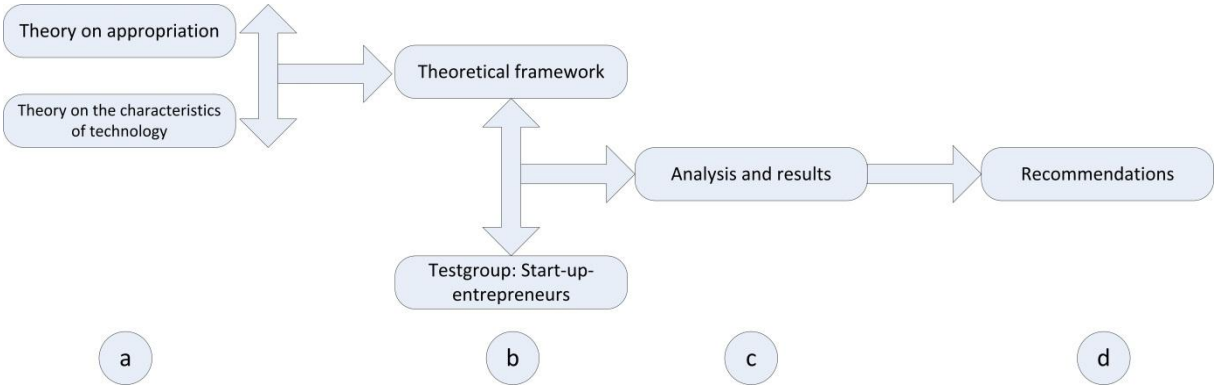


Figure 1: Research model

In the above figure, which uses the terms employed by Verschuren and Doorewaard, (a) is the literature study, (b) is the research perspective and the research object, (c) is the research analysis and (d) is the research goal. The research strategy is the case study, in which a small test group is analyzed intensively while not losing sight of the width of the research.

Parahprased, this research is a study of theories of appropriation and the characteristics of technology (a), which produces a theoretical framework for possible best-practices, to which the practices of several participating start-up-entrepreneurs are compared (b). The results (c) will be processed into recommendations for the appropriability strategy for start-up-entrepreneurs (d).

Each of the following chapters corresponds to a research step; Chapter 2 is the literature study (a), chapter 3 forms layer (b), chapter 5 are the analysis and results. Chapter 6, the conclusion, sums up the recommendations.

1.2 The research questions

Through this build-up (by employing the structure laid out above), we will find answers to the research question:

What are the effects of the nature of a technology on the appropriation strategy of start-up-entrepreneurs?

This question exists of several parts which raise questions of their own. Some of these questions are sub questions in this research, others will be explained here. The sub questions are also stated and numbered in appendix C. This research focuses on start-up-entrepreneurs, as is part of the research goal. Rising enterprises can still choose how they want to do business. This flexibility, together with the fact that starting entrepreneurs are in need of a guideline of best practices, justifies the emphasis on new enterprises in this research and thus in the main question.

The term “technology” can be perceived as a pretty vague term. What is technology and what is not? In this research, “technology” is the attribute in the end product that distinguishes it from all predecessors. New production mechanisms, parts, used materials, assemblies or whole inventions or products are examples of things that can be defined as a technology. The sub question *“What are important and distinctive features of technology?“* will be answered to define the independent variable, the characteristics of technology.

New technologies, which will give you a lead on your competition, should be defended against imitation and other competitors, from which you will lose your competitive edge. This raises the sub questions "*Which appropriation mechanisms exist?"* and "*What are distinctive characteristics of these mechanisms* ?" Together, these questions will define the dependent variable of this research: the appropriation strategy.

As stated earlier, the research perspective is that of a theoretical framework. This framework is the theoretical match between the independent and dependent variable. This is also the theoretical result of this research. The sub question "*How do, theoretically, the characteristics of the mechanisms and the features of the technology match*? "results in this framework.

To fulfill the research goal (giving recommendations to start-up entrepreneurs, as well as researching the applicability of the theoretical framework) real-life practices will be researched through case studies. These studies answer the sub question "*How do, in real-life, the characteristics of the mechanisms and the features of the technology match?* " Hereafter, the sub question "*What are the similarities and differences between the theory and real-life?*" can be answered. These similarities and differences can indicate improvements on current practices of the case study participants or on the theoretical framework, both of which are valuable for the research goal. This will be revealed by answering "*What are the recommendations for start-up-entrepreneurs on tailoring their appropriation strategy?*" The recommendations and the theoretical framework together form the answer to the main research question.

The sub questions will each be answered in different parts of this research report. The first ones, *"What are important and distinctive features of technology?"* , "*Which appropriation mechanisms exist?"* and "*What are distinctive characteristics of these mechanisms* ?" are all questions that will be answered in the literature study.

2. The literature study

A big part of this research is the identification and analysis of appropriation mechanisms, being the dependent variable. The literature study will provide the overview of mechanisms, as well as the characteristics of these mechanisms, on the basis of which the theoretical matching will be made. The characteristics of technological innovation will also be researched in this chapter as it forms the independent variable of this research.

2.1 Appropriation

Appropriation can best be described as the practice of capturing the profits generated by an innovation. **(Teece, 1986)** Over the years, it has been a popular subject of research.**(Arrow, 1962), (Harabi, 1994)**,**(Levin et al, 1988)** A company uses different mechanisms to ensure appropriation, and these mechanisms should be tailored in a way that has proven to be the best fit. The appropriation regime is described by Arrow as the extent to which the technology is protectable by market characteristics such as statutory provisions and geographical density of knowledge. This research does not consider market characteristics and the appropriation regime is therefore not taken into account. The combination of appropriation mechanisms a company uses is called the appropriation strategy.

Following the example of **Laukkanen and Puumelainen** (**2007**), this research distinguishes between two different aspects of the appropriability strategy; the institutional protection on one side and the practical and technical means on the other. Institutional protection covers the way in which the technology used is protected by intellectual property rights (IPRs). Practical and technical means are several mechanisms that can be used to enforce the company's market position and revenues, both current and future. The appropriability mechanisms Lead Time, Moving quickly down the Learning Curve and Sales and Service Efforts are associated with this**.** These mechanisms and their description are the answer to sub questions 1 and 2. Intellectual property rights are best known as ways to

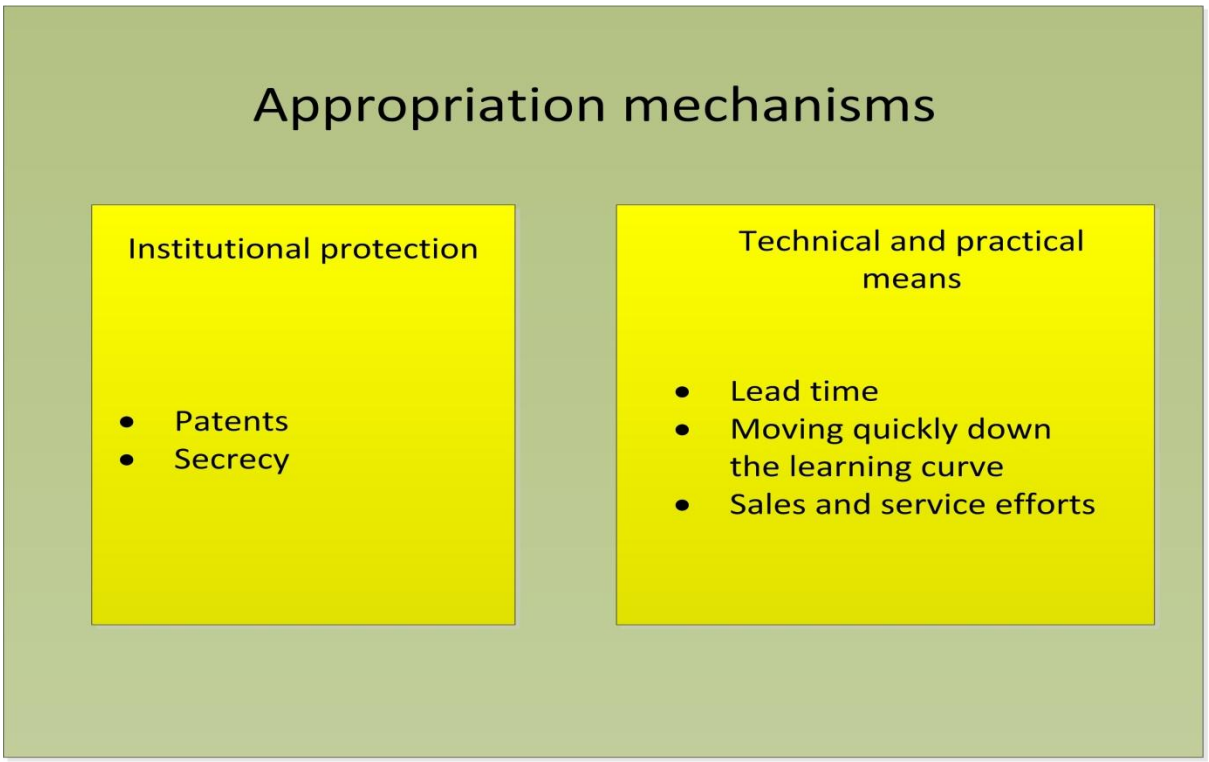


Figure 2: Appropriation Mechanisms

protect the fruits of a company's innovation, but research has shown that managers often value the practical and technical means above the institutional protection. **(Levin et al., 1988)**

2.1.1 Institutional protection

Starting with the institutional protection, we distinguish three possibilities. You can protect your technology with a patent, a trade secret or not at all. Not at all is not an appropriation mechanism and should be treated as a neutral way of coping with technology, free from all advantages and disadvantages of the mechanisms. Once a patent application is filed, the technology is out in the open and cannot be kept secret anymore. The reverse is also true: if you hold the technology secret, you cannot file for a patent. Sometimes, not excluding anyone from accessing your technology can be the best practice. One of these three possibilities must be chosen.

In case of software or other technologies that are protected by copyrights, you can treat them as being protected by a patent. Patents and copyrights are both exclusionary rights, meaning that they both enable you to exclude imitators by law or demand royalty payments. These technologies are in the open and accessible to everyone, so they cannot be protected by secrecy. This is logical, because they are protected by another way of institutional protection: a copyright as the substitution for the patent.

Patents

Though maybe the best known appropriability mechanism, patents are not always the most favorable. **(Levin et al., 1988)** While Levin et al. and Harabi split the patenting mechanism into patenting as a means for ensuring royalty payments and patents as a means for opposing imitation, this research does not. When it comes to institutional protection, one choice should be made: do nothing, apply for a patent or keep a trade secret. Both ways in which patenting can be used as an appropriation mechanism are covered by this one choice and as we are discussing the choices, we regard patenting as one possibility. If you have succeeded in acquiring a patent, you are going to look for royalty payments, such as licensees, and you are going to act against imitators. Both aspects have their own function in the appropriability literature, but they represent one choice.

Applying for a patent bring some practical advantages. Especially for small, unknown, new companies, having a patent can contribute to their bargaining position towards third parties. Starting up with a new technology that you keep secret will raise skepticism with your intended partner. As **Arundel (2001)** indicates, the time-to-market is longer for small companies than for the larger ones. This carries the threat of competitors profiting from their speed. Patents can help create the temporary exclusive position you need to launch your technology.

On the other side, patents do not provide a waterproof protection. As **Harabi (1994)** states, patents can be invented around, and require disclosure of, information. When applying for a patent, you have to reveal all details concerning your technology. Once this has happened, the competition can start to invent exceptions to the rule. One of the methods that can be used for this is TRIZ. **(Shulyak,1997)**

TRIZ is a method that is developed by Genrich Altshuller. He investigated thousands of worldwide patents in the leading engineering fields and analysed the solutions which were, according to him, the most effective. Through this investigation, a first understanding on patterns and trends in the evolution of technical systems was created. The investigation was the foundation of the analytical

tools that together form TRIZ. By analyzing existing patents, TRIZ can predict by several laws and patterns the evolution of technologies. Patenting can therefore negatively affect your market position not only by direct disclosure of information to your competitors, but also by technology-analytical tools like TRIZ.

Because many patents are very complex in nature, there is also a chance that the patent does not protect your technology due to misfiling. This way, the competitors may be able to find loopholes in your application. In these cases, applying for a patent can work in your competitor's favor. The high costs for both the patent application and defense in court are also disadvantages, especially for small companies. Additionally, it also take some time to file for a patent. Although this time is valuable, when the patent is filed right, it is far outweighed by the time you create for exploiting the patent. This is another reason why filing for a patent should be done first-time-right.

Secrecy

The second option for institutional protection is handling a trade secret. Keeping knowledge secret and making people involved sign contracts or agreements that they will not make it public is a great solution for some technologies. It does not cost lots of resources and you do not have to apply for it. **Arundel (2001)** states that small firms are less likely to find patents to be more valuable than secrecy than large firms, mainly because of the costs involved. For complex products, secrecy tends to be more applicable than patenting, as patenting is unlikely to exactly cover the entire product and secrecy favors from the complex, hard to understand product design.

However, secrecy can increase the product-to-market time. Because negotiations can be slowed down by secrecy and unclear product specifications, especially for engineered products, secrecy can be costly in terms of production time and money. This makes collaboration hard. It is often the reason small companies join larger players in the market, which also reduces entrepreneurial risk. It is clear that not all companies can successfully use secrecy as institutional protection, but how can we tell them apart?

2.1.2 Practical and technical means

While institutional protection is a way of protecting your aimed profits by law, the practical and technical means are mechanisms to enhance your revenues by positioning some of your practices the right way. The three best-known appropriability mechanisms that are considered in this research as practical and technical means are Lead Time, Moving quickly down the Learning Curve and Sales and Service Efforts. An important theory considering these means is that of **David j. Teece (1986).** In his research he mentions that when introducing a new product, a dominant design is searched. The product will not be perfect when first introduced, but it will be developed further, possibly by several firms, so it will better fit customer demand. Eventually, one of these newly developed designs will prove itself to be the market standard. This one is called the dominant design. If a company develops and introduces a new technology itself, it has an advantage over its competition. The practical and technical means help a firm expand the advantage into a better chance on becoming the dominant design.

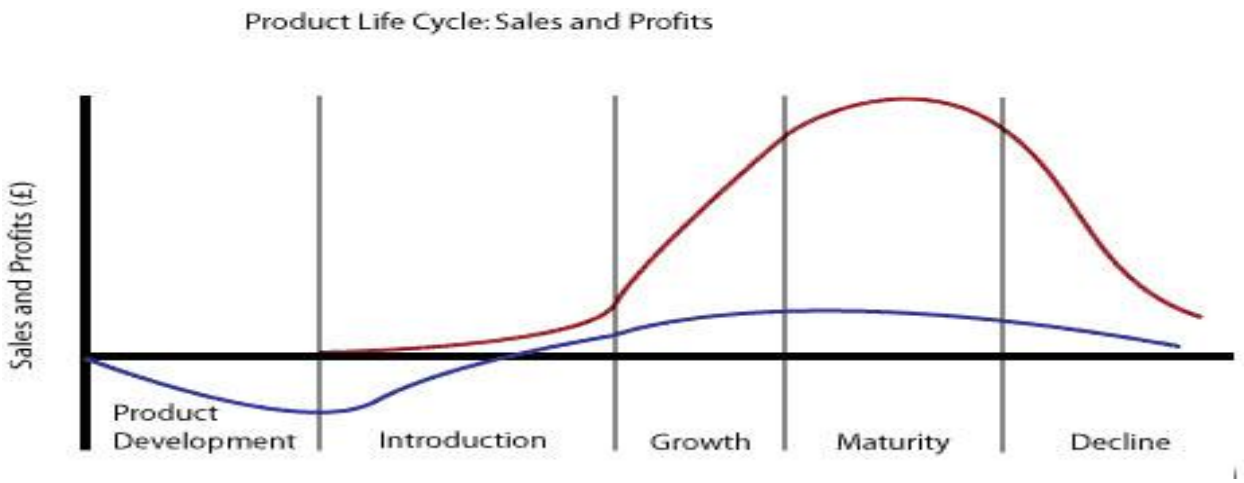


Figure 3: The Product Life Cycle

The dominant design is often a collaboration between important players in an existing market. Examples of standards that are created by collaborations between several hardware manufacturers are the VHS, DVD and Blu-ray. The DVD is for instance a composition between a format created by Toshiba and a source-code produced by Philips and Sony. However, this was after both groups tried to launch their own format, which created a struggle for power which cost lots of money. Likewise, mobile-phone producers Nokia, Ericsson, Panasonic, Samsung, Motorola and Psion tried to collaborate and launch their mobile operating system Symbian, but were less successful. Competing against existing operating systems like Apple iOS, Blackberry OS, Windows Mobile and Android, competition was tough and the producers of Symbian surrendered one by one.

The way towards a dominant design can also be illustrated with the product life cycle. Where sales rise at first, the growth stage, is where the dominant design is searched. Once this is found, the product starts to really generate revenues. We call this the maturity stage. This counts for the sum of all products that use the concerned technology. The dominant design takes the largest part of these revenues.

Lead Time

Lead time as an appropriability mechanism means getting your technology on the market as soon as possible. Patents and Secrecy had their own effect on the product-to-market time, which is the lead time. **Swink et al. (2006)** describe the trade-offs that a focus on lead time brings. Using more employees for a project does speed up the process, but it will reduce the marginal contributions of those employees. Overlapping activities in the project creates complexity, raising coordination costs and increasing product quality risk. **(Graves, 1989)** It is also proven that, because of the probabilistic nature of the development process activities, accelerating those activities contributes to the increase of costs. **Scherer (1966)**

As reducing your product-market-time can be costly, the right tradeoff should be searched. This is a dilemma every entrepreneur faces: speeding it up too much can cost too much money, but not speeding it up enough might just make you lose the dominant design. By acting quickly and keeping an advantage on your competition, yours can stay the dominant design. Research has shown that the market leader, independent from the duration of your leadership, generates extra profit, just by

being market leader.(**Flaherty, 1984)** The size of the company is an important factor in the capability of reducing lead time and as this research addresses start-ups we should not forget this factor in trying to realize a reduction of lead time. However, this research covers the possible applicability of the mechanism lead time, not the actual realization of this mechanism. Some other important factors will be discussed in chapter 2.3.

Moving quickly down the Learning Curve

The learning curve is a graphical representation of the marginal costs of a product. Where with a high production level people tend to think of economies of scale, the learning curve focuses on actual learning, such as labor learning. Doing something once may take long, but it will go faster the second time. With every iteration, the time spent on the next one decreases. While the relative benefits of producing one item more are big at the start of the curve, where accumulated volume is low, they will be smaller as the accumulated volume increases. **(Hartley, 1965)**

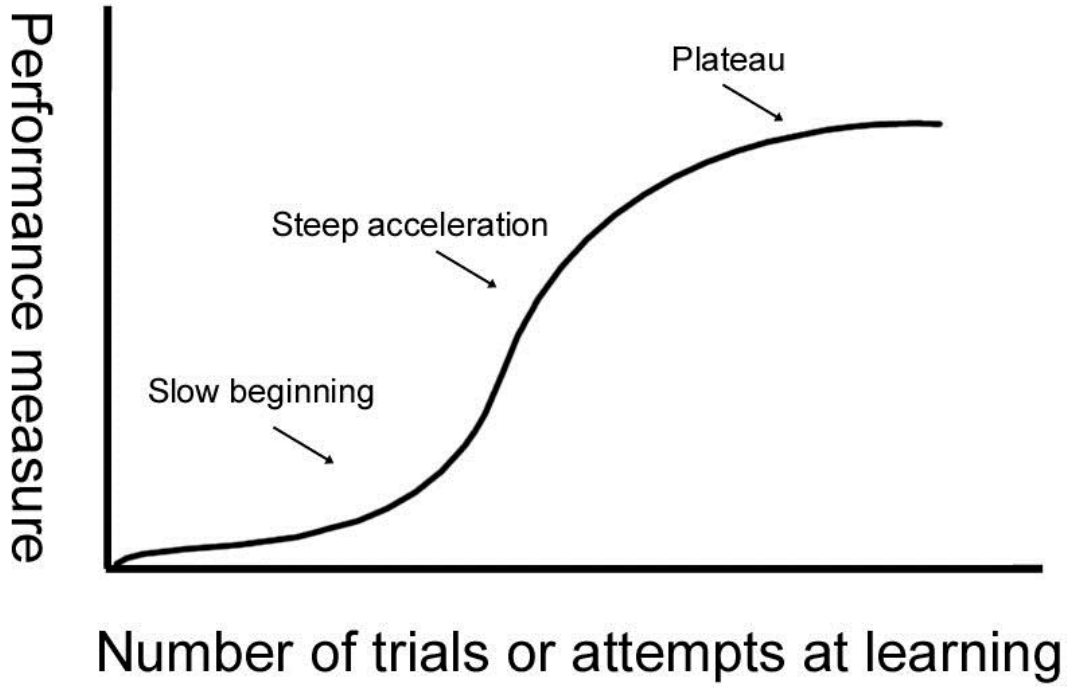


Figure 4: An example of a learning curve

The Moving quickly down the Learning Curve mechanism thus states that if you start with a large production, you will be able to rapidly decrease your break-even point, which enables you to lower your prices. However, the future sales volume should compensate for this rapid investment in production volume. Another advantage of this mechanism is that as you learn quickly, your product will improve. Engineering mistakes are quickly noticed and because you have so many products on the market, although initially at lower profit margins, your product will have a better chance of becoming the dominant design.

Sales and Service Efforts

The third mechanism of the practical and technical means is the use of Sales and Service Efforts as an appropriability mechanism, relative to your rivals. **(Flaherty, 1984)** Aftersales practices and the use of launching customers are examples of these efforts. By encouraging your customers to give you feedback and listening to them, you can quickly adapt your technology to their wishes and win the battle of the dominant design.

The Sales and Service Efforts mechanism that is widely applicable, but you have to be able to do it. Small companies do not always have the time or skills to interact with the customer or launching customers. The identification of consumers that can help you is an important practice which can be hard, especially for startups without managerial or entrepreneurial training.

All methods of appropriation discussed above are widely applicable. But how do we know when a patent can be valuable to your firm or when you can benefit from moving quickly down the learning curve? This research differentiates firms based on the characteristics of their technology. But what are these characteristics?

2.2 The characteristics of technology

The characteristics of the technologies used in this research are researched by Souder and Shrivastava (1984). This answers sub question 3. These authors developed a scorecard to rate technologies for their "Readiness of the technology" (RT). This readiness is an indication of the property of a technology to displace current practices, calculating among others the easiness of adoption and effect on current practices.

The scorecard (Appendix D) consists of six factors, or 'dimensions', and three scales. These six factors, impact, accessibility, connectedness, state-of-art, resources required and substitutability, are measured over the three states, the Organizational Application State (OAS), the Innovation State (IS) and the Technological Field State (TFS). The authors generated the dimensions by asking several middle managers, industrial scientists and engineers for the distinguishing factors between high- and

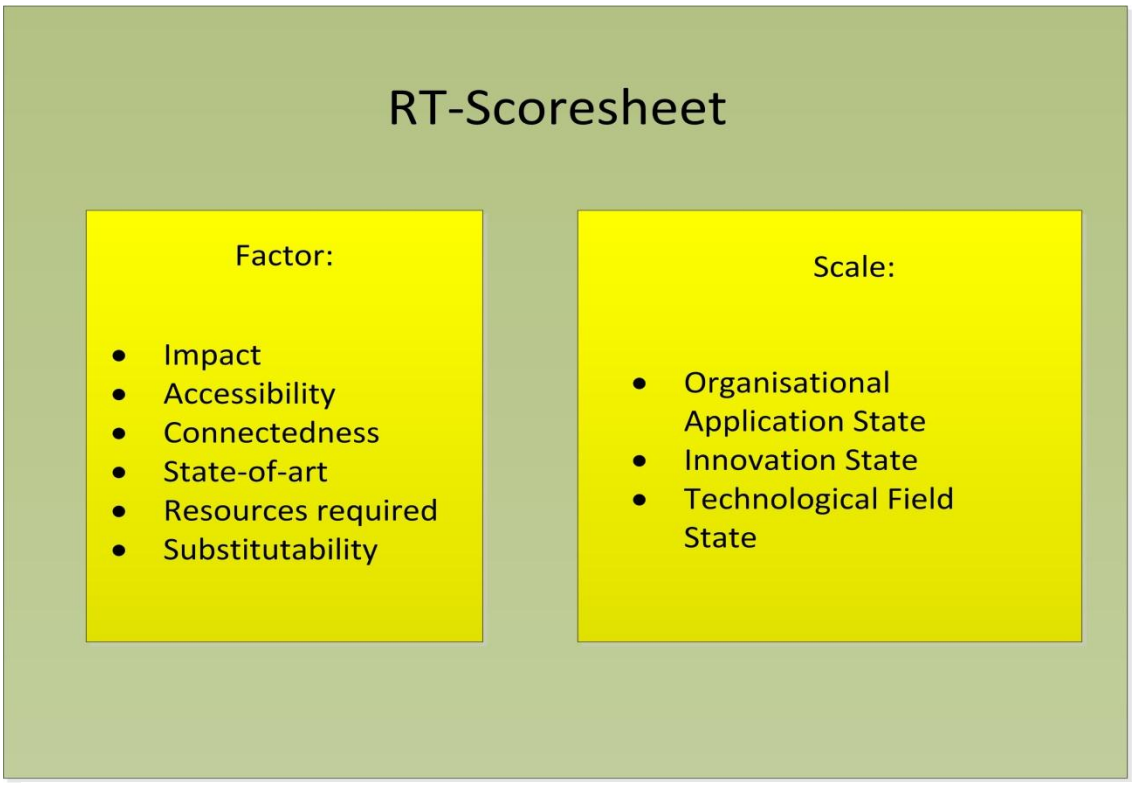


Figure 5: RT-Scoresheet

low- tech technologies and testing these factors among a large test group. The authors interpret a high-tech technology as one with a high RT-score and thus as a renewing, applicable and useful technology. A simple calculation can generate the RT-score, but in this research only the scores on the individual factors and scales are used.

2.2.1 The factors

Each of the mentioned factors above consists of different measured variables used in Souder and Shrivastava's research and deserves some explanation. **Impact** refers to the influence the technology has or could have on consumers, producers and the quality of life in general, as well as to the number of applications the technology has. With a high impact comes a high score on this dimension. A high impact can lead to a great demand or willingness from customers to pay a higher price, resulting in more revenue.

The second factor is the **accessibility** of the technology. The ease of understanding and using it and the extent to which it can be explained in easily comprehensible terms to various stakeholders cover this factor. If the technology is easily accessible it gets a high score on this dimension. Being accessible can lower the bar for possible customers, investors or other stakeholders to collaborate with the technology, but makes imitation easier.

Connectedness includes the amount of skills needed for development or production, the way workers need to collaborate and the extent to which the technology draws upon diverse scientific disciplines. A high level of connectedness leads to a high score. If your technology is very much connected to other disciplines and technologies, your technology is more easily embraced by customers, for instance if your technology uses an established platform to work on.

The variables that show the degree to which the technology has been developed are called the **state-of-art**. Newness, age, sophistication of methodological tools and accumulated knowledge in the area contribute to this factor, along with the knowledge of possible applications and the robustness of the technology. A technology that is state-of-art has a lead on rivals and has a better chance of succeeding as innovation and of raising revenues.

The fifth factor is called **'resources required'**. This consists of the amount of resources such as money or personnel involved with the development of the technology. The actual research on the technology is one part of these costs, but the costs that are involved with actually taking the technology into practice are also contributing to this dimension. If a lot of resources are spent or have to be spent, the resources required-score is low. The score on this dimension can indicate how likely the competition is to reenact your practices, and thus imitating your technology.

Substitutability indicates how many substitutes there are for your technology. If your technology is perceived as rather unique, you score a low score here. Having a lot of substitutes, you lose your bargaining position, but if you excel you can win market share.

2.2.2 The scales

All of the factors are scored on three scales: the **Organizational Application State**, the **Innovation State** and the **Technological Field State**. These scales form the total of current and future possible applications of the technology.

The first scale is the Organizational Application State (OAS). This scale represents the way the technology in itself is applicable and worthwhile for the implementing organizations. For example: the impact of a technology in the OAS refers to the impact the technology has as a product a company should market themselves.

The Innovation State (IS) treats the property of a technology to be part of an engineered product. If we look at car batteries for instance, we see that few people would buy a single car battery, but when engineered in a car, lots are sold. When a technology is part of an engineered product, its market view partly shifts from business-to-customer to business-to-business.

The last scale is the Technological Field State (TFS) and refers to the technology as subject to scientific development. Are there future developments or is this as good as it gets? Certain technologies can be worthless in terms of end product (OAS) or part of an end product (IS), but given some time will become valuable eventually.

As stated before, these factors come from a research by Souder and Shrivastava and seem fairly conclusive. However, there are additional factors can influence an entrepreneur's decision on the use of several appropriation mechanisms. These are not researched here, but should be taken into account when considering your appropriation strategy.

2.3 Other factors

The characteristics of technology are not the only factors that play a role in the decision-making process of a starting entrepreneur. There are, for instance, the nature of the product, the industry and the size and resources of the company. As this research is conducted for starting companies, the impact of the size of the company will be taken into account when making recommendations.

Sichelmann, (2005), lists the reasons why a start-up should patent. These reasons are largely the same as researched by **Cohen et al. (2000)**, but their approaches are somewhat different. The most important one is perhaps patenting to secure investments and financing. Investors may see patents as tangible proof of an intangible idea. They may also be evidence for the investor of the company's mastery of the technology. An established name in a market may find an investor just by mentioning the fact that they have something new that is going to be big, but small companies cannot use their reputation. They need proof.

The main reason not to patent is that the technology is not patentable. This can have several reasons. A technology may not meet the novelty requirement that is needed to apply for a patent. A prior art search is conducted for every patent application and if your technology is not new, the application is rejected. There also has to be an 'inventive step'. If the step from the existing technology to your innovation is obvious to some extent, the application is rejected as well.

Some innovations simply are not patentable. Software, for instance, relies on copyrights, rather than on patents, and for the architecture of semi-conductor chips there is the industrial design right and the right on the topography. These rights are, just like patents, exclusive rights and will in this research be seen as a patent for sake of appropriation. A copyright is not an IP that you have to file for. You automatically have them, but using it as institutional protection only occurs when actively excluding people from using your work or licensing them.

The considerations regarding the choice of appropriation strategy that are discussed in this research are all directed at the position of the start-up-entrepreneur. This position copes most of the time by one major factor in the decision-making-process, which is risk. Because this is such an important factor, risk cannot be left out of the discussion.

2.4 Risk and appropriation.

A major incentive for entrepreneurs when considering appropriation is the amount of risk they are taking. Because appropriation is all about securing the profits of a product, we should discuss the effects of the methods of appropriation on the chance of success. Taking risks is introducing the possibility of a loss. Investing in a product and expecting more profits than losses is therefore taking risk. Entrepreneurs are risk-takers and choosing their appropriation right can improve their chance of success.

Research has indicated that people tend to take more risks to avoid losses than to pursue gains. This is called loss-framing. **(Bromiley, Raw and St. John)** This is one of the major differences between the entrepreneur and the investor(s). Investors are spending money to make more money, entrepreneurs often put their home and savings at stake pursuing their belief in their company. The image and overall reputation of the entrepreneur is at stake as well and the potential loss of it can, certainly in the start-up fase, be of influence in the decision-making process. Bromiley et al. distinguish two different situations for entrepreneurs: 1) The entrepreneur is dissatisfied with his current working situation and tries something for himself, or 2) The entrepreneur has a great idea which can make him rich. In the first case, the entrepreneur tries to avoid the current unwanted situation, whereas in the second case he tries to pursue gains. He will therefore be taking more risks in the first situation. This is a factor that will not play a great role in this research, but could explain some irregularities and ambiguities.

The fact that entrepreneurs are willing to take more risks to avoid losses than to pursue gains makes us take a look at the product life cycle. At the beginning of this cycle, investments are made and there are not yet any revenues. Later, in the maturity stage of the cycle, the situation is turned around. There are a lot of revenues and only little investments. This means that the amount of risk concerning the decisions made by the entrepreneurs will decrease over time. As this research looks at a company in the start-up phase, considerable amounts of risk are expected to be come across.

But of what concern is risk to this research? Some innovations require a high investment to produce, which Souder and Shrivastava call ‘Resources required’. When a lot of resources are required for the innovation to succeed, more risk will be taken then when this is not the case. The risk concerning patents is a little ambiguous. On the one side, applying for a patent is an expensive investment that can lead to more revenues. This indicates risk-taking. On the other hand, owning a patent ensures that you don’t come across competitors whose patents you are infringing, which can be very costly. This would make patenting risk-averse. In complex product environments, of which a low score on ‘accessibility’ is the indicator on the scoresheet, the chance on infringement is smaller than in discrete industries. **(Cohen et al., 2000)** Thus, in complex industries, patenting could be seen as risk-taking because the risk-averse reason, the possibility of infringement, is not relevant here. In discrete industries, with a considerable chance of infringement, patenting could be seen as risk-averse.

Moving quickly down the learning curve can be seen as risk-taking, as it contains short-term money spending for little direct income. This method can be used to avoid losses when your company

suffers from overcapacity and to pursue gains when sales forecasts are good. This is company- or industry-specific and therefore not tested in this research. It is, however, important for an entrepreneur to consider when choosing his appropriation methods.

The risk considering Lead-time is called risk pooling. **(Thomas&Tyworth, 2006)** Risk pooling concerns the variability in lead-time from both customers and suppliers. Because the supplies and demands are not perfectly distributed over time and quantity is variable, there is statistical variation in both of them. This variation can be very costly because of back-orders or stocking costs. When risk pooling, your company takes batches on at a time, where the plusses will compensate the minuses, reducing the variation and the overall costs. This will, however, reduce the lead-time. Using Lead-time as a method of appropriation, you should appraise the variation of your supplies and demands and try to forecast the implications of speeding up the process. Using Lead-time when taking more risk therefore means that less pooling is used and that smaller batches of products will be produced and/or delivered simultaneously.

As seen above, the dependent and independent variable are researched and discussed, as well as some other factors concerning the decision-making-process of the appropriation strategy. The characteristics of the appropriation mechanisms and the factors and scales of the RT-scoresheet are determined and now ready to be linked together.

3. The scorecard as indicator

The method used to answer the sub question "*How do, theoretically, the characteristics of the mechanisms and the features of the technology match?"* is that the scorecard's dimensions and scales are used as indicators for the appropriability mechanisms a firm should use. For every dimension and scale can be determined? Which scores point towards which mechanisms. These are possible reasons why a strategy would fit a certain dimension but are not a commandment for what to do, for there are other factors at play. We will systematically discuss all factors on the scorecard and their possible influence on the decision of the appropriation strategy an entrepreneur should choose, linking different theories together to create new insights.

3.1 Impact

A technology with a high impact score is important to consumers, for it can improve the quality of life and affect other sciences. Although the impact score does not immediately lead to an emphasis on one of the appropriability mechanisms, it certainly enhances the importance of appropriation. When impact is big, more customers, non-customers and competitors will notice your technology and try to piggyback on your success.

Impact can lead towards a tendency to patent. As **Mann (2005)** states, a young company is challenged to divide their limited resources well. Patenting should become more important as the technology is more promising.

"*If the nature of the firm's innovation is such that (patents) are* ever *likely to be important, it must spend sufficient resources on the protection and development of intellectual property from the earliest days of the company-as an investment in the possibility that the firm* might *grow to the point at which (patents) are useful."****(Mann, 2005)***

Such technologies will stand out and draw attention of second and third parties. This means that competition will be fierce and the battle for the dominant design will become warlike. The chosen appropriation regime must be first-time-right. Unnoticeable technologies are less likely to raise a direct struggle when first introduced and can afford themselves a second chance on appropriating their results.

3.2 Accessibility

Easily understandable technologies score high on the dimension of accessibility. If a technology is difficult to understand, especially for manufacturers, the learning process can play an important role. A difficult technology can provide greater labor learning advantages than easy technologies.

If a technology is really hard to understand, it is hard for competitors to imitate the technology by means like reverse engineering. That is, if the details about the technology are kept secret. Secrecy should work for technologies with a low accessibility score, and it should not for those with a high score.

Cohen et al (2000) have conducted research on the differences in patenting between so-called complex and discrete industries. We can translate complex to inaccessible and discrete to accessible industries. This way, it can be shown that discrete product manufacturers often rate patents as a

good appropriability mechanism, especially because in complex industries it is easier for competitors to 'invent around' your patent than it is in discrete industries, for the existing patents can be too specific or simply ill-defined.

Lead Time advantages are not recommended for less accessible technologies. Technologies that are hard to understand are not easily accelerated by methods such as using more employees, because they require a certain education or training, or by overlapping activities, because it only clutters the whole project.

If accessibility is low, customers may find it hard to use the technology and may waive their purchase. By using Sales and Service Efforts, you can explain the technology to your customers, adapting them to your product, and work together with them to make it more accessible. This is called using launching customers. These launching customers can help spread enthusiasm and publicity for the technology, as well as discussing the ease of using it, making the product easier to adopt for new customers.

3.3 Connectedness

The connectedness of a technology refers to the dependence of workers on each other. It also includes the interconnectedness of the different types of skills and scientific disciplines that are required for developing the technology. Linked to the different mechanisms, we can reason that a small amount of connectedness favors secrecy and lots of connections make it hard for a company to keep secrets. If less people are involved and the sharing of information is of lesser importance, secrecy becomes more attractive and applicable. Having a lot of connections can mean that a patent is a great way to put everything together. Patents can refer to other patents, which requires the approval of the referred-to patent. This can come with royalty payments, which means that lots of referrals make patenting a great source of income.

A technology that scores high on connectedness can utilize Lead Time as appropriation mechanism. If a lot of relationships exist, they can be coordinated. Maybe some activities can be carried out parallel or maybe they need to be fit together. Although the absolute time-to-market may still be fairly long, the utilization of this appropriation mechanism, monitoring and improving the lead time, can be valuable for technologies with a high connectedness.

3.4 State-of-Art

The state-of-art-score indicates if the market has reached a state of saturation or still can grow or decline. A technology with a high score on this dimension should also be robust: the market should have the potential to grow. In a growing market, appropriability is extra important because you still can win the battle over the dominant design. State-of-Art technologies have yet to settle into mainstream products. The process concerned with this change is in many aspects similar to the dominant design battle. A state-of-art product has yet to reach the dominant design. All the technical and practical means can be utilized.

Mechanisms with the capability to capture so-called innovation spillovers **(Teece 1986)** are valuable when a product is state-of-art. Spillovers refer to the part of the market that has grown unexpectedly, so you are not able to service them yourself. Patents can capture spillovers greatly, because you can search for licensees who can satisfy market demands.

3.5 Resources required

If the research and development of a technology is very expensive, the chance that competitors are aching to reenact you by developing your product themselves is small. In this case, secrecy works really well. Patenting is neither a better nor a worse fit solution for different amounts of resources required.

Moving down the Learning Curve is hard to realize if production facilities are expensive. The initial investment can bear too many risks to wield this method. If expanding production is cheap, this can be an excellent mechanism.

3.6 Substitutability

When involved with a lot of substitutes, the institutional protection is weak. Patenting can be hard because of the novelty requirements, but can be a decisive differentiator. Secrecy is hardly valuable because of the expertise of the substitution's producers. Reverse engineering may be easy because of the existing knowledge on that field of knowledge. You can win the battle for the dominant design or the biggest market share by strong usage of the practical and technical means.

Moving quickly down the learning curve can be useful with products with a lot of substitutes because of market power. The existing possibilities have a certain market share and consumers may be hard to win to your side. Sales and service efforts work well as a differentiator on the tailoring of the product. Not every product is suited for this, but for some it may work well.

3.7 The organizational application state (OAS)

A technology that has a high OAS-score is well fit for the organization to exploit the technology by itself. This enables the firm to work by itself and keep secrets. A low score does not mean that collaboration is needed, but for their own efforts, the firm is not likely to generate a lot of revenues.

3.8 The innovation state (IS)

A high score on the IS means that the technology can be used as part of an engineered product, for which patents are a great way to generate royalties. Secrecy is counterproductive when collaboration is needed. However, a low score on the IS does not mean that practical and technical means should be used. A low score indicates that the product is not useful as part of an engineered product. This negates the reason to patent for collecting royalties and makes secrecy attractive.

3.9 The technological field state (TFS)

If a firm wants to assure itself of the revenues made by its technology in the future, good institutional protection must be made. Patents can provide you with this protection. Future patents can reference yours, generating revenues for your firm. Whether or not the company wants to develop the technology further by itself or not is an important factor on deciding whether or not to keep secrets. If the firm does not want to develop the product by itself, keeping secrets can oppose the technological growth. For the applicability of the practical and technical means, the TFS is not important.

3.10 The data collection

For the collection of data I have interviewed seven entrepreneurs who recently launched a product within a new company. These entrepreneurs were all participants of Venture Lab Twente and through Venture Lab I was able to contact them and interview them. Due to agreements on

nondisclosure not many specifics of these entrepreneurs and their companies can be given, but a small overview of these companies is given in Appendix B, i.a. to illustrate the diversity between these companies.

Sample construction

The participants were selected by reviewing their participation in the Venture Lab program, which pointed out which entrepreneurs were suitable as participants for this research. The most important criterion on the basis of which the participants were chosen was that they had to have a form of intellectual property to protect and exploit. Companies such as consultancy agencies do not use any institutional protection and cannot use a learning curve. Due to the rather short time span of this research and the summer holiday, seven entrepreneurs were able to participate. This eliminated the option of doing statistical research and made me choose for the use of case studies.

Interview protocol

During these interviews, the entrepreneurs were asked to view their products from several perspectives, the scales from the scorecard (wat moesten ze hier mee doen?), and were asked to give their opinion on the characteristics of the product, the dimensions and scales. The participant was for instance asked how difficult or expensive it is to further develop their technology or if their product can easily be replaced as part of an engineered product. All of these different angles could confuse the participants a little, but by systematically walking though the score sheet, the changing of angles could be reduced. The best way for this was taking the angle of one of the states, OAS, IS and TFS, and reviewing all of the dimensions for that state before moving on to the next state.

Scaling

After this, the entrepreneurs were questioned about the applicability of the different appropriation regimes and their reasoning behind their choices. In earlier researches, the participants were also asked to rate the applicability of the appropriation mechanisms. Harabi (1994) uses a seven-point scale and Arundel (2001) uses a five-point scale to distinguish applicable methods from useless ones. Because the RT-score sheet uses a five-point scale it seemed practical to use a five-point scale to rate the appropriation mechanisms.

So, the ranking of the dimensions and mechanisms was done on a five-point scale, where 1 was the lowest score, which either means a lack of presence of that dimension or effectiveness of the appropriation mechanism. By comparing different connections between scores on dimensions and effectiveness of appropriation mechanisms throughout different technologies, shared motives or reasoning can be found. These shared motives and reasoning can be of great value for new starting entrepreneurs, which can take them into account when standing for the decision themselves.

The entrepreneurs were asked to review the position of their company on the subjects, but did not rank them themselves. This was the case because test results are more consistent and truthful when ranked by an objective outsider. Another reason why the entrepreneurs did not rank the technologies themselves was because of the possibility that the participants could misunderstand the scoresheet. As much as possible, the participants were not asked directly for the score or the direct subject, but were asked questions regarding the criteria concerned with the dimensions. This helped to create consistent results from the scoresheet between different participants.

By reviewing all of these factors, the participants reason towards a high or low score on a score sheet. By first discussing the score sheet and then the appropriation mechanisms, the participants come up with motives and connections between their characteristics and the applicability of different mechanisms. This way, the scores are well-reasoned and great examples for the case study are generated. The generation of the scores thus enabled the forthcoming of examples behind the reasoning, illustrating the connections and forming the case study.

The theoretical framework and the data collection method together form the basis of the case studies. The data on the perception and proceedings of the entrepreneurs can now be discussed in the light of this theoretical match.

4. Results

The interviews with the participants proved to be great case studies. The group of participants worked with a variety of technologies, scoring differently on the mechanisms, dimensions and scales. Their reasoning and motives behind the choices they made was mostly logical and almost all of the reasons why one should use an appropriation mechanism were mentioned by the participants. By analyzing the scores, statements can be made about the argumentation behind the choices of appropriation mechanisms. These statements apply to all of the interviews and are, if possible, illustrated with examples from the cases. This answers sub questions 5 and 6.

4.1 Patents and Secrecy

All of the entrepreneurs had a good reasoning behind their choice on whether they should apply for a patent or not, and why they kept their secrets. Not all of them had a distinct preference between the two of them because of the nature of their product. Some products had patentable parts, but some other parts could profit more from secrecy. As a robust method of data-processing, we differentiated between the companies who rated patents higher and those that preferred secrecy and researched the differences in scores between these two categories.

All of the participants that preferred secrecy over patents scored higher on the **OAS scale** than on the **IS scale**, and of the participants that preferred patents only one had an even score on those two scales; the others scored higher on the IS scale. This confirms the theory that having a lot of collaborations means needing a formal way of licensing or sharing of information. The other way around works as well: commercializing the innovation by yourself points towards being better able to keep things for yourself, eliminating the need for a lot of paperwork and enabling the use of secrecy.

One of the participants had for instance developed a new, sustainable concrete mixture. The participant's company developed the recipe but was not planning on producing the concrete itself. At the time, it was looking for producers and end users. It used a patent on the recipe to ensure royalty payments, granting a manufacturer access to their recipe for the right price.

If we look at the scores of the **Technology Field State** and order them from low to high, we see that the score on patents increases as the TFS-score increases. The turning point lies at an average score of 3, which is average on a one-to-five scale over six dimensions. This corresponds to the theory on the TFS state concerning patents.

One of the participants developed a method to reduce the data to digitalize DNA, which speeds up the process of examining DNA a lot, significantly reducing the time to diagnose. They were certain that this mechanism could be developed and further ??, making it wider applicable for more DNA diseases. This prospect is one motive to patent. As development continues, royalty payments grow along.

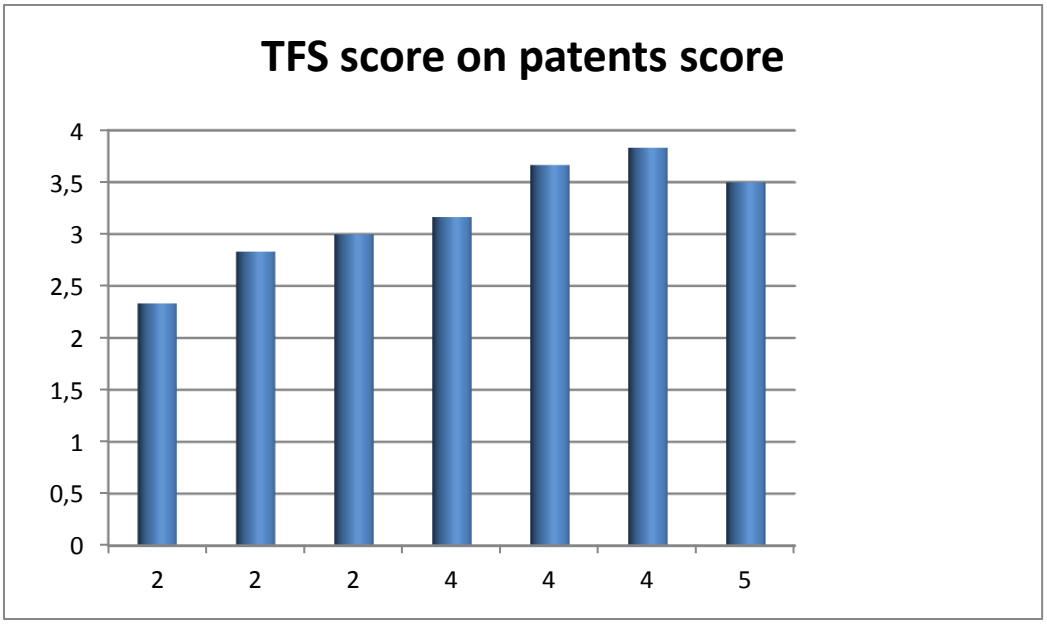


Figure 6: The average score on the TFS-scale (Y-axis) for different scores on Patents (X-axis)

The possible **impact** of the innovation is not something that entrepreneurs tend to look at when considering patenting or secrecy. This may be involved with (due to?) the risk that the entrepreneur is taking. In none of the interviews patenting was viewed as an investment for pursuing possible profits. If they could patent and if it could help them, they would. The fact that applying for a patent and the litigation costs are high is a retainer, but none of the entrepreneurs spoke of the risk, viewing the patent application as an investment. This way, the impact of an invention is no variable in the tradeoff considering whether to patent or not and not relevant to what?. This is something that could be more important to the participants and perhaps should be.

The participants of this research are all exploiters of their invention and are all experts in their field of technology. That is why, while considering the possible **impact** of an invention could be of a more managerial view, they emphasized the **accessibility** of their product a lot. Overall, the companies with a higher score on accessibility, meaning they worked with a discrete product, rated the use of patents above secrecy. A major incentive for this is that for these products reverse-engineering is an easy way for competitors to copy their products. As the participants were experts on their technology, they knew how competitors could copy them. One participant was coping with the problem that a large international firm was trying for years to develop what they had developed. If they leaked information in an early stage or misfile a patent, the large international firm could hop in and capture the fruits of their invention.

There were different motives for the companies with a complex product. Some said that patenting required too much disclosure of information that competitors could almost never find out on their own, but one entrepreneur mentioned that the product was too complex for competitors to imitate, even if they had the information from the patent application. This participant had captured patents from the CERN research center and was planning on commercializing them. Lots of possible customers did not believe that what he could do was possible or simply did not know of its mere existence. To successfully commercialize the inventions, the participant wanted to raise awareness of

the technology, hoping to create a bigger market rather than winning on the small, if not miniscule, market.

For one of the participants, the complexity of their product was a motive to use the so-called Coca-Cola model of secrecy: no single employee knows all of the secrets behind the innovation, so the information could not be passed on through one person. This method of protection only works for complex products.

Connectedness is a dimension that not all of the participants emphasized in their policymaking. One motive for not patenting was that the product one participant produces was so single-disciplined that a lot of third parties could use it to fit with their product. If a product has more connections, it is more specialized for one purpose only, reducing the market and the amount of imitators and with it, the urgency to defend yourself. This does not work the other way around, because if your product is very specialized, parts of it could be used in other fields or products. This could still make it worthwhile to patent.

The fact that participants considered their product **state-of-art** did not contribute to the emphasis on neither patents nor secrecy. However, their belief that they had something new, useful and robust, in which robust can be translated into a reduced amount of risk for the entrepreneur, triggered the participants into starting up their own company. Overall, you could say that the score on state-of-art pushes the entrepreneur to more risk-taking and investing in the innovation, and that it persuades entrepreneurs into the use of appropriation mechanisms. This was noticeable in the interviews. The more the participants ranked their product state-of-art, the bigger their faith on succeeding was and the more urgent they were to protect themselves.

An important reason for patenting is to attract investors. This was mentioned by several participants. Even just patenting for the investors, while not planning on enforcing the patents, was mentioned. The higher the **resources required** are, the more this reasoning holds. The participant with the CERN patents mentioned that their technology was so expensive to develop that, combined with a high complexity, the acceptance of the market of the technology was an issue. Investors for a production facility could not believe the possibilities and neither could possible customers. Altogether this led to a decrease in protection, spreading details of the technology and trying to get the product mainstream. As mentioned above, the aim shifted from primarily getting the biggest market share to expanding the total market for your product.

Substitutability is an ambiguous dimension. For some participants, dealing with a lot of substitutes could lead to a bigger struggle over market share and the dominant design, requiring more differentiation and protection of your their property and thus increasing the urge to patent. For others, entering a market with an established power of substitutes could be hard because of other companies trying to make it hard for new companies to enter the market, for instance by purposefully binding suppliers or end users. This was the case for the participant with the sustainable concrete recipe. Several big players in the market were known to purposefully try to block new, innovative entrants from the market to keep the power from shifting, trying to stay on top. If this happens, holding too much information for yourself and creating a too big potential threat may lead to a rejection of the market, making your product a niche. Market acceptance is key in launching a product. This is a difficulty that can occur when you are introducing a product in an established market where there already is a dominant design.

4.2 Technical and practical means.

Of the three states mentioned in the Souder and Shrivastava article, only the **Innovation State** has some influence on the technical and practical means. If the product is being offered as part of an engineered product, this can be a reason to use the learning curve. If the product can be part of many different end products, the learning curve can be used to help the company adjust the product to fit into different end products as good and as quick as possible over time. One participant for instance developed a wireless energy distribution system that has umpteen uses. It can collaborate with a television manufacturer to fit the distribution system in televisions, creating a wireless television. Once this process of collaboration is finished, the second time the company tries to fit their technology in for instance a refrigerator, the process takes less time. The participant mentioned that they did not use it purposefully, but discussing this mechanism he found that it applied to their technology and method of product positioning.

The **impact** of an innovation can have two implications for the use of lead time advantages. On the one hand, an innovation of great impact should be introduced as quickly as possible if it can enhance the quality of life, which is one of the indicators of the dimension Impact. On the other hand, the innovation with a lot of impact can be a rather radical one, and it can take some time for the market to get used to it. This, again, is important in a market with an established power that can make it hard for you to enter the market. So, it is market-dependable if lead-time advantages can be realized, but it can still be used, especially when driven by ideological incentives.

As for the participant with the DNA data compression method, making mistakes diagnosing cancer could not only break their product, but could also lead to a feeling of personal guilt, as it could cost people their lives. On the other hand, the faster this technology is accessible to doctors and research centers, the more people could benefit from this technology. To this participant, this dilemma was of great importance. Together with the Innovative State, the **accessibility** of an innovation was considered as an important factor for the use of the learning curve.

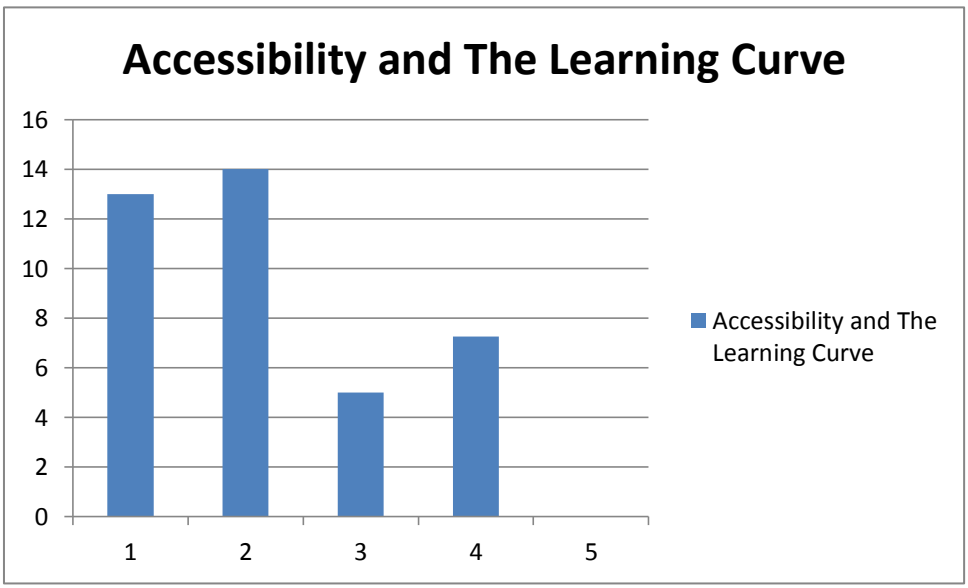


Figure 7: The average total score on Accessibility (y-axis) on different ratings of The Learning Curve (X-axis)

The participants with a product with an accessibility score that was considerably above average rated moving quickly down the learning curve the lowest. These participants indicated that their product

was understandable by both producers and customers. By this logic, the learning curve should be steep, neglecting the use of the learning curve as an appropriation mechanism.

All the participants with a complex product rated lead time low, while the discrete products scored high. Just as the theory prescribes, the product-to-market time of innovations that are difficult to access is hard to accelerate. The participants mentioned several reasons for this. The first reason is that because of the complexity of the technology, there was no need to speed up the process. It was not likely that competitors could reenact their efforts, so they could take their time. The second reason is that a product can be too complex to raise a demand. Again, this has to do with market acceptance. You should first introduce the technology to customers and producers so they will want your product. If they do not know it exists, think it is not yet possible or just do not understand it, they do not want your product. This is a problem for complex products. These problems do not apply to discrete products. There products can benefit fully from lead time advantages.

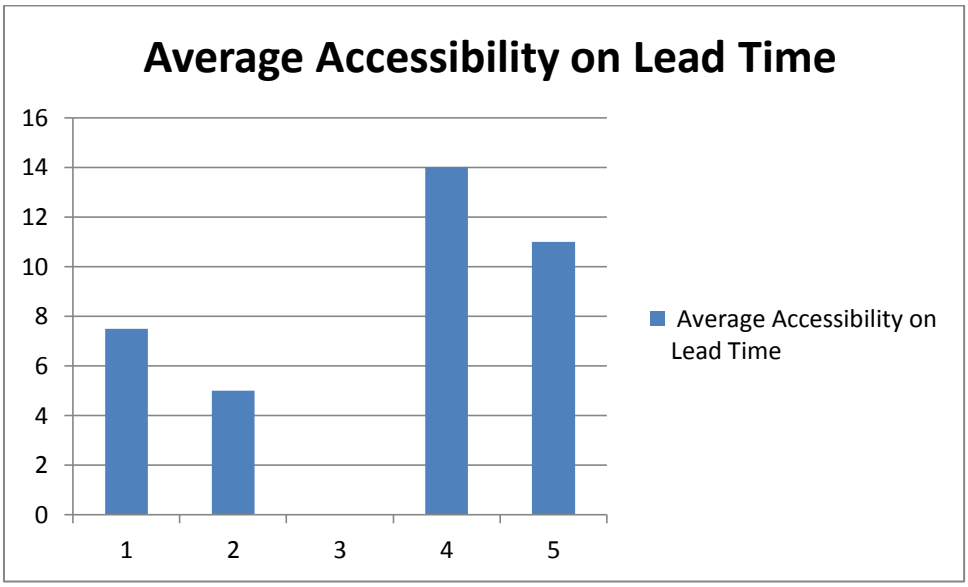


Figure 8: The average total score on Accessibility (y-axis) for different scores on Lead Time (X-axis)

The **connectedness** is a dimension the participants did not really take in account. This is probably because of the fact that the companies participating in this research are all small. The need to coordinate is not yet that important because the proceedings can still be overseen easily. Especially because the participants were all themselves the innovators, they are the ones who understand the complete product. It is possible, however, that on different levels in the company, whatever the size, other employees feel that they could benefit from less, or perhaps even more, lead time advantages or that they could learn more by doing more. For the size of the companies and the position of the participants, however, this was not disclosed.

The dimension **state-of-art** has the same connection to the technical and practical means as to patenting or secrecy. The score does not point directly towards one of the means, but increases the overall emphasis on the use of appropriation mechanisms. All of the participants were convinced that their product was state-of-art. Whether or not this is, again, due to the angle of the participants being entrepreneurs with a technological background or not cannot be clarified.

The amount of **resources required** by an innovation proved to have its effect on the use of moving quickly down the learning curve. As it appears from the interviews, the more resources it takes, the more learning is applicable. An emphasis on the learning curve could work for innovations with a low amount of resources required because of the low entry barrier for this mechanism, because of the lower investment it takes that when a lot of resources are necessary. However, it appears to appeal more to innovations where a lot of resources are required. The explanation for this is that if an innovation requires lots of resources, there is more that can be reduced by learning. When coping with small investments, little can be gained. The participants tended to rather invest more in an expensive product to enhance the possible profits than in an inexpensive one. This corresponds with the theory on risk-taking by entrepreneurs. Entrepreneurs are more willing to invest more to counter losses than to pursue gains.

The results on **substitutability** are clear. For products with few substitutes, lead time advantages are considered less important than for those with many substitutes. Being one of the few enables companies to take their time developing the product with no need to raise expenses in speeding up the process, while coping with a lot of substitutes stimulates the need of reducing the time-to-market. The use of the learning curve is also more applicable to innovations with few substitutes than for those with a lot of substitutes. If you have a lot of competition, you can learn from them and there is no need to move along your own learning curve. Thus, the amount of substitutes contributes to the steepness of your learning curve.

Sales and service efforts are ranked high by every participant. For every product, no matter what the scores on the different dimensions, sales and service efforts are important and applicable. Whether it is through the use of lead-users or an important after-sales process, the entrepreneurs rate sales and service efforts high. It may make a bigger difference for one company than for the other, but all will rate the efforts as important.

5. Conclusion

Which mechanisms of appropriation should be used by entrepreneurs depend on several factors. The factors are Impact, Accessibility, Connecteness, State-of-art, Resources required and Substitutability and these are measured over three states that represent the use of the innovation as an end product for the company itself, the ability of the innovation to be used as part of an engineered product and the innovation as part of a scientific discipline, subject to further research. The appropriation mechanisms are divided into two groups: the institutional protection and the practical and technical means. The institutional protection represents the choice between patenting, the use of secrecy and doing nothing. The practical and technical means consist of the use of lead-time advantages, moving deliberately quickly down the learning curve and the use of sales and service efforts. How these relate to each other and how this shows in reality answers the main research question "*What are the effects of the nature of a technology on the tailoring of the appropriation strategy of start-up-entrepreneurs?"*

5.1 On the institutional protection

As both the interviews and the theory have indicated, some indicators lead towards an emphasis on what institutional protection to choose. If a company is able to produce and exploit an innovation by itself, secrecy is a viable option. If the company needs to collaborate with others to market their product as part of an engineered product, patenting eases collaboration and helps cope with finance. If the product has a future by being developed further, patenting helps generating revenue.

Technologies that are hard to understand enable the use of secrecy, and patenting works for simple technologies. If you need a lot of resources from investors, patents can help attract them. The amount of substitutes you cope with can either mean that you should protect yourself well by patenting or that you need to be accepted by the established market players and should not use institutional protection at all.

5.2 On the practical and technical means

Of the three practical and technical means, one can always be used. Sales and service efforts always work, but to what extend is different every time. An important consideration is what amount of resources should be used for this means of appropriation. The purposeful descent on the learning curve is suited for technologies that are hard to understand for users and manufacturers, as well as for products that need to be engineered in an end product. Products that need a lot of resources to enable production are more suited for the use of the learning curve, as well as products with few substitutes.

The last means, the use of lead time advantages, is a difficult consideration for technologies that have great impact. When the quality of the end product is utterly important, the time-to-market can be vital for these technologies. Easily accessible products can benefit more from lead-time advantages, along with products with a lot of substitutes.

6. Discussion

When making statements about the best practices for entrepreneurs, we should consider the validity of these statements. There are some points of discussion that should be considered when applying the results of this research.

Firstly, this research is based on a scoresheet that was developed by Souder and Shrivastava. This scoresheet provides a list of dimensions and their characteristics, which they researched themselves. Whether this list is complete and robust is not clear. In current literature, no additives are given and no concerns are expressed, but it is not an often-used method. As far as current literature goes, we may therefore assume that the dimensions are a complete set of usable variables, but this is not entirely certain.

Secondly, the participants in this research were all from the Venturelab Twente program. This program tries to help people with a good idea, mostly scientists or researchers, in successfully starting their own business. They help these scientists and researchers become entrepreneurs. However, this means that the participants in this research are all technology-driven and may lack a managerial view. This may have expressed itself in an emphasis on the technological characteristics given by the scoresheet like accessibility and connectedness and a lack on emphasis on managerial characteristics like impact and resources required. This may have affected the results of this research, where we try to illustrate and apply the theory in a way that they?? may be more conclusive on the technological characteristics, where the theory emphasizes on all the characteristics.

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Appendix B: Participants overview

In this appendix, I will try to explain a little about the test group that was used in this research. They work in different markets and have different backgrounds, though their reasoning regarding appropriation is largely aligned. Because of the fact that these companies are yet in the development phase, I have agreed not to publish any details about these companies, so I am limited in the information I can give in this appendix, though a small overview of the participants contributes to this research.

Participant 1.

Participant 1 has developed a method to compress digitalized DNA without loss of data. This, combined with an analytical tool, can speed up the process of diagnosing diseases and give more detailed diagnoses. At the time of the interview, they were focusing on cancer research, though their product is not limited to this research topic. Founded in 2010, this company is still expanding, trying to gain more and more opportunities to exploit their product as they try to become the industry standard.

Participant 2.

The second participant is, at this time, still developing an energy distribution platform, containing a wireless-energy distributor and a chipset for the conversion of solar energy with a high efficiency, though it is already proven to work. The credit crunch was a barrier for this company as they were looking for investors and manufacturers, as they still need believers to participate with their technology. This was proven to be an entrance barrier, and a careful approach was needed to succeed on their market. This screamed for a look at their appropriation strategy, which was, although not always purposefully as a means of appropriation, well-reasoned and thought of.

Participant 3.

This participant developed a recipe for durable and lightweight concrete. The business model was not to produce the concrete themselves, but to enable manufacturers to produce the concrete for multiple purposes like viaducts or structures. A major issue of this participant was the power of the established market. Because the market was driven by contractors who order their concrete at a manufacturer, it isn't easy to enter the market as manufacturers, contractors and end-users should agree to use the new recipe.

Participant 4.

Participant 4 exploits so-called Ion Mobility Spectometry. Through this technology, you can detect traces of certain substances in the air. They thought of a device that can 'sniff' the air for molecular traces of these substances. They aim to use this mechanism for tests on drugs or explosives on airports and the like, but the possibilities are immense. One of the difficulties they encounter is the fact that it is a rather complex product which makes it hard to understand for the possible customers, which leads to skepticism and a reduced demand.

Participant 5.

The fifth participant specializes in the conversion of analogue to digital. This is expressed in chipsets which reduce the loss of quality in the conversion. They design chipsets, they don't product them themselves, though they want to produce chips for a niche market in the future. Their biggest problem at the time of the interview was their publicity. Their belief was that a lot of companies could benefit from their expertise, but their customers meet them more or less by chance. They need to win market share or expand their current market if they want to keep growing.

Participant 6.

Participant 6 exploits two patents that were developed by the CERN research center in Switzerland. Both of the patents regard X-ray technology, which enables this participant to optimize a super high-tech X-ray camera which can increase the delivery of visual details and contrasts by a factor of ten. The technology can also be used for the examination of materials and medicines. The first step in the business model is to just deliver service with this knowledge and create a market demand, and then trying to start manufacturing these cameras. It is hard to find believers for a technology this high-tech, and market demand needs to be raised. A good case to look at the appropriation.

Participant 7.

The seventh participant is specialized in wireless and mobile communications, especially in setting up temporary hotspots. Customers can be both festivals and such, where a lot of people come together, all demanding bandwidth and accessibility and governmental institutes like the police or the army, who in certain cases should retain their communication at all times. This company is an experienced player and is a spin-off of a big company, but to get the reputation for especially governments to go in business with them is a troublesome practice.

Appendix C: The Souder&Shrivastava scorecard

Dimension and descriptors	Scales: TFS scale (Qualities as a field of inquiry) Very low				Very high	IS scale (Qualities as product & process sources) Very low				Very high	OAS scale (Qualities for implementation) Very low				Very high
1. Impact															
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
-on consumers															
-on other sciences															
-on manufacturers/ industry															
-global impact on quality of life															
2. Accessibility															
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
-for understanding															
-for use															
-for research															
-for communication															
3. Connectedness															
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
-degree of development															
-based on multiple disciplines															
-interdependence among workers															
-need for coordinating many aspects of the technology															
4. State-of-art															
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
-degree of development															
-robustness															
-potential applications															
5. Resources required															
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
-monetary investment															
-personnel skills															
-plant & equipment															
-research & development															
6. Substitutability															
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
-by other technologies															
-for other technologies															