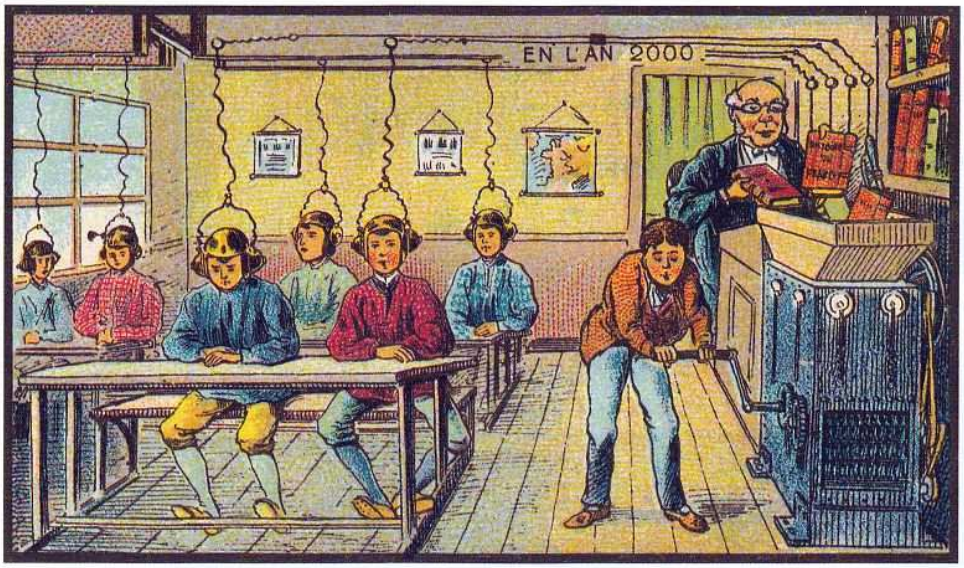
When novelty is the norm

Decision-making, uncertainty and investments in the creation of Intellectual Property within a European Research and Technology Organisation.



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Disclaimers

The information shared by respondents for this thesis is of a highly confidential nature. To protect the public and economic interests of the interviewees and their organisations, all data presented in this study have been anonymized and the interview transcripts have been omitted.

The interviewees and their teams, co-workers and/or employees are structurally referred to in the female gender. Please be advised that these people may be of any known gender, or lack thereof.

Front cover

The front cover illustration is part of a series of futuristic images 'En l'an 2000' issued as premiums in tobacco boxes in France to celebrate the 1900 World Exhibition in Paris. The images depicted a view of the world in the year 2000 in 1899. The artist of this particular image is unknown. Science-fiction writer Isaac Asimov came across a number of these images by chance and published them in 1986 in the Book "Futuredays: A nineteenth century vision of the year 2000".

Students can only wish that accumulating knowledge will someday be as easy as depicted in the image, until that time we'll just have to settle for plain hard work …

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Summary

This study investigated the relationship between uncertainty, decision-making and investments for IP creation within a Research and Technology Organisation (RTO). RTOs are organisations whose task it is to innovate and create value for others by means of research and development (R&D). These R&D activities result in intangible resources, intellectual property (IP), and within this resource set in specific intangible assets, intellectual property rights (IPR). IP is a vital intangible resource which increases the competitiveness of organisations and societies. IP is difficult to manage. It is never certain whether a novel innovation, even when it is technologically superior to existing solutions, will be successfully adopted by firms, consumers, governments or citizens. This uncertainty makes it difficult to valuate IP. Despite these uncertainties RTOs continue to successfully deliver novel innovations which meet market and societal needs. This study aims to better understand, given the perpetual level of uncertainty, how decisionmakers within RTOs judge to which IP creation activities they should, or should not, allocate scarce resources.

This study demonstrates that for RTOs uncertainty is perpetual due to the nature of the R&D process. This perpetual uncertainty influences decision-making processes on investments in IP creation. The influence of perpetual uncertainty is observable through the deployed heuristics of the decisionmakers. Heuristics are decision-making processes based on simple rules used in contexts of uncertainty when information is overwhelming, scarce or even absent and the outcome of their decisions cannot be reliably predicted in advance. Decisionmakers experience their decision-making on investments in IP creation as a one-directional process within an interlinking set of processes, strategic market based on (a) the desired temporal market position of their organisation and (b) a specific function the created IP has to fulfil in the market. This strategy is executed via a string of individual investment decisions. For each investment decision, decisionmakers have been found to rely on the use of heuristics, using their past experiences to weigh and rank information provided to them. The information is weighed and ranked by means of the perceived trustworthiness of the source of the information and on the credibility of the information this source provided.

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1 Introduction

A key characteristic of contemporary dynamic economic forces is that they have been able to develop because of the dominance of intangible resources as sources of competitive advantage for organisations. (Bontis, 1998, p.64; Grant, 1991, p.119). A practical description of intangible resources has been offered by Edvinsson (1997, p.367-368), intangible resources are all those things that remain in the organisation when every human has left the building but that cannot be found in the balance sheet. More formally, intangible resources encompass the non-physical results of human endeavours of an organisation, as both assets and competencies, which it owns or controls and which can be legally protected (Modic & Damij, 2018, p.18). The legal term of intangible resources is Intellectual Property (IP) and when they have legal effect, Intellectual Property Rights (IPR). IPRs are intangible resources as assets (Hall, 1992, p.136; Roos & Pike, 2019, p.34).

Numerous studies have demonstrated the value and strategic importance of intangible resources for organisations (Hall, 1992; 1993; Edvinsson, 1997; Bontis, 1998, Al-Aali & Teece, 2010). The challenge for management is not only to leverage their investments in terms of the value offered by current intangible resources, but also to be able to identify, create and protect the value offered by tomorrow's intangible resources (Penrose, 1959; 2009, location 1338; Bounfour, 2003, p.112). Value in most organisations is determined by accounting standards and these are generally unhelpful in offering information for determining the full value of intangible resources (Bontis, 1998, p.63). The long-term goodwill of intangible resources is considered a trash-item from an accounting point of view (Edvinsson, 1997, p.366). As a result, the 'true' source of the competitive advantage which intangible resources as competencies and intangible resources as assets offer to organisations is unknown, or causally ambiguous (Augier & Teece, 2018, p.694). The intertwinement of intangible resources as competencies and intangible resources as assets makes IP creation, IP identification, IP valuation and IP management a complex undertaking (Hall, 1992, p.136; Lin & Tang, 2009, p.679).

Research and Technology Organisations (RTOs) are mission-oriented providers of research and development (R&D) services to a variety of organisations in the common market of the European Union (EU). RTOs aim to add value to the EU society by improving quality of life and building economic competitiveness through the fruits of their R&D processes (EARTO website, 2018). It is fair to say that it is an RTO's job to create value for others through the creation of IP.

The combined aspects of the dynamics of IP creation, the importance of IP and the complexity of IP management create a context of perpetual uncertainty for decisionmakers within RTOs, making RTOs a suitable context for this study. Uncertainty refers to situations in which a decisionmaker does not and cannot know all possible options available with all their consequences and probabilities (Artinger, Petersen, Gigerenzer & Weibler, 2014, p.1). Perpetual refers to the continuousness of the uncertainty.

With stakeholders demanding that organisations clearly explain the current and expected return on investments (Al-Aali & Teece, 2013, p. 17) decisions on scarce resource-allocation, or investments, for IP creation carry a high degree of uncertainty (Penrose, 1959; 2009, location 1338).

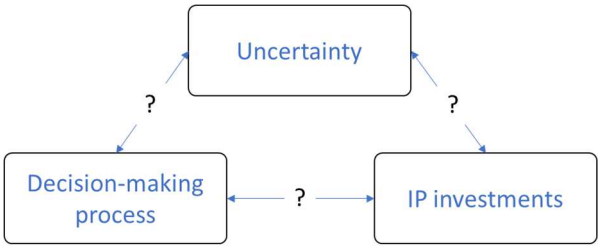
In situations of uncertainty decisionmakers tend to rely on heuristics (Simon & Newell, 1958, p.6; Neth & Gigerenzer, 2015, p.3). Heuristics is a much discussed academic term. In this study a heuristic is a set of simple rules which can be modelled. The purpose of heuristics is to describe the actual process of decision-making (Gigerenzer, 2004, p.64) when information, time, and processing capacity are limited (Kazakova & Geiger, 2016, p.128). Many studies on heuristics have a commonality in that they view heuristics as decision-making processes to use in discrete situations of novelty and uncertainty (Kazakova et al, 2016, p.134; Bingham and Eisenhardt, 2011, p.1449). These studies do not take perpetual uncertainty into account, where novelty is the norm rather than the exception. Some of the most influential studies on heuristics (Tversky and Kahneman, 1978; Gigerenzer, 2008) have studied heuristics as a means to solve binary choice problems with answers that were known to be correct. This concept of so-called cue validity has been subject to academic critique (Hilbig, 2010, p.923-925). In contexts of perpetual uncertainty, the correctness of an answer may only be known after years or even decades.

The aim of the study is to result in a proposition or in a number of propositions on the relationships between uncertainty, decision-making processes and investments in IP creation. This theory building study makes an academic contribution in that it will demonstrate that uncertainty for RTOs is perpetual due to the nature of the processes associated with IP creation and due to the specific market contexts in which RTO decisionmakers operate. This perpetual uncertainty influences decision-making processes on investments in IP creation in that decisionmakers use heuristics. Using heuristics to judge investments in IP creation, allows decisionmakers to view one investment decision as a process within a larger set of interlinking processes. This larger set of processes is one-directional to achieve a strategic market position for the RTO. In addition the effect of perpetual uncertainty is observable through the deployed simple rules of the heuristic, where decisionmakers will rely on their past experiences to weigh and rank information based on information source trustworthiness and the credibility of information provided by that source.

The central question to this study is how does uncertainty influence decision-making processes on investments in Intellectual Property creation within Research and Technology Organisations?

The literature review has resulted in a conceptual framework as illustrated in Figure 1-1. The conceptual framework served as an orientation for the literature review, design, method and field work of this study.

Figure 1-1: Conceptual framework



The practical contribution of this study follows the reasoning that *"nothing is quite as practical as a good theory"* (Van de Ven, 1989). Decisionmakers engaged in the study will gain deeper insights into how their own heuristics influence the way in which they invest in IP creation. By gaining insight into their own and one-another's decision-making processes, or heuristics, decisionmakers may be able to make critical know-how explicit. Such explication may allow them to share information and so improve the way in which they strengthen their organisations' successful IP creation abilities and so increase their organisations' competitive advantage.

The study will start with a literature review on the importance and uncertainties of IP creation for organisations and how heuristics play a role in these uncertain contexts. Next the study design, method, data collection and data analysis will be described. This is followed by the within-case results and analyses and the cross-case results. The study finishes with conclusions drawn from the cross case analyses enfolded in literature, a set of propositions, a description of the weaknesses of the study and suggestions for further research.

2 Theoretical background

2.1 Introduction

This chapter first outlines the importance of IP for organisations, then describes how IP is created within organisations. This is followed by the influence uncertainty has on IP creation and the influence uncertainty has on decision-making processes in general. It then investigates decision-making processes as heuristics followed by known critiques on this approach and a conclusion of the literature.

The type of theoretical background analysis conducted is a traditional literature review based on peer reviewed journal articles and academic books. Extensive academic material is available on the topics of IP creation, IP investments, uncertainty, decision-making and heuristics. The first sources were found by means of Google scholar searches. The search words used, were various combinations of key words in the research question or their synonyms. From those first articles other sources were selected by means of the snowball method (Easterby-Smith, Thorpe & Jackson, 2015, p.15-26).

2.2 The importance of IP for organisations

The growth of an organisation through the expansion of resources is a process governed by two types of factors. The first factor is the internal expansion of resources, also called organic growth (Lockett, Wiklund, Davidsson & Girma, 2011). Organic growth achieved through internal expansion is a deliberate long term process. The second factor is the acquisition of resources readily available in the market (Helfat & Peteraf, 2015, p.833, 842; Lockett et al, 2011). Strategic resources are versatile (Penrose, 1959; 2009, loc.392), valuable, rare, inimitable and non-substitutable (Barney, 1991, p.105-106). It can be reasoned that organisations whose objective it is to create superior and strategic resources which can be acquired by others will not only add value to the organisations acquiring these resources, but will also add value to the organisations creating them. Being an 'organic growth' producer of strategic resources for others will offer opportunities for specific types of organisations such as, but not limited to, Research and Technology Organisations.

Organisational resources are both the tangible and the intangible assets that are semi-permanently nested within an organisation (Wernerfelt, 1984, p.172; Kristandl & Bontis, 2007, p.1512). Intangible resources form the prime source of value for organisations (Bontis, 1998, p.64; Grant, 1991, p.119). Intangible resources are both people-dependent and people-independent (Hall, 1992, p.611). Intangible resources are people-dependent as the competencies of the employees within an organisation, embodied in the things the employees do on behalf of the organisation. These include know-how of employees and the ability of the organization to organise itself (Teece, 2000, p.36; Hall, 1992, p.136). People-dependent intangible resources are also referred to as an organisation's Intellectual Property (IP). IP is problematic to

manage (Modic et al 2018, p.3) and complex to protect legally[1] (Roos et al, 2018). Intangible resources can also be people-independent (Hall, 1993, p.611), as assets, which an organisation owns or controls because they can be legally protected (Modic et al, 2018, p.10-25). These assets include Intellectual Property Rights (IPR), contracts on both tangible and intangible resources and personnel. All IPRs are also IP, but not all IP has an IPR. There are circumstances in which it is hard to find the distinction between IP and IPR. For this reason the study generally refers to IP.

2.3 IP creation within organisations

The relationship between intangible resources as assets (IPR) and intangible resources as competencies (IP) can be linked to various organisational capabilities (Hall, 1993, p.610). A diverse set of activities will follow from the management of this relationship, and these activities can be viewed as business processes (Modic et al, 2018, p.5). Intangible resources allow an organisation to do things, such as making products and delivering services for customers (Wernerfeld, 1984, p.171) and so shape an organisation's functional capabilities (Hall, 1993, p.610). Intangible resources also provide a method, or resources transformation process, in which these things can be being done and as such give an organisation its organisational capabilities (Pike, Roos & Marr, 2005, p.114). As a consequence of past decisions and previous actions, an organisation will have a positional capability, or market attractiveness, based on its IP and IPR (Hall, 1993, p.610).

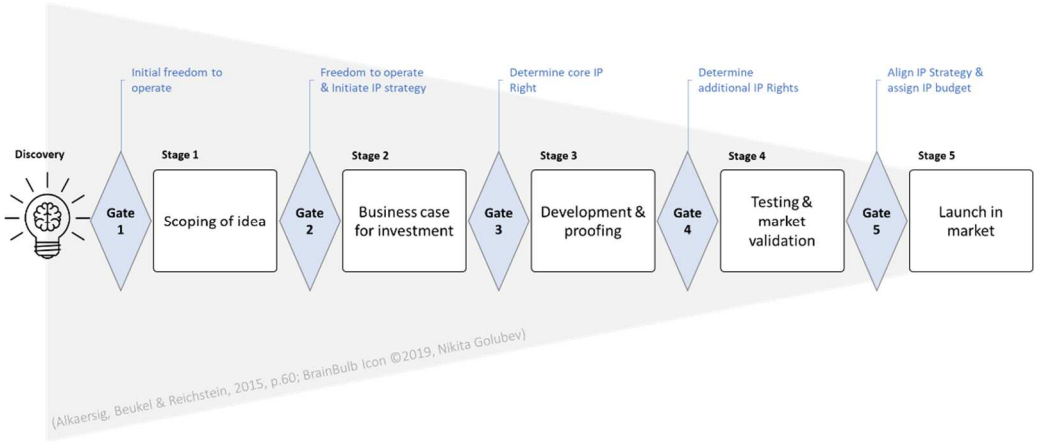
The strategic importance of IP management decisions cannot be understated (Marr, 2008, p.172; Al-Aali et al, 2013, p.15; Roos et al, 2019, p.5). Setting the conditions for growth through the process of IP creation is part of the administrative organisation and as a result also fundamentally limited by decision-making under uncertainty (Penrose, 1959; 2009; loc.2114). While a given set of IP may have the potential to yield value, that value will remain latent if an organisation does not have the capabilities to (a) to identify the IP as being potentially valuable or potentially strategic (Barney, 1991, p.105) and (b) to deploy the IP as IPRs within a suitable appropriability regime in order to capture that value (Teece, 2000, p.49; Chesbourg, 2008, p.336).

IP is to a large extent created in research and development (R&D) processes (Cooper, Edgett & Kleinschmidt, 2002/I). An activity can be called R&D when it satisfies five core criteria: novel, creative, uncertain, systematic and transferable and/or reproducible. (OECD, 2015, p.28). When creating IP it is common practice to follow a multi-step 'go, no-go' approach to allocate scarce resources, such as people, lab facilities and budget, to various R&D projects. By breaking scarce resource allocation decisions down

[1] Directive (EU) 2016/943 of the European Parliament and of the Council of 8 June 2016 on the protection of undisclosed know-how and business information (trade secrets) against their unlawful acquisition, use and disclosure is an attempt to make legal protection of intangibles as competencies easier. Currently the IP that resides in certain tacit and explicit knowledge is not protected by an accompanying IPR, rather this unique knowledge is 'protected' from certain unlawful acts of misappropriation. EU member states had to bring into force the laws and administrative provisions necessary to comply with the Directive by 9 June 2018 within the context of their own national laws and regulations.

into smaller manageable steps and having management give a “go” or a “no go” to allow the project to proceed to the next step, organisations expect to decrease the overall level of disinvestments in IP (Bonfour, 2003, p.118; Yoon, Lee, Lee & Yoon, 2015, p.747). To ensure that the organisation’s strategic objectives are met, there should be both an initial evaluation of R&D projects and a continual review throughout the lifespan of these projects. (Coldrick et al, 2005, p.186). A widely used methodology to allow for this type of evaluation and review of R&D activities is the Stage Gate™ process (Cooper et al, 2002/I), which has been adapted to fit the specific context of IP creation strategies (Alkaersig, Beukel & Reichstein, 2015, p.60-62). Using a Stage Gate™ process will break the total creation of IP down into smaller steps, allowing decisionmakers to gradually commit resources and limit the investment scope of each step. What it will not do, is reduce the overall uncertainty of IP creation itself.

Figure 2-1: Stage Gate™ process for IP creation strategies



2.4 The effect of uncertainty on IP creation

The intertwinement of intangible resources as competencies and intangible resources as assets makes IP recording and IP management a complex undertaking (Lin et al, 2009, p.671). One of the biggest challenges for decisionmakers is the valuation of IP and so in determining its contribution to organisational performance (Sveiby, 1997, p.76). Most organisations focus on short-term creation and quick benefits. Organisations who do execute longer-term R&D activities to create IP do so by closely aligning these activities to the organisation’s strategic objectives, rather than promoting ad-hoc curiosity driven research (Bounfour, 2003, p.113).

IP creation has at least seven specific uncertainties (Troy & Werle, 2008, p.14-16): uncertainty associated with the R&D activities themselves, uncertainty related to the novelty of the innovation, uncertainty associated with the projection of market needs in conjunction with the uncertainty of valuation, uncertainty arising from the application procedures of the IP or those arising from formal conditions related to the use of informal protection mechanisms, uncertainty associated with the failure of the IP markets, and uncertainty associated with the protection of IP.

As a result, IP is often undermanaged, underexploited or IP valuation is miscalculated (Lin et al, 2009, p.679; Pedro, Leitao & Alves, 2018, Pike et al, 2005, p.111). Some authors argue that the role that intangible resources, and thus IP, play in organisational performance is insufficiently understood by decisionmakers (Grant, 1991, p.119).

2.5 The effect of uncertainty on decision-making processes

A method to manage uncertainty when creating IP has been described in the Stage Gate™ process. Another approach is to use Technology Readiness Level (TRL) to manage technological uncertainty in R&D. The TRL scale is the official innovation policy tool of the European Union (EU) in the Horizon 2020 public innovation policy (European Commission, 2017). Initially the scale was developed by the National Aeronautics and Space Administration (NASA) to manage the uncertainties associated with R&D in the space domain and to reduce the risk of technology failures during actual space flight of rockets and satellites. For the EU the scale applies to any technology in any industry (Héder, 2017, p.1-3). Using TRL levels may make technological uncertainty more manageable, it does not reduce the uncertainty of IP creation in itself.

Uncertainty is about decision-making on the 'unknown unknowns' (Neth & Gigerenzer, 2015, p.3). Uncertain conditions generate ill-structured problems of which (i) the variables are not numbers, but, say, symbols, (ii) the activity purpose is vague and not quantitative, such as 'improve competitive advantage' and, (iii) there are no calculation methods available to reliably solve the problem (Simon & Newell, 1958, p.4-5). Milliken (1987) has made an attempt to describe uncertainty as a non-uniform phenomenon taking into account the type and source of the uncertainty. She distinguishes three types of uncertainty (i) state uncertainty, (ii) effect uncertainty and, (iii) response uncertainty. These types of uncertainty respectively seek to answer the following questions: what events could happen in the future, what do these events mean for us and what should we do? (Milliken, 1987, p.136-138). The tools to be used to answer the questions associated with uncertain contexts are heuristics (Simon et al, 1958, p.6; Neth et al, 2015, p.3).

Table 2-1: Three contexts and their tools
(adapted from Neth et al, 2015, p. 3)

Problem solving	Context		
	Certainty	Risk	Uncertainty
Available options:	Known	Known	Unknown
Consequences of applied options:	Known with certainty	Unknown, but can be reliably estimated	Unknown
Appropriate tool:	Logic	Probability theory & statistics	Heuristics

There is considerable debate amongst scholars whether heuristics have a negative or a positive influence on decision-making (Vuori & Vuori, 2014, p.1659). This study does not take a normative stance. The

seminal study of Tversky and Kahneman (1974) concluded that heuristics will lead to undesirable outcomes that decisionmakers will tend to rationalise in hindsight. This study follows the approach that Tversky and Kahneman (1974) aptly demonstrated that heuristics are not the right tools for solving problems in risk contexts. This notion is supported by Tversky and Kahneman's second article on the subject in which they conducted an analysis of decision under risk (Tversky & Kahneman, 1978). When faced with problems in contexts of risk, use probability theory and statistics. The applicability of a decision-making tools is context dependent, where certainty, risk and uncertainty are not to be confused with one another. Decisionmakers must realise that no matter how strongly they wish to solve problems in uncertain contexts with 'cool' statistical tools and intelligence dashboards, these tools are not suited (Simon et al, 1968, p.5-6; Neth et al, 2015, p.3).

In this study heuristics are viewed as a model describing a decision-making processes that must embody three qualities (Gigerenzer, 2004, 93-94). Firstly, heuristics exploit the evolved capacities of the decisionmaker. A heuristic is relatively 'simple' when compared to the capacities a person has developed. This simplicity allows for transparent and robust judgements. It is transparent in that it can be easily be understood and taught to someone else. It is robust in the sense that it can be generalised to apply to new situations. From this perspective it can be agued that heuristics are an integral part of decisionmaker's learning cycle (Bingham & Eisenhardt, 2011, p.1457)

Secondly, heuristics exploit structures of environments (Gaissmaier, 2011, p.457). This implies that a heuristic can only be qualified in relation to a specific context or environment, so all heuristics are to some degree domain-specific. Heuristics are designed by those who use them, to address specific types of problems. Heuristics can take advantage of certain structures of an environment or change an environment through their domain specificness.

Thirdly, heuristics are distinct from models of optimisation under constraints to explain human behaviour. Models of optimisation under constraints are based on numeric measurements and statistical calculations to predict outcomes and are lacking the actual and underlying human behavioural process. A heuristic is a rule set whose purpose it is to describe the actual process and the outcome of problem solving. With a heuristic model, predictions can be made that cannot be obtained from optimisation models. (Gigerenzer, 2004, p.64).

Heuristics are a part of managerial cognition, permitting decisionmakers to anticipate on the consequences of their decisions, allowing them to take action (Helfat & Martin, 2015, p.1285). Decisionmakers seek to answer the questions: what events could happen in the future, what do these events mean for us and what should we do? (Milliken, 1987, p.136-138). From these qualities it follows that heuristics are decision-making processes leading to outcomes which can be modelled and as such made explicit (Bingham et al, 2011, p.1438). A model of a heuristic specifies a process rule, it specifies that the human capabilities that the rule takes advantage of are simple and it specifies the kinds of

problems the heuristic can address. In order to understand how good and bad decisions come about, the structure of the environment needs to be analysed. It may very well be possible that a person has an unbiased mind but that a certain environmental structure generates a certain judgement. For instance the information that the environment can make available to the decisionmaker, is unreliable. It is unreliable in the sense that the available information is incorrect, too limited, too much or fluctuating. The unbiased decisionmaker will need to compensate for this lack of reliability by means of heuristics but may not be able to do so (Gigerenzer, 2004, p.66). This does not mean the decision-maker is biased (Tversky et al, 1974; 1978) but the information available to the decisionmaker is biased.

This study will focus on heuristics for inferences, such as comparative judgments, classification and estimation. It must be possible to identify how heuristics are successfully applied in specific contexts by decisionmakers to reach a desired outcome. It must also be possible to identify how decisionmakers are able to deploy successful heuristics in similar contexts resulting in similar outcomes. This means that some criteria for accuracy of the heuristic must be demonstrated even if this criteria is an outcome definition made by the decisionmaker themselves (Gigerenzer, 2004, p.64, Bingham & Eisenhardt, 2011, p.1437).

Heuristics often occur in specific patterns suited for particular classes of tasks, which offer decisionmakers simple rules to follow so they can conduct specific activities in the decision-making process (Todd & Gigerenzer, 1999, p.32; Kazakova et al, 2016, p.137-138). The observable heuristic patterns are firstly based on specific abilities of the decisionmakers which allow them to perform adaptive tasks, these are also called the application strategies of heuristics. Secondly the patterns describe specific inference tasks on information collection and processing to support the adaptive tasks. These inference tasks form the activity building blocks of heuristics which exploit the decisionmakers capabilities (Todd et al, 1999, p.32; Gigerenzer & Todd, 2003, p.132; Artinger et al, 2014, p.7-11). Together these types of heuristic patterns result in a multitude of different sets of observable heuristics, a limited number of these are discussed below and summarised in Table 2-2. This is by no means a definitive set of heuristics decisionmakers can deploy.

2.6 Heuristics

Heuristics can be used to make predictions (Gigerenzer, 2004, p.78; Artinger et al, p.3). In this study the task for decisionmakers is that they must be able to predict which one of a number of *objects*, for example R&D projects to create IP, scores higher on a specific *criterion*, for example the expected commercial or societal success of the IP, and from that *decide* which action to perform on the selected object, for example to invest in a project or not. Sometimes the criterion can be judged based on one or a number of *cues*. Examples of cues might be: estimated speed of market adoptability of the IP, the TRL level of IP and the business case underlying the created IP.

The building blocks contain specific rules on where to look for information, when to stop searching and how to decide (Gaissmaier et al, 2011, p.456). A decisionmakers' capabilities play a critical role in the building blocks. When the decisionmaker is knowledgeable on the object of decision, options can be sought in some order determined by a criterion. This criterion can be based on a recollection about which options or cues worked previously when making the same type of judgment. When the decisionmaker has less knowledge to rely on to guide their search, the search can be random (Todd et al, 2013, p.149). Other capabilities are, amongst others, recognition, frequency monitoring, object tracking and imitation (Gaissmaier et al, 2011, p.456). In some studies these building blocks are referred to as procedural heuristics (Bingham et al, 2011, p.1448). Because of their ecological rationality heuristics can exploit environmental structures (Gaissmaier et al, 2011, p. 457) and are very suited to particular contexts of uncertainty. Environmental dynamics will influence how well a criterion can be predicted as well as the volume of observations available relative to number of cues. Cues may have (in)consistency in weights, either cues have different weights or cues have the same weight and the co-relation or dependency between cues, may influence the substitutionability of cues.

Decisionmakers use social heuristics (Gigerenzer, 2004, p.73; Gaissmaier, 2011, p.472) to exploit the capacity of humans for social learning and imitation. The smart follower heuristic follows this simple rule: infer that the majority of one's peers displays a certain behaviour, engage in the same behaviour. The environmental or context specifics in which the smart follower heuristic tends to be successful is when the observer and the demonstrators of the behaviour are exposed to similar environments that are stable rather than dynamic, and noisy. That is, there is a lot of fluctuating information making it difficult for the decisionmaker to recognise patterns and so to see what the immediate outcome of their choice is.

Satisficing (Todd et al, 1999, p.13-14; Artinger et al, 2014, p.8) is a one-reason heuristic that can exploit some evolved capacities of the decisionmaker in terms of the body of knowledge the decisionmaker has access to, which allows the decisionmaker to have a 'knowing of what is important' based on expertise, past experience, etc. In the satisficing heuristic the decisionmaker selects a threshold which in their experience or opinion predicts a 'good enough' outcome. The satisficing heuristic follows this simple rule: infer that the object which positively fulfils the aspiration level has the higher value with respect to the criterion. The environmental or context specifics in which this heuristic tends to be successful is when there is some knowing about what to achieve, the environment is uncertain, the available information is unreliable (too much, too little or fluctuating) and there is considerable time-pressure.

The hiatus heuristic (Gaissmaier et al, 2011, p.455-457) is a one-reason heuristic that can exploit some evolved capacities of the decisionmaker in terms of their ability to remember events. In the hiatus heuristic a decisionmaker selects a threshold in terms of time, the hiatus. The hiatus heuristic follows the this simple rule: infer that the object which is less than the set hiatus has the higher value with respect to the criterion. The environmental or context specifics in which this heuristic tends to be successful is when there is some

knowing about what to achieve, the environment is uncertain and the available information is unreliable (too much, too little or fluctuating).

Take-the-best heuristic (Gigerenzer, 2004, p.73-74; Gaissmaier et al, 2011, p.457) also called lexicographic strategies (Artinger et al, 2014, p.9) is a one-reason heuristic that can exploit some evolved capacities of the decisionmaker in terms of the body of knowledge the decisionmaker has access to, which allows the decisionmaker to have a 'knowing of what is important' based on expertise, past experience, etc. In the take-the-best heuristic the decisionmaker selects the cue which, in their experience or opinion, most accurately predicts the desired outcome. The take-the-best heuristic follows this simple rule, infer that the object which positively fulfils the valid cue when the other does not, has the higher value with respect to the criterion. The environmental or context specifics in which this heuristic tends to be successful is when there is some knowing about what to achieve, the environment is uncertain, the available information is unreliable (too much, too little or fluctuating) and the stakes are 'high' (Gigerenzer, 2004, p.75).

Tallying heuristics (Gigerenzer, 2004, p.74-75; Artinger et al, 2014, p.8) are trade-off heuristics (Gaissmaier et al, 2011, p.472) which exploit some evolved capacities of the decisionmaker in terms of the body of knowledge the decisionmaker has access to, which allows the decisionmaker to have a 'knowing of what is important' based of expertise, past experience, etc. This knowledge allows a decisionmaker to select similarly weighted cues, and to add up cues by means of tallies until a previously set threshold is met. The object with most tallies is decided upon. The tallying heuristic follows this simple rule, infer that the object which positively fulfils the most valid cues, has the higher value with respect to the criterion. The environmental or context specifics in which the this heuristic tends to be successful is when there is knowing about what cues are valid, their order of validity is irrelevant as the cue weights are quite similar and the available information is too much for the decisionmaker to fully comprehend.

The recognition heuristic (Gigerenzer, 2004, p.68; Artinger et al, 2014, p10) is a trade-off heuristic that builds on an evolved capacity for recognition and it is useful when there is a strong relationship between recognition and the criterion. The relationship is often applied from a positive perspective, the object that is recognised is chosen. The recognition heuristic follows this simple rule if one of a number of objects is recognized and the others are not, then infer that the recognized object has the higher value with respect to the decision standard. The environmental or context specifics in which the this heuristic tends to be successful is when 'not-knowing' is systematic rather than random and a decision has to be made with little information. Note that the capacity for recognition is different from that for recall, one may recognize something but not recall anything about it.

The similarity heuristic (Artinger et al, 2014, p.11) is a trade-off heuristic that builds on an evolved capacity for the human ability to see similarities between objects, such as an industry or customer set, even when they clearly belong to a different class of object. The recognition heuristic is useful when there is a strong relationship between similarity and the criterion. The similarity heuristic follows this simple rule, infer that

the identified object has a higher perceived criterion value than those from a reference class. The environmental or context specifics in which the similarity heuristic tends to be successful is when 'not-knowing' is systematic rather than random in one class and knowing is systematic in another class, information available is relating to a different set of objects and the available information is unreliable, it is too much, too little or fluctuating.

2.7 Academic critiques

The strength in using these type of heuristics lies in their inference rules and how these might be easily identified in a heuristic's building blocks. This strength is also an immediate weakness. Critique has been offered to the assertion that heuristics may provide a general description of inferences for a decision-making process based on cue-validity (Hilbig & Richter, 2011). In previous experiments done on heuristics, one can never be absolutely certain what cue was under actual consideration by participants. Research done to identify the inference rules of heuristics have been mostly conducted in experimental settings where the heuristics are used to solve binary choice problems with known correct answers, or valid cues (Bingham et al, 2011, p. 1450). That this is problematic has been demonstrated by the positive identification of the so-called "alphabet heuristic" (Hilbig, 2010, p.293-925). In a critical study Hilbig (2010) set out to identify how people decide which city they found most attractive. Although the "alphabet heuristic" would qualify as a robust heuristic by the standards set forth by Gigerenzer and others, it is unlikely that participants in the experiment would have compared the attractiveness of cities on the basis of their alphabetical ranking.

The heuristic framework used for this study is derived from studies that identified heuristics in experimental setting with a heavy emphasis on computational analysis. The 'validity issue' of the identification of cues and inference rules is a valid academic concern which is addressed through the methodology of this study. A number of qualitative case studies have successfully demonstrated the academic applicability of heuristics which use inference rules (Kazakova et al, 2016; Gilbert-Saad, Siedlok & McNaughton, 2018).

2.8 Conclusion

The capabilities of an organisation are based on specific arrangements of heuristics (Bingham & Eisenhardt, 2007, p.29). It can be stated that heuristics are, in essence, intangible resources as competencies, or Intellectual Property, which may have been converted to intangible resources as assets (Hall, 1993, p.610), or IPR, when they are modelled. This process of modelling will allow explicit learning to take place within the organisation (Bingham et al, 2011, p.1438), making heuristics transparent and robust. From this point of view heuristics, as intangible resources, can be regarded as key components of any business process (Modic et al, 2018, p.5). Bingham, Eisenhardt and Furr (2007, p.40) support this view when they conclude that

"heuristics are at the heart of high performing organizational processes, and so are central to organisational capabilities".

An example is offered in the literature where it is demonstrated that decisionmakers manage the uncertainties associated with R&D while creating IPR by adopting Stage-Gated™ processes and also by classifying IP and IPR according to technical maturity in TRLs. Both methodologies were modelled on organisations who were capable of innovating successfully. I am arguing that these are in fact successful heuristics that have been modelled so they can be, and have been, applied by other organisations. Both the stage gated approach and TRL classifications, in their many adapted forms, have in fact become innovation standards.

As a consequence, having decisionmakers learn a small set of successful heuristics from other decisionmakers allows an organisation to build a superior organisational capability (Hall, 1993, p.610). Organisations that are capable of identifying, expliciting and managing successful heuristics will have created IP that give them a significant competitive advantage over those peers who are incapable of this (Bingham et al, 2007, p.40). Following this line of argument the literature review supports the following conclusion, the act of decision-making on investments in IP creation may lead to the creation of Intellectual Property when decisionmakers use transparent and robust heuristics.

Table 2-2: Heuristic patterns: application strategies, characteristics and building blocks (Gigerenzer, 2004; Gaissmaier et al, 2011; Artinger et al, 2014)

		MANAGERIAL APPLICATION						
		Smart follower Based on ability to imitate	**Satisficing** Based on ability of object tracking.	**Hiatus** Based on ability of recency monitoring.	**Take the best** Based on ability of memory recall.	**Recognition** Based on ability of recognition memory.	**Tallying** Based on ability of frequency monitoring.	**Similarity** Based on ability of experience memory.
CHARACTERISTICS	**Type**	Social heuristic	One reason decision	One reason decision	One reason decision	Recognition heuristic	Trade-off heuristic	Trade-off heuristic
	Rule of inference	Infer that the majority of ones peers displays a certain behaviour, engage in the same behaviour.	Infer that the object which positively fulfils the aspiration level, has the higher value with respect to the criterion.	Infer that the object which is less than the set hiatus, has the higher value with respect to the criterion.	Infer that the object which positively fulfils the valid cue when the other does not, has the higher value with respect to the criterion.	If one of two objects is recognized and the other is not, then infer that the recognized object has the higher value with respect to the criterion.	Infer that the object which positively fulfils the most valid cues, has the higher value with respect to the criterion.	Infer that the identified object has a higher perceived criterion value than those from a reference class.
	Environ-mental context	Dynamics: moderate Volume: high Inconsistency: is moderate to high (cues have different weights) Substitutionability: the inter-dependency between cues is unknown.	Dynamics: moderate to high - there is high time-pressure Volume: high (In)consistency: unknown Substitutionability: is high, there is low interdependency between cues.	Dynamics: high - there is high time-pressure Volume: high (In)consistency: unknown Substitutionability: is high, there is low interdependency between cues.	Dynamics: high - there is high time-pressure Volume: can vary. Inconsistency: is moderate to high (cues have different weights) Substitutionability: is high, there is little interdependency between cues.	Dynamics: are characterised by systemic uncertainty Volume: moderate to high. (In)Consistency: unknown. Substitutionability: is low, there is high interdependency between cues.	Dynamics: moderate Volume: high. Consistency: all cues have the quite similar weights Substitutionability: is high, there is little interdependency between cues.	Dynamics: are characterised by systemic uncertainty Volume: moderate to high, but relating to different class of objects. (In)Consistency: known for the 'other' class. Substitutionability: is low, there is high interdependency between cues.
BUILDING BLOCKS	**Search rules** where to look for information	Determine the peer group to observe.	Set an aspiration level and search through objects. Aspiration level may be fixed or adjusted up or down.	Set a threshold in terms of time and search through objects.	Search through cues in order of their validity. Look up the cue values of the cue with the highest validity first.	Search for an object that you recognize.	Search through cues in any order. Look up the cue values. Add positive cues to the tally, and deduct negative cues from it.	Search for an object that is more similar to the target than objects drawn from a reference class.
	Stopping rules when to stop searching	Stop search when it is clear what the (vast) majority of the peers does.	One-reason stopping rule: Stop search when the first object meets the set aspiration level.	One-reason stopping rule: select the object that falls under the threshold.	One-reason stopping rule: If one object has a positive cue value and the other does not, then stop search and decide. Otherwise exclude this cue and look for more information.	Stop as soon as an object is recognized.	Stop after *n* cues (where *n* can be any number up to the complete set of cues) and determine which object has more positive cue values and decide. If the number is equal, look for more information and search for another cue.	Stop as soon as a more similar object is found.
	Decision rules how to decide given the attained information	Choose this object.	Choose this object.	Choose this object.	Choose the object with the positive cue value. If after searching through all cues there is a draw or no more cues are found, guess.	Choose the recognised object.	Decide for the alternative with the higher tally. If after searching through all cues there is a draw or no more cues are found, guess.	Choose the more/most similar object.

3 Research approach

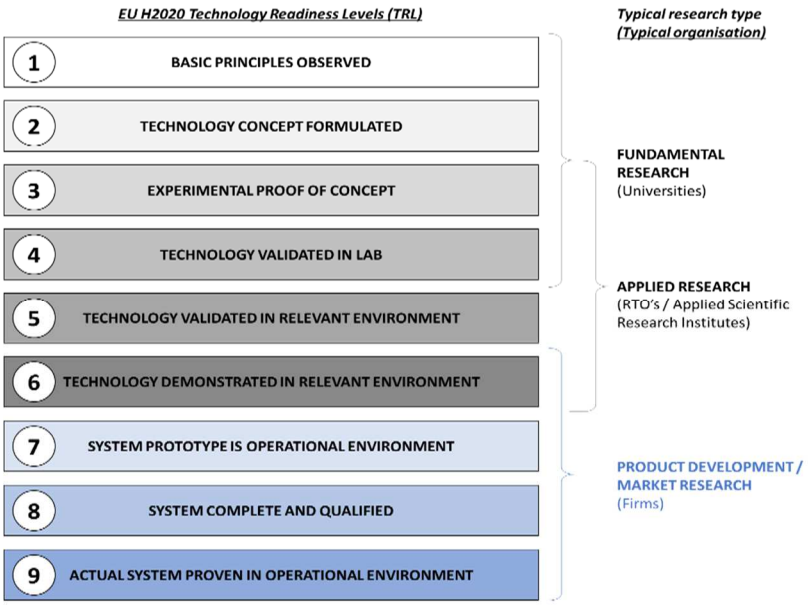
3.1 Introduction

This chapter first describes the design of the study. It then describes the method in some detail. how the cases were selected and how data was collected for the cases. The chapter finishes with a detailed description on how the data has been analysed and initial findings were corroborated.

3.2 Design and object of study

The design of this study is theory building and of an exploratory nature. The research has a narrowly defined object of study, the decision-making processes of investments in IP creation. IP creation has been bounded to R&D processes for Applied Scientific Research. Applied Scientific Research typically occurs at an IP maturity status of Technology Readiness Levels 3 through 6 as illustrated in Figure 3-1.

Figure 3-1: Description of the EU H2020 TRL levels



Within the EU organisations exist which are specialised in applied scientific research for the creation of IP. These are Research & Technology Organisations. RTOs are mission-oriented providers of R&D services to a variety of organisations in the common market of the European Union (EU). RTOs are organisations whose objective it is to create superior and strategic resources in the form of IP through 'organic growth' which can be acquired by others (EARTO website, 2018). The combined aspects of the dynamics and the importance and the complexity of organic growth via IP creation entails a continuous and ongoing high level of uncertainty for decisionmakers within RTOs. In this study we refer to this as perpetual uncertainty. RTOs are of particular interest for this study because they operate in contexts of perpetual uncertainty.

Following the literature this perpetual uncertainty will ask for a structural use of heuristics as decision-making processes when determining whether or not to invest in IP creation.

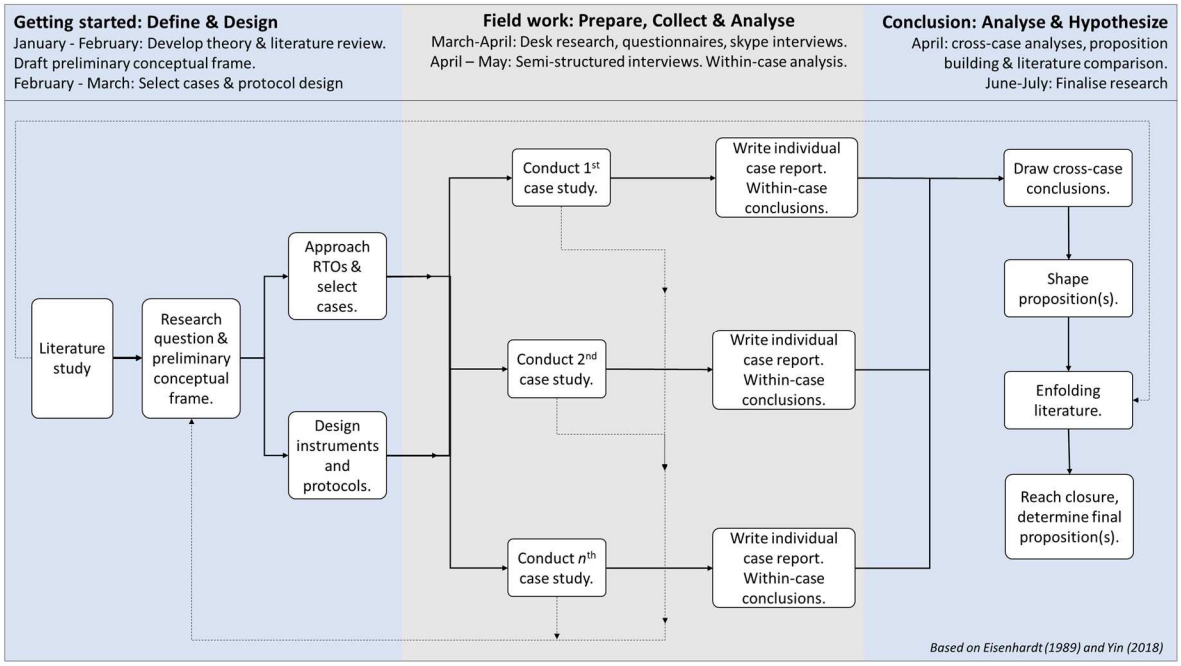
3.3 Method and plan

For this research the qualitative exploratory multiple-case study method has been used. The case study approach, in general, is especially suited for an iterative approach towards the production of new insights by following a linear but iterative exploratory path (Yin, 2016; 2018, p.4). Exploratory case studies are particularly suited to address "how" research questions where the topic of investigation is a contemporary social phenomenon and there is an inability to manipulate or control relevant behaviours (Yin, 2018, p.8-13). Exploratory case studies are distinct from other types of case studies in that they lack initial propositions. Building theory or propositions is the purpose of an exploratory case study (Mils, Wiebe & Durepos, 2010, p.372-373; Eisenhardt & Graebner, 2007, p.28). Using multiple cases allows for investigation of a social phenomenon in different contexts and to compare those within and across settings (Mils et al, 2010, p.372). For this reason the method follows replication logic, rather than sampling logic (Yin, 2018, p.55). To facilitate replication and the reliability of this study, the methods of case selection, data collection and data analysis have been described in some detail.

In this study the social phenomenon under study is decision-making processes on scarce resource allocation for IP creation in R&D processes for applied scientific research within RTO's who operate in a context of perpetual uncertainty. The exploration is on the relationship between heuristics as decision-making processes, investments in IP creation and uncertainty. The method is one of multiple cases with within-case and cross-case analysis to increase the reliability of inductive reasoning through replication, while still achieving a high level of validity associated with case-studies (Voss, Tsikriktsis & Frohlich, 2002, p.211).

The study followed several phases of progression (Eisenhardt, 1989, p.533; Yin, 2018, p.xxxi). In the getting started phase a literature study was conducted, the research instruments and the research protocols were designed. The field work phase was executed by preparing data-collection, actual data-collection and within-case analyses of the data. The study finished in the conclusion phase with cross-case analyses, cross-case conclusions enfolded in literature and proposition formulation. These phases and their expected timeframes are visualised in the research plan in Figure 3-2.

Figure 3-2: Research plan



3.4 Case selection

The cases were selected within a single RTO by means of purposive sampling (Yin, 2016, p.93). This type of sampling requires deliberate choice to select those instances that will yield plentiful, relevant and information-rich data.

Four division heads with decision-making mandate were approached to participate in the study. Each division is part of a different semi-autonomous business unit within the RTO. Each business unit targets a specific industry and/or a specific set of societal problems. As a result, there is no activity overlap between the divisions and each division has its own unique context of uncertainty. By selecting cases from four different divisions, generalisability increased and the assumed difference in contextual uncertainty could be investigated within and across the cases. To ensure anonymity the decisionmakers and their divisions will be referred to as Triangle △, Square □, Circle ○ and Diamond ◇. Using names which could also be symbols facilitated the coding of the collected data. Per division two decision-making processes of investing in IP creation for applied scientific research were selected as cases to study, resulting in a total of eight cases: △1, △2, □1, □2, ○1, ○2, ◇1 and ◇2.

The case selection criteria were based on two factors which were assumed to affect their level of uncertainty. The first factor was the mandate of decisionmaker, where a case can fall within the decision-making mandate of the decisionmaker or the case can exceed the mandate of the decisionmaker. The second factor was the technological maturity of the IPRs under creation, where a case can be early application and have an EU TRL level 3 or 4 or it can be early prototype, EU TRL level 5 or 6. A case that fell

within mandate with a higher TRL was assumed to have lower overall uncertainty that a case that feel outside the mandate and had a lower TRL level.

3.5 Data collection

*"In **handling your data**, no amount of care is too much care."* (Yin, 2016, p.31. Emphasis in original text.)

During data collection field notes were made hard-copy in a notebook. The notes were digitally scanned and stored in a secure online environment to protect against loss immediately after a note-taking occasion had occurred. The notes were used as additional reference material.

A four-step approach of qualitative data collection and findings corroboration was executed. The data collection was grouped in categories to faciltate understanding of each case in terms of a general understanding of the IPR performance of each division, the specifics of contextual uncertainty of each division and the heuristics deployed in terms of activity sets found in the literature and summarised in Table 2-2. IPR perfomance was chosen, as opposed to IP, because IPRs are intangible assets that can be counted, such as patents, trademarks and copyrights. A pragmatic choice, since IP can be hard to identify and hard to count.

Step 1: Desk research

Desk research on different publicly available sources of data on IPR performance per division as a preparation for step 2. The RTO has a consolidated annual financial statement. No specific information could be found on the financial performance of the individual divisions. The researcher was given access to two of the RTO's corporate online dashboards to collect data to make an upfront overview of the current composition of each divisions' IPR portfolio and the number of spin-offs created in 2018. The central department responsible for the IPR dashboard indicated that they only report on IPRs for which the RTO has to pay an invoice and that the online dashboard is updated irregularly. As a result, the copyrights mentioned are only those copyrights that have been stored as a so-called I-DEPOT[2] or those licensed out to third parties. The actual number of copyrights per division is likely to be much higher.

Step 2: Short fixed open-question interviews via skype

This interview technique was essentially semi-structured in nature with an emphasis on structure. The main goal of this step was to develop a deeper understanding of each divisions' context of uncertainty in which decision-making on IP creation takes place. A sub-goal was to gain insight in the IP creation, or R&D,

[2] An I-DEPOT is an official 'time stamp' service offered by the Benelux Office for Intellectual Property. This time stamp is admissible as evidence in court to prove that a copyright was created at a certain date. The RTO uses I-DEPOTS for 'product' bundles of copyrights such as: code, models, and accompanying (technical) documentation.

process the decisionmaker followed. Lastly the step 2 interviews allowed for building a level of rapport for the more in-depth semi-structured interviews.

The information from the desk research in step 1 was used to compose a set of four, fixed but open, questions. These questions were sent to participants in advance as part of a research brief, which is included in Appendix A.1. The decisionmakers were asked to share supporting documentation if possible. The questions were repeated during the interview with a request to elaborate and to refer to any documentation shared in advance. The interviews were recorded and literally transcribed. The transcript template is included in Appendix A.2 To protect the societal and commercial interest of the divisions the full transcripts are not included in this study.

Step 3: Semi-structured interviews

The goal of the semi-structured interviews was to gain an understanding of how heuristics, as a decision-making process, play a role in scarce resource allocation within the IP creation process and how uncertainty may influence this relationship. The heuristic patterns summarised in Table 2-2 were used to compose a guiding set of questions for the semi-structured interviews. The questions are included in Appendix A.3. The semi-structured interviews were conducted face-to-face and on-site with each decisionmaker separately. During the interviews room was left for unstructured elements, which allowed the division hards to provide in-depth information on case particulars. Enough time was left between interviews to allow for detailed recording of responses and information given. The interviews were all recorded and literally transcribed. To protect the commercial interest of the divisions, the full transcripts are not included in this study.

Step 4: Initial finding interviews

After the first within-case and cross-case analyses were completed, the initial cross-case findings were shared with the division heads. Interviews were held to offer the decisionmakers the opportunity to provide feedback on the initial findings. Three out of the four decisionmakers were available for a third interview, as a consequence no verification of the findings was possible on two cases. During these interviews notes were taken, the interviews were also recorded but due to time pressure these were not literally transcribed. The insights resulting from these interviews were used in the within case analyses, cross case analysis and conclusions.

3.6 Data analysis

To allow for structured within case and cross case data analyses, the data has been coded. Yin (2016, p.196-199) describes a coding logic as a method for structuring qualitative data. For each step a general data-analysis array was made to conduct an in-case analysis (Eisenhardt, 1989; Voss et al, 2002). This ensured that each case was analysed in the same fashion. At the outset of the research thought was given

on how to develop a coding logic to strengthen validity and reliability of the research (Voss et al, 2002, p.212).

The basis of the data analysis of the step 2 interviews was formed by the literal interview transcripts. Two coding types were used to code the data of the step 2 interviews. The first type is the elemental method of In Vivo coding (Saldana, 2013, p.61). In Vivo coding is particularly strong to identify what matters to those interviewed since it uses literal words from the data file, or the actual language of the decisionmakers, as opposed to a code created by the researcher. The second coding type used is Theming the Data (Saldana, 2013, p. 67). Theming the Data allows for whole data blocks, groups of words or sentences, to be coded so that the essence of a meaning can be obtained. By using Theming the Data after In Vivo coding, the In Vivo results could be placed in a broader context of meaning.

The transcripts of step 2 interviews were consolidated into one large datafile which consisted of a total of 5505 words. This consolidated data set was fed into an online word frequency counter to measure the frequency of unique words in the data set. The flat text result was entered into an excel sheet. To refine the data-set conjunctions, pronouns, adverbs and the like were removed. This resulted in a total of 733 words for data analysis. Some of the words in this data set of 733 words had a frequency of 2 or higher. For instance of all 733 words, 5 were of the unique word “technology”. The number of unique words within the data set was 198. These 198 unique words were then sorted alphabetically to allow very similar words to be grouped together. For example the unique words ‘tech’ (frequency 1), ‘technologies’ (frequency 6) and ‘technology’ (frequency 5) were grouped into one set with one descriptive word for the set, the groupword. In this case the groupword “technology” with an occurrence of 12. This resulted in a data set of 165 groupwords.

These groupwords were then sorted into common themes based on my own insights. Forty of the groupwords were hard to assign to a common theme convincingly without the context of the full data set. The combined frequency of these ‘unassignable’ groupwords was 180 words of the 733 total. These are groupwords such as ‘important’ (groupword frequency 22), ‘process’ (groupword frequency 18) and ‘different’ (groupword frequency 10). These ‘unassignable’ groupwords were discarded for the first analysis. This resulted in 129 groupwords, whose frequencies summed to 553 of the 733 words, to be assigned to a common theme. These seven themes were used to conduct a data analysis of the full skype interview transcripts by using the methodology of Theming the Data. The seven themes were used to identify blocks of data and were allocated a basic colour code for easy identification. The identified thematic data blocks were pasted into excel in a separate sheet per theme. These separate sheets were printed hard copy and compared with one another for similarities and dissimilarities.

Table 3-1: Thematic coding colours

Step 2 theme based colour coding of data blocks
Time (purple)
Strategy (navy blue)
Protection (light blue)
Proof (dark green)
Money (lime)
Market (orange)
Knowledge (sienna red)

The coding method used in step 3 was based on a predetermined conceptual framework of heuristic patterns as presented in Table 2-2 to facilitate data analysis both within-case and cross-case. In other words, Table 2-2 provided the conceptual framework for data structuring. This coding method is referred to as provisional coding (Saldana, 2013, p.144-146) of data and has structured subsequent data analysis (Saldana, 2013, p.65).

Additionally Step 3 also used the Step 2 results as a conceptual framework to test for patterns in contextual uncertainty for each case. The Step 2 findings were put forward to the decisionmakers to corroborate at the start of the semi-structured interviews for the cases to test the findings of step 2. For each case the decisionmaker was asked to choose the most relevant investment objective from two sets of objectives. These generic investment objectives were distilled from the dataset of step 2. How these objectives and statements were found is explained in the cross case analysis in Chapter 5. The first set of strategic objectives the decision makers had to choose from was (a) I want to exercise control through IP investments or (b) I want to engage collectives through IP investments. The second set of strategic objectives was (i) I am striving to create a position for the short term or (ii) I am striving to create a position for the longer term.

To counter the possibility of researcher bias, the decisionmakers were also presented with four statements on their investment objectives for that particular case, which they were requested to rank. By following this approach the decisionmakers were asked to self-apply magnitude coding. Magnitude coding is a method that applies numbers or other symbols to data that represent values on a scale (Saldana, 2013, p.63). Per case decisionmakers were asked to rank four different statements on their objective for the IP investment of that particular case. Where 1 is most applicable objective and 4 is least applicable objective. The four statements on objectives were taken from the data of step 2 and were: (a) Set (inter)national standards to help industries achieve scale on innovations, (b) Keep up a pace of innovation which consistently outperforms the industry, (c) Use IP as marketing instruments to gain referrals through existing customers and (d) Use IP to create well-protected innovations for select customers. The decisionmakers were first asked if they found these statements logical and if they thought any statements were missing or should be removed. The only suggestion made by all decisionmakers is to delete the word “existing” in statement (c). Lastly the decisionmakers were also asked to plot each particular case on the

Stage Gate™ process of IP creation strategies as illustrated in the funnel of Figure 2-1 to gain insight in where in the R&D or IP creation funnel the particular case was situated.

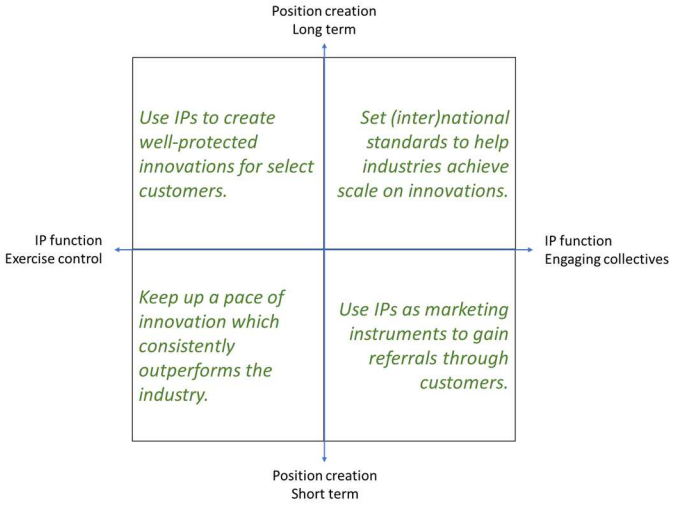
4 Within case analysis

4.1 Introduction

The subchapters are constructed as follows, first an brief overview is given of eachon the division's IPR performance. Then a description and analysis is given of the broad context of uncertainty of each division. Subsequently each case is described and analysed. The chapter is completed with a description of the within case data results.

As discussed in Chapter 3, at the start of each case the decisionmaker was asked a number of questions derived from the step 2 interviews. I briefly want to skip ahead to the cross case analysis, which resulted in a model containing the choice of strategic alternatives decisionmakers were asked to choose from and the four predefined statements the decisionmakers were asked to rank, as illustrated in Figure 4-1. To avoid influencing the decisionmakers, they were not presented with the model during the case discussions although I did use it for the within case analyses.

Figure 4-1: Strategic market objectives and investment decision goals



4.2 Triangle division

In 2018 Triangle created one spin-off. All the RTO's spin-offs are based on IPRs developed by the RTO brought to market under a centralised Technology Transfer Programme. Triangle's substantial IPR portfolio was composed as indicated in Table 4-1.

Table 4-1: Triangle division IPR portfolio

Patents	Copyrights	TradeMarks
218	2	10

Triangle clearly has a patent based IPR portfolio, she states that this has to do with the following.

"Companies have much less interest in collaborating with us on technologies that have not been patented. […] This sounds a little strange since the fact that these patents exist actually means that they must do business with us in order to gain access [...] but they rather have that, then when we ..[would].. come up with ideas that have no protection. Which means that they ..[need].. the guarantee that they ..[can].. have access to a certain level of protection for their own position."

In order to build an attractive patent portfolio for future research partners, Triangle uses four criteria to develop the IPR portfolio. The first is that the technology underlying the patent must have a direct link with the strategic priorities of Triangles' division. In the early stages of creation at the lower TRL levels, quantity is considered to be more important than quality. At the beginning of the creation funnel there are no constraints on patent applications as long as the patents fit the strategic priorities. As time progresses and the technologies mature, many individual patents will be abandoned before the patent application process reaches the 30 month[3] mark since the costs rise exponentially if the quantity approach is pursued in the country phase of patent application.

Patent coherence, where a set of patents together form a structure, is mentioned as the second investment criterion of Triangle. The breadth or reach of a patent, or set of patents, is the third important criterion. If possible Triangle will strive to build sets of patents so relevant to fundamental production requirements of a technology that they are *"unavoidable"* patents. The last important criterion for IPR investment is the level of infringement detectability. The easier it is to detect infringement the better, the harder the worse. From the industry context perspective Triangle is clearly interested in shaping strongholds.

"We really want to build a little castle with fortified walls and towers – something like an IP fortress – around that specific way of manufacturing."

That Triangle aims for a recognisable role as a determined dominator and a reliable relation is expressed by the fact that her division not only has great ideas but that it also already has protection on these great ideas via patents, making her division a more attractive partner to team up with for firms.

4.2.1 Triangle case one

Triangle case one evolved around an investment decision for a new battery technology based on an abandoned patent. The original concept was too expensive for mass production at the time of creation. Due to new technological creations the original idea may become commercially feasible by applying new technologies to it. Triangle could not indicate the exact investment amount for the battery technology

[3] Please see Appendix C for a brief description of the formalities involved with, and the timeframes of, the patent application process.

case. The discussion on the case evolved around a decision that Triangle had to make to invest time and budget to demonstrate of the functional concept of the novel aspects of the battery technology during a site visit to a major automobile manufacturer.

Table 4-2: Triangles responses to the predefined questions for case △1

IPR StageGate™ funnel	
Gate	1
Stage	1
Choose between alternatives	
IP function: exercise control or engage collectives	Control
Position creation: shorter term or longer term.	Longer
Ranking statements	Rank
Set (inter)national standards to help industries achieve scale on innovations	4
Keep up a pace of innovation which consistently outperforms the industry	3
Use IP as marketing instruments to gain referrals through customers	2
Use IP to create well-protected innovations for select customers	1

Triangle placed this case in both gate 1 and stage 1, making the demarcation of the boundaries of this case less clear. The answers on the strategic alternatives support Triangle's indication in the step 2 interview that she aims to use patents in order to create strong long term positions. She preferred to exercise control over engaging collectives. Triangle described this technology as a possible game changer for both the European automotive and Energy industries. From Triangle's point of view there is not only an economic need to protect the technology, also a geopolitical one.

Triangle's ranking of statements provided an inconsistency in their answer. Bearing Figure 4-1 in mind, marketing instruments and customer referrals are shorter term objectives which are hard to control. Triangle ranked this statement as the second most important. Setting (inter)national standards would have been a more likely choice as second most important statement since standards are all about control. Triangle ranked that statement last, declaring it *"completely irrelevant"*. Which in light is salient given fact that Triangle stated that the technology was a possible game changer, in such cases the ability to set a new and accepted standard would mean the division would have created a strong long term market position. The reason for the order of ranking provided by Triangle may stem from the value Triangle places on the opinion of a leading manufacturer on Triangle division's novel battery technology which is expected in the short term and the possible impact the manufacturer's opinion may have on the long term IP creation activities related to the technology.

" ... that we have the faith of an external party [and that we are] gaining credibility with a major large manufacturer. They have to believe in it."

The specific R&D uncertainties identified for Triangle in Table 4-3 are related to the novelty of the technology, the technical feasibility of the concept and whether or not the new battery concept will in time be adopted by the market.

"It's combining an old idea with a new toolbox. For us it was completely new. We didn't 'do' batteries. People said I was crazy."

Table 4-3: R&D uncertainties identified for case △1

Specific R&D uncertainties	
R&D Activities	HIGH
Novelty	HIGH
Market needs	HIGH
Evaluation	Unknown
IP application procedures	Unknown
Conditions & protection	Unknown
Failure of IP markets	Unknown
Protection of IP	HIGH

The data suggests that Triangle used the heuristic of Satisficing. The identified capabilities that Triangle used in this case was experience memory. Triangle relied on her experience with the people who provide her with information. She recalled earlier decisions and judged whether or not this was someone who

"is in touch with the outside world or whether this is someone who lives in an academic ivory tower."

Time pressure for Triangle is always high, she has hundreds of things to do, her time is limited. She feels her whole division is under high time pressure. *"Continuously. All the time. Always."* This means that she cannot afford to dive into a topic thoroughly, to read up on it and check things herself. She relies heavily on others for information. This case was also marked by high systemic uncertainty. This is corroborated by the R&D uncertainties identified in this case. Triangle described it as follows:

"Even when all those lights are green, then there will still be questions left. … even if we can do it with an economic business case, is this industry prepared to adopt a pretty new and disruptive method for making batteries? There are many examples of superior technologies that didn't make it."

For the case Triangle set her aspiration level to be able to demonstrate the principles of the technology to a large manufacturer who had considerable expertise in battery manufacturing. The identified heuristics building blocks were related to this aspiration level, where different concepts for the new battery technology were worked on and at some point the one that seemed to be working best was chosen. What her team had done is to start by thinking in vey broad terms and for a while put a few different developed concepts next to each other. When asked, the team indicated that they had identified one technological

approach that seemed to be working. For Triangle this was the object that met her aspiration level was considered good enough to go forward.

Table 4-4: Heuristics data for case △1

(CAP)ABILITIES	**(Cap)Abilities** *Which capabilities were used*	
	Imitation	NO
	Object tracking	NO
	Recency monitoring	NO
	Memory recall	NO
	Recognition memory	NO
	Frequency monitoring	NO
	Experience memory	YES
HEURISTIC CHARCTER-ISTICS	**Environmental context** *How uncertainty manifests itself*	
	Dynamics	HIGH
	Volume	Unknown
	Inconsistency	HIGH
	Substitutionability	HIGH
HEURISTIC BUILDING BLOCKS	**Search rules** W*here to look for information*	
	Peer group observed	NO
	Aspiration level set	YES
	Time threshold set	NO
	Cues validity assessed	NO
	Cue validity ranked	NO
	Object recognised	NO
	Object similarity sought	NO
	Stopping rules *When to stop searching for information*	
	Peer group behaviour understood	NO
	Aspiration level achieved	YES
	Time threshold reached	NO
	First positive cue identified	NO
	Cue tally conducted	NO
	First object recognised	NO
	First similar object found	NO
	Decision rules *How to decide given the attained information*	
	Best object identified and chosen	NO
	Best object guessed	YES

Triangle provided the insight that the source of the information is important in terms of both credibility and trust, and that some sources are considered to be more credible and trustworthy that others. For

Triangle this relates to both the feasibility of the technology and market creation of the new technology. She indicated that she finds it prudent to not just follow the judgements of her own people. When presented with information she will ask herself whether it was compiled by someone who is sitting in their own technological ivory tower dispensing judgements or whether it is someone who is very aware of what other parties are doing and how the technology is related to everything that is going on outside the organisation, in the rest of the world. She finds the latter an important aspect of credibility and she will ask herself: *"Do I really believe them?"*

In principle she values the opinion of a company who has considerably more expertise in battery creation more, than the opinion or judgement of her own people. For her the major trigger was a large company indicating that they thought that is was an interesting technology. That this company, as experts on battery technologies, did all sorts of calculations and that their conclusion is that the technology her division is creating made technical sense.

Table 4-5: Heuristics additional results for case △1

Object trustworthiness assessed	YES
Cue credibility assessed	YES
Cue credibility ranked	YES
Process typology	Process within process

In this case Triangle found it difficult to isolate one decision to focus the discussion on. She described her hesitation as follows, where the underscores in the quote indicate conversational silences:

"I think, _I, _, I find it very hard to split such a trajectory in well this was part A and then a decision, and then part B. And, _ and _ , it is much more."

This supports the additional case result that Triangle experienced the decision as a process within a process. This is corroborated by Triangle not being able to place this case in either a stage or a gate but in both gate 1 and stage 1 as indicated in Table 4-2.

4.2.2 Triangle case two

The second case involved an investment decision on the creating of a spin-off for display manufacturing technologies. The investment amount involved was not disclosed publicly, nor could it be distilled from the consolidated annual statement of the RTO. Triangle stated that the spin-off fell within her mandate, while the formation of a spin-off requires the formal agreement of the RTO's Board of Directors and in this case even the approval of RTO's Board of Supervisors. This suggests that having to formally involve both Boards does not seem to impede Triangle's sense of freedom to decide.

Table 4-6: Triangles responses to the predefined questions for case △2

Choose between alternatives	
IP function: exercise control or engage collectives	Control
Position creation: shorter term or longer term.	Shorter
Ranking statements	Rank
Set (inter)national standards to help industries achieve scale on innovations	1
Keep up a pace of innovation which consistently outperforms the industry	3
Use IP as marketing instruments to gain referrals through customers	2
Use IP to create well-protected innovations for select customers	4

The intended strategic objective of the investment was to create controlled IP for the shorter term. Taking Figure 4-1 into account, the highest ranked statement seems contradictory to the indicated strategic objectives. Setting standards is associated with longer term collectives engagement. Using IP as a marketing instrument is indeed shorter term, but not one that would be associated with control. The reason for this inconsistency may lie in the following. Triangle described the history of the case, the value-chain of the technology and the context leading up to the spin-off of the display technology. She stated that when this display innovation was brought to the market different parties were and are needed.

"This is interesting because, you're dealing with a value chain. When you bring this display innovation into the market you need parties that can make production machines [for displays] and you have parties who buy these production machines so they can manufacture displays."

Parties that can make production machines for displays can be seen as 'ASML analogues'[4]. The other type of party would typically be electronics giants, who buy these production machines so they can manufacture displays. As an 'ASML analogue' the spin-off will have few customers, mostly the large electronics giants. Whereas the electronics giants have masses of both business and consumer customers. For the latter type of company, engaging the masses is indeed an objective. Throughout the interview Triangle switched between two types of parties.

In the media one of the investors in the new company stated that the spin off had the potential to become a leading machine supplier in the global display market. This exemplifies that the spin-off was launched by the RTO to create an 'ASML- analogue' to build machines for electronics giants, allowing the identification of a clear strategic market position and a clear customer objective for the spin off.

The R&D uncertainties are high in relation to being able to fulfil two identified market needs, display flexibility and display energy efficiency. The R&D activities have to do with the spin-off's ability to be able to make a machine that can produce the new type of displays and fulfil these identified market needs.

[4] This refers to the company ASML who makes machines that can manufacture computer chips for companies such as Intel.

Novelty and evaluation are more certain since Triangle had done a similar thing with the core technology in the manufacturing of solar cells.

Table 4-7: R&D uncertainties identified for case △2

Specific R&D uncertainties	
R&D Activities	HIGH
Novelty	LOW
Market needs	HIGH
Evaluation	LOW
IP application procedures	Unknown
Conditions & protection	Unknown
Failure of IP markets	Unknown
Protection of IP	Unknown

The identified heuristic is the Similarity Heuristic. Triangle used her experience memory from innovation on previous products.

"We're good at making very, very, thin layers. With this knowledge we started in OLEDs and because we became good at manufacturing processes for OLEDs, moved to solar cells and we ended up in the display industry."

The environmental context of this case is characterised by a high dynamics and high time pressure, since an investor had been found who expected the technology to be brought to market via the spin off at a certain date. Triangle perceived the volume of information supplied to her as high.

"There was a lot of information to keep track of."

Triangle indicated that her division had been active with the thin layer technology for over ten years. That she had created a very similar spin-off earlier with the same base technology for OLEDs and solar cells. As a result she had already discovered that it would be possible to apply this technology, be it in another domain. Triangle felt confident she could translate it to a production machine that was capable of claiming a position in the display market. Triangle described that she felt very comfortable to move ahead with the spin-off even when the envisaged partner company shied away at a late stage. She knew from experience that the technology would work and that the spin-off could be successful. This was her core motivation to take the decision.

"We had the technology, we knew the market, we had the position, let's go and do this ourselves and create a joint venture."

Table 4-8: Heuristics data for case △2

(CAP)ABILITIES	**(Cap)Abilities** *Which capabilities were used*		
	Imitation		NO
	Object tracking		NO
	Recency monitoring		NO
	Memory recall		NO
	Recognition memory		NO
	Frequency monitoring		NO
	Experience memory		YES
HEURISTIC CHARCTER-ISTICS	**Environmental** *How uncertainty manifests itself*	**context**	
	Dynamics		HIGH
	Volume		HIGH
	Inconsistency		Unknown
	Substitutionability		Unknown
HEURISTIC BUILDING BLOCKS	**Search** *Where to look for information*	**rules**	
	Peer group observed		NO
	Aspiration level set		YES
	Time threshold set		NO
	Cues validity assessed		NO
	Cue validity ranked		NO
	Object recognised		NO
	Object similarity sought		YES
	Stopping *When to stop searching for information*	**rules**	
	Peer group behaviour understood		NO
	Aspiration level achieved		YES
	Time threshold reached		NO
	First positive cue identified		NO
	Cue tally conducted		NO
	First object recognised		NO
	First similar object found		YES
	Decision *How to decide given the attained information*	**rules**	
	Best object identified and chosen		YES
	Best object guessed		NO

Triangle's effort to apply clear boundaries for the case was very similar to the first case, illustrating that Triangle considered this decision-making process to be part of a much larger process. The underscores in the quote indicate conversational silences:

"I find it a bit _ a bit hard to determine how I should interpret _ the _ the terminology. It's not one or a case _ well [sighs] _ yes. I'm going to make it nice and complicated ..."

Triangle could clearly indicate how she came to the investment decision for the spin off. Her division and another company who was active in the display market jointly made a good and solid business case and plan. On the one hand she had someone from her own organisation in the lead. Someone whom she believed, someone whose competence she trusted. On the other hand this person's technical knowledge was augmented by a company active in the display industry who knew their industry well. This company could asses a business case from their level of market knowledge and demonstrate that the technology would have added value for the industry.

"... in this case credibility has less to do with technical credibility but much more with the question: will this technology have added value in the display industry?"

Table 4-9: Heuristics additional results for case △2

Object trustworthiness assessed	YES
Cue credibility assessed	YES
Cue credibility ranked	YES
Process typology	Process within process

4.3 Square division

In 2018 Square created one spin-off. All the RTO's spin-offs are based on IPRs developed by the RTO brought to market under a centralised Technology Transfer Programme. Square's IPR portfolio was composed as indicated in Table 4-10.

Table 4-10: Square division IPR portfolio

Patents	Copyrights	TradeMarks
39	18	8

Square's IPR portfolio is mixed. Depending on the context an emphasis will be placed on either patents, copyrights and/or know-how.

"We keep ownership of, and license out, our IP. Patents are often licensed to spin-offs. Software ..[is].. put .. at arm's length quite quickly ..[and].. we give someone else the right to license. We are not going to license it ourselves. [This way] ... we are also securing the relation providing us with something we can build on. "

The creation of IP occurs via knowledge investment programmes, where the portfolio of generated and existing IP is managed diligently since they are extensive processes involving a lot of money. When developing patents there is a formal application procedure. Before Square's division enters into these patent application formalities an internal process is run. This is typically for teams working on strategic IP creation, with patent creation objectives. The division's IP manager acts as a gatekeeper. She puts forward the patent requests to be discussed with her division head, the IP manager and the inventor. The business case is assessed and whether a business developer will support the business case. Sometimes interesting things will *"just pop up"* because people have an idea, depending on the idea it can be evaluated and possibly patented.

Software is a way in which Square division's unique know-how on how to grasp and harness complexities can be made explicit and transferrable. Patents are a way to secure unique inventions for which Square has a dual approach, a set of 'interesting things' requiring further investigation and 'strategic IP' which supports two key knowledge positions of the division.

Square is very clear about pursuing the role of reliable relation by following the investment objective goals of shaping strongholds and crafting crowds by creating multiple spin-offs per year. For her patents are a form of security underpinning the spin-off. If there are no patents in a spin off she states it ends up being loose sand.

"Patents offer protection to a spin-off to allow it to develop itself and it secures the relationship between our organisation and the spin-off. For me that is also important, that with the license on the patent(s) we are also securing the relation providing us with something we can build on."

4.3.1 Square case one

Square case one concerned the decision to invest 100.000 Euro to build a lab setup, or proof of principle, for a heat storage technology. The intended strategic objective for the investment was to create controlled IP for the longer term. This is reflected in the ranked statements where using IP to create well protected innovations was selected as most important. The second ranked statement is in the same area of control but on the shorter term. Square indicated that she found the ranking a bit hard, she thought out loud while considering the statements and explained her choices as follows. Her division was ahead of the market in heat storage technology due to an earlier innovation. She wanted to keep her market lead, so she needed her division to keep up the speed. In this case her priorities were organised this way: protect IP, keep up the speed and then use the newly created patents and momentum from this case for marketing purposes in the near future to be an attractive partner in collaborations. She did not consider upscaling a factor of importance in this particular case.

Table 4-11: Square's responses to the predefined questions for case ☐1

Choose between alternatives	
IP function: exercise control or engage collectives	Control
Position creation: shorter term or longer term.	Longer
Ranking statements	Rank
Set (inter)national standards to help industries achieve scale on innovations	4
Keep up a pace of innovation which consistently outperforms the industry	2
Use IP as marketing instruments to gain referrals through customers	3
Use IP to create well-protected innovations for select customers	1

The R&D uncertainty for the novelty of the technology and the market needs are related. She wants to build a heat storage technology development line so that a system can be created that is potentially fit to install in a household. The previous version of this technology that used a different chemical compound was developed up to TRL level 6 to 7, when it became clear that it might create a security issue due to the toxic nature of that compound. This case saw to the proof of principle of another type of chemical compound which was not toxic. Although the patents were secured just prior to starting the lab setup, she viewed the first filings of the patents to be more of a first assurance of the total concept. She indicated not to have a full IP strategy yet.

Table 4-12: R&D uncertainties identified for case ☐1

Specific R&D uncertainties	
R&D Activities	Unknown
Novelty	HIGH
Market needs	HIGH
Evaluation	Unknown
IP application procedures	LOW
Conditions & protection	Unknown
Failure of IP markets	Unknown
Protection of IP	HIGH

Two heuristics were identified Take the Best and Similarity. The similarity heuristic was used by Square because she drew on experience done up with a previous version of the storage technology, using a toxic chemical compound. Although work on the old technology was discontinued, it had provided a frame of reference for the current case. Square explained that the new technology was much safer and also considerably cheaper to develop than the previous technology.

"And I thought: 'This is what I'm getting for 100k€? Well that's actually quite a bargain!', but I didn't tell them that! [laughs]"

Square used her memory recall capabilities to learn from her experience with the previous version of the heat storage technology. Take the Best was related to having a few alternative technologies to choose from, one toxic and a few non-toxic alternatives. She initially received three stories on non-toxic

compounds and she knew that the added value of the technologies *"would be of the Big Picture kind"*. At some point she had a meeting with the business developer, lead scientist, and the rest of the team and asked them to help her identify the best one. The team clarified how they would execute the project, it would be a modular approach with a number of readily available items they wanted to buy. The team described how they wanted to assemble the setup and they explained what parts they had to develop. Finally they indicated what they thought was the best of the concepts. She weighed the three alternatives in her mind and followed the advice of her team. The chosen heat storage technology had the benefit of not only requiring less initial investments but it could also be developed the quickest of the technologies under investigation. She remembers thinking

"hey wait a minute so they can bring this to TRL 4 in just 18 months … and that for 100k€ and then I have something that has the same benefits as the old technology using Compound 1 and all the risks removed. Well, …" [smiles broadly and lets the sentence trail off]

Table 4-13: Heuristics data for case ☐1

(CAP)ABILITIES	**(Cap)Abilities** *Which capabilities were used*	
	Imitation	NO
	Object tracking	NO
	Recency monitoring	NO
	Memory recall	NO
	Recognition memory	YES
	Frequency monitoring	NO
	Experience memory	YES
HEURISTIC CHARCTER-ISTICS	**Environmental context** *How uncertainty manifests itself*	
	Dynamics	HIGH
	Volume	Inconclusive
	Inconsistency	HIGH
	Substitutionability	HIGH
HEURISTIC BUILDING BLOCKS	**Search rules** *Where to look for information*	
	Peer group observed	NO
	Aspiration level set	YES
	Time threshold set	YES
	Cues validity assessed	YES
	Cue validity ranked	YES
	Object recognised	NO
	Object similarity sought	NO

HEURISTIC BUILDING BLOCKS		
	Stopping rules *When to stop searching for information*	
	Peer group behaviour understood	NO
	Aspiration level achieved	YES
	Time threshold reached	YES
	First positive cue identified	YES
	Cue tally conducted	NO
	First object recognised	NO
	First similar object found	NO
	Decision rules *How to decide given the attained information*	
	Best object identified and chosen	YES
	Best object guessed	NO

Although Square listened carefully to her team she is very much aware that a setup for a new technology *"is always someone's darling"*. She understands that people have the tendency to cling to their own ideas, making them less objective towards their own research. She is always filtering information offered to her as follows,

"Is this a realistic story or is someone exaggerating or are they being carried away by their own energy, and sometimes also by their own ambition?"

Square is sensitive to the credibility of the information offered to her. She will use different people to qualify different pieces of information available to her. What is leading for her is,

"Where do I trust someone and where does it stop? Every person that I use in that, has a certain area in which I trust them and an area in which I don't trust them."

If the involved lead scientist would have indicated that the calculations did not add up to something positive and that the technology would not work out, she would not have given her consent.

Table 4-14: Heuristics additional results for case ☐1

Object trustworthiness assessed	YES
Cue credibility assessed	YES
Cue credibility ranked	YES
Process typology	Process within process

Square had a clear plan and timeframe in her head when making this decision, which she explained. Square case 1, the Lab setup, would lift the technology to TRL 4 in one and a half years. After completion she made another investment in another project running at the moment, which is not under discussion in this study, to lift the storage technology to TRL 5. This project is scheduled to be completed before the project of Case 2, the EU project, could commence. Her reasoning is that in EU Framework projects the technology entered must be at least at TRL 5 at the start of the EU project. She was clear that although the investment

decision of Case 1 was an identifiable decision, she considered it to be part of a grander strategy in a heat storage technology development line.

4.3.2 Square case 2

The investment decision for Square's second case, the EU project, amounted to 1.000.000 Euro in order to enter a bid for a Horizon 2020 call for proposal with the same storage technology as Case 1. The two cases are closely related and part of the same strategy for a technology development line. Square indicated that she felt that her mandate was exceeded, not because of the required budget but because of the implications of the EU project for her division. She made sure her boss was *"on board"*. The TRL was set between 4 and 5. The intended strategic objective of the investment was to engage collectives to use the IP for the longer term. When the ranked statements are taken into account, bearing Figure 4-1 in mind an unexpected shorter term goal appears, use IP as market referrals. Square made comments while ranking the statements, indicating her train of thought. When the technology is entered in the EU project the situation shifts and the pace of innovation becomes important because the technology must be upgraded to TRL level 7 during the four year project. She wanted to have her secured her IP upfront to allow her unique technology to become more of a marketing instrument within that consortium.

"the consortia are always big and you need to bring something to the table if you want to have a role of any importance in such a large group".

She had entered the patent application before Case 1 started, so that point was addressed. She indicated scaling would occur after the EU project is completed, since the heat storage concept is expected to have the required technological maturity by then.

Table 4-15: Square's responses to the predefined questions for case ☐2

Choose between alternatives	
IP function: exercise control or engage collectives	Collectives
Position creation: shorter term or longer term.	Longer
Ranking statements	Rank
Set (inter)national standards to help industries achieve scale on innovations	4
Keep up a pace of innovation which consistently outperforms the industry	1
Use IP as marketing instruments to gain referrals through customers	2
Use IP to create well-protected innovations for select customers	3

The R&D uncertainties for this case were low, the storage technology with the new chemical compound was easier and safer to build, the technology was proven in the lab setup and another national project. Due to changing perspectives on climate and geopolitical changes, the market was expected to be receptive to the technology.

Table 4-16: R&D uncertainties identified for case ☐2

Specific R&D uncertainties	
R&D Activities	LOW
Novelty	LOW
Market needs	LOW
Evaluation	Unknown
IP application procedures	Unknown
Conditions & protection	Unknown
Failure of IP markets	Unknown
Protection of IP	Unknown

The heuristics identified in Square case 2 were the Take the Best heuristic and the Recognition heuristic. The Recognition Heuristic is related to her memories of the previous heat storage technology. This older concept had been entered in an earlier H2020 project which Square had decided to leave. After understanding the consequences of the toxic compound used, she seriously questioned the commercial feasibility of the old technology. From this earlier project she knew who the noteworthy players in this particular market were. From her previous experience she had expected a number of manufacturers to participate in the project. She searched for these names, and was surprised to not to recognise the names of the participants in the bid at hand. For Square it was about expecting to recognise an information cue in the bid, and the failure of being able to do so that caught her attention. The Take the Heuristic is based on her memories and experiences with the previous heat storage technology and the lab setup of case one. These two cases provided her with a means to validate the information offered to her. She compared the information in this case with investments from the past, and from that experience judged the validity of the claims in the bid she was asked to sign.

"… and then I have to spend so much on this project, so how does it relate to this [previous] case?

Square explains that for EU projects the scope is always clearly defined, this has to do with the large amounts of money involved and with the complex administrative requirements of EU projects. Square will routinely match the information in the management summary to the project scope which she defined upfront with all the involved researchers and business developers. When she sees things that she does not recognise because they are out of the predefined scope she will reject the summary and send it back. For her cue validity is based on her assessment of the EU project proposal itself. She had to send back the management summary a number of times. Details on the consortium, financing, objectives and roles of the Square division in the proposal did not match the agreements she made with her team earlier. This implies that for her cue validity is not so much related to the cue as being true or correct in itself but true or correct in relation to previously defined scope and related agreements. She will base these agreements on her ability to recall earlier experiences.

"That you look at: what is my option, and you look at: is the investment in proportion to the future benefits. But as a kind of option of course ... And you compare it with investments from the past."

Table 4-17: Heuristics data for case ☐2

(CAP)ABILITIES	**(Cap)Abilities** *Which capabilities were used*	
	Imitation	NO
	Object tracking	NO
	Recency monitoring	NO
	Memory recall	NO
	Recognition memory	YES
	Frequency monitoring	NO
	Experience memory	YES
HEURISTIC CHARCTER-ISTICS	**Environmental context** *How uncertainty manifests itself*	
	Dynamics	HIGH
	Volume	LOW
	Inconsistency	Unknown
	Substitutionability	Unknown
HEURISTIC BUILDING BLOCKS	**Search rules** *Where to look for information*	
	Peer group observed	NO
	Aspiration level set	Inconclusive
	Time threshold set	YES
	Cues validity assessed	YES
	Cue validity ranked	NO
	Object recognised	YES
	Object similarity sought	YES
	Stopping rules *When to stop searching for information*	
	Peer group behaviour understood	NO
	Aspiration level achieved	YES
	Time threshold reached	YES
	First positive cue identified	NO
	Cue tally conducted	YES
	First object recognised	NO
	First similar object found	NO
	Decision rules *How to decide given the attained information*	
	Best object identified and chosen	YES
	Best object guessed	NO

In this case Square was dissatisfied with the details on the budget in particular, it was nearly double of what was agreed with the team, and from Square's perspective an invalid piece of information that needed correction.

"So I had something like, wait a minute – what's this?"

The aspect of being able to trust the source of information was a critical factor. EU proposals are very formal requiring a specific country spread of participants coupled with strict budgeting rules. This amounted to confusion in the bid as the researchers attempted to solve a formal problem while building the consortium for the bid, by allocating the budgeted costs to Square's division and the budgeted income to another organisation. Square had to actively pursue the matter herself to obtain the information behind the budget overshoot which cost her several months. After discovering why the bid went widely over budget and confronting those responsible, the budget error was corrected in a few days. Square was not amused, the underscores in the quote indicate conversational silences:

"What are they messing about there, are they trying to give me the run-around? You see this department trying to stretch their budget _ and then you feel _ that dents the trust _ that's damaging."

Eventually the team did write a bid that matched the agreed upon scope. The moment the summary met this threshold, Square agreed to sign the EU bid.

Table 4-18: Heuristics additional results for case ☐2

Object trustworthiness assessed	YES
Cue credibility assessed	YES
Cue credibility ranked	YES
Process typology	Process within process

Square also indicated that the credibility of the information offered is important. She stated that the researchers involved in making the bid have *"a low critical capability"* to make an objective cost-benefit analysis of the financials of the bid. Indicating that researchers generally just want to find a way to realise their scientific ambitions. As a result they have a limited interest to assess aspects such as the return rate on investments for the Square division or the RTO as a whole.

"For him [the researcher] it's just a game on how to get financing for the next step in his research."

4.4 Circle division

In 2018 Circle created two spin-offs. All the RTO's spin-offs are based on IPRs developed by the RTO brought to market under a centralised Technology Transfer Programme. Circle's substantial IPR portfolio was composed as indicated in Table 4-19.

Table 4-19: Circle division IPR portfolio

Patents	Copyrights	TradeMarks
256	21	5

Circle's IPR portfolio is primarily patent based, copyrights are of secondary importance and trademarks are recently gaining in importance. The reason for emphasising speedy patent creation is this,

"We must be able to create and sell a lot of new knowledge positions very fast. This is contrary to how most RTOs operate. Most RTOs want to create and maintain a certain position for a long time. This does not work for us, we operate in a market in which technologies evolve so rapidly that they are obsolete after 3 years. When you compare this to formal patent application processes, which on average last 10 years, that takes too long."

Circle makes a distinction between know-how and show-how. IP creation is done via portfolio management and knowledge investment programmes. For Circle IR is only interesting as show-how. From her view IPRs are there to act as demonstrators that the division can apply specific knowledge and technologies. Patents are used as a form of evidence, proof of that the technologies which the division develops matter in the long run. Patents are interesting since they can contribute to scientific positioning metrics and contribute to valorisation targets set by the RTO's Board of Directors. When having to choose between a publication in a peer-reviewed journal or filing a patent, Circle will choose to apply for the patent since patents are an applied form of publication. Although software can be patented, this is rare. More often software has a copyright which is used to claim ownership to code. The code is increasingly made available in a gratis Open Source license. Licensees are obliged to refer to the origin of the base code when re-using the code facilitating a fast and large scale uptake of the code. In the industry in which Circle operates, these structural referrals to the RTO are noticed quickly.

"By making it open we can fire up more people and create a community. This will make us more attractive for companies to partner with."

Circle describes three investment goals maintaining momentum, crafting crowds and gaining rapid referrals. Circle switches between various roles. The role of determined dominator is achieved because she only focusses on a very select number of strategic positions that she wants to retain for her division for the long term. At the same time copyright will remain important to her division because ownership of the code remains with Circle, even when the code is open. Circle also aspires the role of Agile Ally in that she wants to valorise all other patents in *"an agile way."* She states to have increased the agility of her division by increasing its' science positions by a factor of times ten. Lastly Circle seeks the role of Mass Moderniser

"A shift that they [customers] are using open source more and more .., this forces us to develop our own software open source. ... the moment we make things OS ... and with this OS license enforce that re-use of

the code requires a referral to us. The value is in the referral, in showing that the code originated with us. That makes us attractive."

4.4.1 Circle case one

The first case from Circle division concerned an investment decision of 150.000 Euro to continue creation of an existing media concept. During the data collection in step 2 it became clear that Circle had not yet made a final investment decision. During the later initial findings interview Circle indicated she had decided not to invest. The intended strategic objective for the investment was to engage collectives for the longer term.

Table 4-20: Circle's responses to the predefined questions for case ○1

IP StageGate™ funnel	
Gate	4 and 5
Stage	4 and 5
Choose between alternatives	
IP function: exercise control or engage collectives	Collectives
Position creation: shorter term or longer term.	Longer
Ranking statements	Rank
Set (inter)national standards to help industries achieve scale on innovations	4
Keep up a pace of innovation which consistently outperforms the industry	2
Use IP as marketing instruments to gain referrals through customers	3
Use IP to create well-protected innovations for select customers	1

When comparing the ranked statements to the objectives it becomes clear that exercising control was a more dominant priority for Circle, the second ranked statement would suggest that dominance is a priority even in the short term. Which, in relation to Figure 4-1, seems contradictory to the long term strategic objective. Circle explains it as follows, for her this case is a typical example of knowledge that the RTO currently only brings to market in a consulting form. The decision at hand was whether or not to do this in a product form as well. The change from knowledge to product is an investment and for her it is all about that investment. She wanted to create a longer term position in the media sector for the product because otherwise it would not make much sense to continue with it right now. The knowledge base for the long term is there, but she also wanted to create short term solid market base for the product. Circle was not able to place this case in either a stage or a gate but in two gates and two stages. This implies that Circle was unable to clearly demarcate the boundaries of this case.

Table 4-21: R&D uncertainties identified for case O1

Specific R&D uncertainties	
R&D Activities	Unknown
Novelty	Unknown
Market needs	HIGH
Evaluation	HIGH
IP application procedures	Unknown
Conditions & protection	Unknown
Failure of IP markets	Unknown
Protection of IP	Unknown

The R&D uncertainties in this case stem from the market needs, she indicated the media sector is a vendor driven market. The vendors have to pre-invest in order to drive innovation and the vendors have to hope for buyers who want to purchase and market a product made by them. This is how a vendor would earn back their investment. For instance if the Circle division would want to deliver a product that it had to develop first, it will ask a company 'will you invest in it?' In the media market companies will respond with 'if you develop the product first and I think it is interesting I will resell the product.' All the innovation risks are with the vendors. On top of that the media market consists of a multitude of small companies and start-ups who have a lot of financial ups and downs. The risk for a vendor is considerable in that somewhere in the commercial relation you are likely to end up in a financial dispute because your customer has run out of money.

"There are a number of characteristics in that market. These characteristics are typical of the entire media market, you could call the uncertainties systemic. I think for us the most important one is the pre-investment, that's where the pain is."

The data of case one was insufficient to identify any capabilities Circle may have used in the decision-making process. As a result these have been omitted in Table 4-22.

Table 4-22: Heuristics data for case O1

	Environmental context *How uncertainty manifests itself*	
HEURISTIC CHARCTER-ISTICS	Dynamics	Inconclusive
	Volume	LOW
	Inconsistency	LOW
	Substitutionability	LOW

HEURISTIC BUILDING BLOCKS	**Search rules** *Where to look for information*	
	Peer group observed	NO
	Aspiration level set	NO
	Time threshold set	NO
	Cues validity assessed	YES
	Cue validity ranked	YES
	Object recognised	NO
	Object similarity sought	NO
	Stopping rules *When to stop searching for information*	
	Peer group behaviour understood	NO
	Aspiration level achieved	NO
	Time threshold reached	NO
	First positive cue identified	NO
	Cue tally conducted	YES
	First object recognised	NO
	First similar object found	NO
	Decision rules *How to decide given the attained information*	
	Best object identified and chosen	Unknown
	Best object guessed	Unknown

In this case no heuristic could be conclusively identified, the data suggests the Tallying heuristic may have played a role but the is data contradictory for a positive identification of this heuristic. Even though Circle calls the context systemically uncertain she does indicate that for her time pressure is always relative. From her perspective the Circle division is *"never engaged in in something that is urgent and of today"*. In her opinion that is simply not how the division is positioned. These two factors do not allow a conclusive interpretation of the context dynamics.

Circle stated that this would be the last investment decision she would make for this technology, regardless of the outcome of this particular decision. Although this could indicate a threshold of sorts, Circle made it clear that she made that decision to stop after this investment already and it would not influence this particular investment decision.

Circle described that she will only find information credible if it contains a lot of external sources. Indicating she will count these on the basis of the more the better. She also indicated that she would find the number five acceptable. Clearly specifying what she considered to be a valid cue, which she both ranked and counted.

"Comparing and weighing different external sources is always a bandwidth. A source of n equals one is not very well weighted ... [I am used to] about five analyst bureaus as a default with whom you can order custom analysis."

For the Tallying heuristic to be in play cue substitutionability must be high, in other words there has to be no to little interdependence between the cues. For this heuristic it really would not matter if you were missing any or even most of the P's or C's[5]. This is contrary to what Circle states,

"You need your target market and all the P's and all the C's, no matter what model you are using. You need a good story on all these dimensions."

Table 4-23: Heuristics additional results for case O1

Object trustworthiness assessed	YES
Cue credibility assessed	YES
Cue credibility ranked	YES
Process typology	Process within process

Circle does elaborate on information credibility and source trustworthiness. She places great value on solid market analysis to deliver proper market figures. The skill to represent these market figures in a credible manner to something that can be concretely applicable to a particular case is of great value to her. In her experience the employees of the Circle division do not have skills and abilities to do this. She absolutely wants a substantiation from external sources.

"Have they underpinned their arguments with reports? So external analysis that they have used, expert views that they have mobilized, … the more external sources that are used to underpin the benefits the more value I will give the information."

She also considers the trustworthiness of her information sources to be important. In her experience the people who report to her *"in all their enthusiasm – just say anything".* She considers enthusiasm to be a poor advisor and realises that her people are not market analysts and they should not promote themselves as if they have all the knowledge on a market. She finds that information on the market needs to be obtained elsewhere.

4.4.2 Circle case two

Circle's second case is on an investment on a new type of infrastructure technology. Although Circle is convinced that an investment has to occur and she is committed to making one, she had not determined the exact amount to invest yet. The intended strategic objective for the investment was to engage collectives to use the IP for the longer term. This is consistent with her ranking statements where setting

[5] This is popular marketing terminology, the Ps are Product, Price, Place and Promotion. The Cs are Customer needs, (customer) Costs, (customer) Convenience and Communication.

standards to scale is given the highest rank. Keeping up a pace of innovation is ranked second, which is associated with shorter term control, as described in the concept of Figure 4-1. Later in the interview Circle says this about the case which is consistent with pursuing shorter term goals,

"And the customer cannot switch … too fast because of their dependency on their suppliers. But we can switch … rapidly, so eventually we can help the customer."

Circle describes that her division is moving from closed source to open source. This means a shift from 'I want more control over what we have' to 'I want to be credible in the community'. For her the collective is *"super-important"*. In line with the importance of the collective she wants a clearly visible knowledge base for the long term on open source technology, she views these two as intertwined. Circle underscores this when she states:

"That's why we have to move now, we have to create a new position now to be relevant in 10 years' time. This is really urgency from the market, changing market relations force us to turn our business model upside down."

The aspect to note is that Circle is striving to achieve a long term strategic objective, but realises that the execution of that strategy involves activities in the short term.

Table 4-24: Circle's responses to the predefined questions for case O2

Choose between alternatives	
IP function: exercise control or engage collectives	Collectives
Position creation: shorter term or longer term.	Longer
Ranking statements	Rank
Set (inter)national standards to help industries achieve scale on innovations	1
Keep up a pace of innovation which consistently outperforms the industry	2
Use IP as marketing instruments to gain referrals through customers	3
Use IP to create well-protected innovations for select customers	4

Circle indicated that this decision is more than just an investment, it is a decision on whether or not to follow a completely different IP strategy. This creates uncertainty in the actual R&D activities the division has to perform and in the needs of their current customer set. Both are geared toward the old technology based on closed IP strategies.

"… the core technologies of our customers is composed of open source components. Well that has put a bomb underneath the business model of traditional suppliers, but it is interesting for us because it creates an entry into a new market."

Table 4-25: R&D uncertainties identified for case O2

Specific R&D uncertainties	
R&D Activities	HIGH
Novelty	Unknown
Market needs	HIGH
Evaluation	Unknown
IP application procedures	Unknown
Conditions & protection	LOW
Failure of IP markets	Unknown
Protection of IP	LOW

The identified heuristics in Circle's second case are those of Similarity and Smart Follower. Circle has assessed that the primary industry they are active in is rapidly switching to open standards. With a specific type of data processing technology used in this industry, this switch has been apparent for quite a while. She compares the changes she is observing in the data processing technology to the infrastructure technology currently being developed.

"I compare these two worlds because here you see the necessity of it. And it also shows how it's hard, because we are not yet broadly engaged in Open Source."

The uncertainty with this case is of a systemic nature. The strategic shift she is about to undertake with her investment has a high level of uncertainty for her:

"A … shift of creating proprietary IPR for a specific customer to developing Open Source for a new customer set … is a monumental shift for us because we have never, never positioned ourselves like this before."

The information Circle has available is related to another type of technology that has undergone a similar path. She compares these two technologies because it shows her the necessity of the change she has to make and the required investment. The data processing technology also shows how the strategic shift is hard, because her division is not yet broadly engaged in Open Source.

"Our model now is to close and protect everything we make, this protection then determines our position. The opposite will be true in the future."

She is bolstered to go forward with the new IP strategy and the switch to open source standards because she has observed that another European RTO has done this already. This RTO has a program in which they use self-invested and self-developed open source infrastructure technology. Circle's division is using this other RTOs' technology to gain experience and to assess the potential of doing something similar. The fact that this other institute has been developing their Open Source infrastructure technology for a few years, and that they are very successful with their Open Source technology is an important indicator for her.

Table 4-26: Heuristics data for case ○2

(CAP)ABILITIES	**(Cap)Abilities** *Which capabilities were used*	
	Imitation	YES
	Object tracking	NO
	Recency monitoring	NO
	Memory recall	NO
	Recognition memory	NO
	Frequency monitoring	NO
	Experience memory	YES
HEURISTIC CHARCTER-ISTICS	**Environmental context** *How uncertainty manifests itself*	
	Dynamics	HIGH
	Volume	Unknown
	Inconsistency	Unknown
	Substitutionability	Unknown
HEURISTIC BUILDING BLOCKS	**Search rules** *Where to look for information*	
	Peer group observed	YES
	Aspiration level set	YES
	Time threshold set	NO
	Cues validity assessed	YES
	Cue validity ranked	NO
	Object recognised	NO
	Object similarity sought	YES
	Stopping rules *When to stop searching for information*	
	Peer group behaviour understood	YES
	Aspiration level achieved	NO
	Time threshold reached	NO
	First positive cue identified	NO
	Cue tally conducted	Inconclusive
	First object recognised	NO
	First similar object found	YES
	Decision rules *How to decide given the attained information*	
	Best object identified and chosen	Unknown
	Best object guessed	Unknown

Circle describes that this decision will be the first of many in an effort to switch to a completely new kind of IP strategy. In that she described a process within a process of which she is adamant that the information which is presented to her must be trustworthy and credible. When one of her people says that someone in the market indicated this is a good strategic move she will respond with:

"I'll tell them 'Show me where and how they said this. Did they send you an e-mail? Make it concrete.' and I am pushing on that, the one way or the other I want my people to gather explicit feedback and I want them to be able to show me. For me that is the key information I'm looking for."

Table 4-27: Heuristics additional results for case O2

Object trustworthiness assessed	YES
Cue credibility assessed	YES
Cue credibility ranked	YES
Process typology	Process within process

4.5 Diamond division

In 2018 Diamond created one spin-off. All the RTO's spin-offs are based on IPRs developed by the RTO brought to market under a centralised Technology Transfer Programme. Diamond's modest IPR portfolio was composed as indicated in Table 4-28.

Table 4-28: Diamond division IPR portfolio

Patents	Copyrights	TradeMarks
4	6	4

Diamond is active in two market types, one is quite mature and the other is still immature. The mature market generates considerable market revenues and it is primarily copyright based, with consulting being done on the copyrights. For example, a software model which simulates climate factors in industrial areas and per hour consulting on the interpretation of the scenario's generated by the model. The other more immature market is patent and know-how based and as yet generates limited market revenue. Within Diamond's division a switch is underway to shift from one type of IP creation activity, copyrights and consulting to another type of IP creation via new patentable technologies and licensing of IPRs. The reason for doing this is because regular consulting firms are building their own sophisticated software tools and the RTO by law may not compete with business. Another reason for the switch is that

"… it is important that we can prove that we have a lead in the market. … Because you have licensing on certain things [patents] you will also have a standing in the market. Because you have them [patents]. I think … it is also a marketing instrument. … you must be able to demonstrate very fast – because that is increasingly so – that you have an added value."

Similar to Circle, the issue that Diamond sees with patent creation is the time required to establish a patent. The market expects that these have been developed and the technology has been proven upfront. One way in which Diamond tackles this is by using patents from one of the other divisions of the RTO for new and novel applications in the industry in which Diamond is active. This is done to instil confidence

with partners that Diamond, as part of the RTO, will also be to create technologies that actually work and deliver value to customers.

The Diamond division seeks to be able to develop patentable technologies that commercial firms would not spontaneously develop on their own, since the problems that these technologies tackle are too collective, the required investments too large and the short term benefits for companies are unclear.

"Our underlying reasons are because we know that "Substance P" wouldn't be measured – eventually it's for the betterment of our health and our society. And to be able to pay for this we will need to do some things on the IP side, better said, to be able to create funds for future investments we must do things on the IP side."

In the long run Diamond views IPR, and patents in particular, as a means to generate some income to facilitate future investments in technology development. From Diamond's point of view this generates a double success, it provides additional funding for the creation of new IP and it bolsters the reputation of her divisions R&D capabilities in the industry.

Diamond indicates two goals are important. The first is maintaining momentum. She has chosen two specific knowledge domains in which her division is already very capable, allowing the Circle division to quickly accelerate knowledge investments and position themselves in a market quickly. Diamond also places importance on the goals of shaping strongholds,

"claiming IPRs are important to us so that we can create value to the innovations we have made with our own funding."

She emphasises the role of Reliable Relation in that she is aware of the perception within firms that there is always a lot of R&D being done, but that it is often unclear to firms how this R&D benefits them in concrete terms. She must deliver her research partners *"technology that works"*. The role of mass-moderniser may apply to Diamond as well

"… together with two other business units [we freed up budget] for a position in a start-up platform."

Diamond pointed out that this way of working is a substantial change to how the various divisions in the RTO operated a year ago.

4.5.1 Diamond case one

Diamond case 1 involved an investment of 300.000 Euro in 2017 to start the new technology development line Sustainable Technologies. While specifying the case Diamond immediately commented that she added another 500.000 to creation line later that year, but that this decision involved the 300.000 Euro.

Table 4-29: Diamond's responses to the predefined questions for case ◇1

IP StageGate™ funnel	
Gate	1, 2 and 3
Stage	1 and 2
Choose between alternatives	
IP function: exercise control or engage collectives	Collectives
Position creation: shorter term or longer term.	Longer
Ranking statements	Rank
Set (inter)national standards to help industries achieve scale on innovations	4
Keep up a pace of innovation which consistently outperforms the industry	1
Use IP as marketing instruments to gain referrals through customers	2
Use IP to create well-protected innovations for select customers	3

Diamond was not able to place this case in either a stage or a gate but in three gates and two stages, illustrating an inability to clearly demarcate the boundaries of this case. The intended strategic objective for the investment was to engage collectives to use the IP for the longer term. The ranked statements are different to the strategic objectives, the first ranked statement is more associated with keeping control over IP for a shorter term position. Diamond explains that by keeping up a stringent pace of innovation for her is a prerequisite to attract customers, since *"I don't really have customers yet"*. It is unlikely the Diamond division would want to postpone efforts to engage customers or funding research partners.

The uncertainties on IP creation were mainly related to which R&D activities to start performing and which to stop, the novelty of the research and the lack of an existing market. The uncertainty on IP application procedures has to do with the upfront investment. These have to be aimed for the long term and budget must be allocated as a pre-investment. Developing IP that results in granted patents takes about ten years.

Table 4-30: R&D uncertainties identified for case ◇1

Specific R&D uncertainties	
R&D Activities	HIGH
Novelty	HIGH
Market needs	HIGH
Evaluation	Unknown
IP application procedures	HIGH
Conditions & protection	Unknown
Failure of IP markets	Unknown
Protection of IP	Unknown

The data suggests that the heuristics of Satisficing and Take the Best were used in the decision-making process. Diamond experienced extremely high time pressure, having to decide on the investment in two to five days. In deciding whether or not to start the new technology development line she gathered a lot of information herself by calling people she knew in the market. The many people she called were easily substitutional for her because of their mostly unfavourable reactions.

"… they were saying 'well I don't know if this will amount to much.' So I didn't call too many of those." [laughs]

To compensate for their lack of enthusiasm she also called a senior executive she knew well. The positive response of that one contact was a crucial cue for her, she took this the most satisfactory piece of information offered to her.

"She is someone with a long term view and she was the only one of the companies who said … I'm … doing everything Sustainable. So I can image that these kind of topics will become very important."

In addition Diamond completely read a number of external publications on the future of sustainable technologies by institutions she respected. The topic was easy for her *"to lean into"* because Diamond had her 'professional roots' in sustainable technologies. Her expertise allowed her to be critical of the content. Those publications gave her enough insights and she could *"identify enough areas to engage in".* This would suggest she performed a form of validation of information and ranking of areas in sustainable technologies. The new creation line meant introducing a completely new technology set which was not only novel to the market but also to her own personnel. Diamond made it clear that she felt that she 'had' to make a positive decision in order to force her division to embark on something completely new to them.

"So in the first period it was also, and that might be a bit dangerous if I'm honest – but it's not like that anymore now – a bit of a 'self-fulfilling prophecy'. You sometimes just have to have the guts to go for something."

Table 4-31: Heuristics data for case ◇1

(CAP)ABILITIES	**(Cap)Abilities** *Which capabilities were used*	
	Imitation	NO
	Object tracking	NO
	Recency monitoring	NO
	Memory recall	NO
	Recognition memory	YES
	Frequency monitoring	NO
	Experience memory	YES
HEURISTIC CHARCTER-ISTICS	**Environmental context** *How uncertainty manifests itself*	
	Dynamics	HIGH
	Volume	Unknown
	Inconsistency	LOW
	Substitutionability	Unknown

HEURISTIC BUILDING BLOCKS		
	Search rules *Where to look for information*	
	Peer group observed	YES
	Aspiration level set	YES
	Time threshold set	YES
	Cues validity assessed	NO
	Cue validity ranked	NO
	Object recognised	NO
	Object similarity sought	NO
	Stopping rules *When to stop searching for information*	
	Peer group behaviour understood	YES
	Aspiration level achieved	YES
	Time threshold reached	YES
	First positive cue identified	YES
	Cue tally conducted	YES
	First object recognised	NO
	First similar object found	NO
	Decision rules *How to decide given the attained information*	
	Best object identified and chosen	NO
	Best object guessed	YES

In the original data analysis source trustworthiness was found to be inconclusive. During the initial findings interview Diamond commented that she considered trustworthiness to be of importance as well. She explained that she fully relied the opinion her former CTO and the information in the two reports as opposed to the other sources she consulted.

"I find the opinion my former CTO and the information in two reports I read crucial pieces of information. I trusted both these sources more than other sources."

Table 4-32: Heuristics additional results for case ◇1

Object trustworthiness assessed	YES
Cue credibility assessed	YES
Cue credibility ranked	YES
Process typology	Process within process

4.5.2 Diamond case 2

The second case of the Diamond division was to invest 30.000 Euro for a study on the feasibility of a spin-off on creating a 'factory' for a specific type of technology.

Table 4-33: Diamond's responses to the predefined questions for case ◇2

Choose between alternatives	
IP function: exercise control or engage collectives	Collectives
Position creation: shorter term or longer term.	Longer
Ranking statements	Rank
Set (inter)national standards to help industries achieve scale on innovations	2
Keep up a pace of innovation which consistently outperforms the industry	3
Use IP as marketing instruments to gain referrals through customers	4
Use IP to create well-protected innovations for select customers	1

The intended strategic objective for the investment was to engage collectives for the longer term. When matching these statements to the strategic objectives as done in Figure 4-1, the first ranked statement is consistent. The second ranked statement is consistent with Diamond's long term objective, indicating she may find this more important than control. The third ranked statement relates to control over IP in the short term, keeping up a pace of innovation to attract customers in the short term.

"Because we want new customers here as well, particularly new customers. Yes."

Part of the process was to use the study to attract potential investors in the spin-off. The uncertainties on IP creation were related to the actual need of the market in terms of potential investors willingness to pay in order to have access to specific IP and on how to evaluate the existing and future IP on offer. The R&D activities are known, novelty of the technology is low and IP application procedures are known as well. Diamond already has a team that 'manufactures' this type of technology, Diamond has been unable to hand it over to someone else because the required expertise is not available in the market.

Table 4-34: R&D uncertainties identified for case ◇2

Specific R&D uncertainties	
R&D Activities	LOW
Novelty	LOW
Market needs	HIGH
Evaluation	HIGH
IP application procedures	LOW
Conditions & protection	Unknown
Failure of IP markets	Unknown
Protection of IP	Unknown

The identified heuristic was the Hiatus heuristic.

"I really decided I wanted an investor who had committed money before a certain date, if that hadn't happened it would have stopped."

Diamond illustrated that she has worked in very different parts of the RTO and as a result she knows from experience that other Units have considerable expertise on Sustainable Technologies topics. By using her experience these other divisions are able to make outstanding contributions to her own topics on sustainable technologies. She finds this ability of the RTO to be very important.

"… we have process technology expertise, [and] we have a strong buildings and infrastructures capability which will allow us to pick up the pace when you're talking about Sustainable Technologies."

There was some time pressure in this case because of the date threshold that Diamond had set. The volume of information offer to Diamond is unknown. The information on whether parties would or would not participate in the spin-off had to come from the investors and there were quite a number of potential investors that were approached.

"For us the business opportunity must be covered, so that we have a reason to talk to the investors. Just having a business case doesn't yet mean that we are actually going to do it. Because we need commitment from the investors for that."

Identifying investor requirements was a part of the feasibility study of the spin-off, coming to terms with investors to participate in the spin-off itself was not part of the feasibility study. Diamond structurally interweaves her decision to fund the feasibility study with the requirement of the investors to participate in the spin-off. Diamond had a very clear date in her mind by which an investor had to commit to investing in the actual spin-off. The point of deciding to stop is important, from Diamond's perspective setting a date and keeping to the date was a quite crucial part of her decision.

"When do you stop? But you must make a mark and determine you won't go beyond it, because you can't just carry on forever."

Table 4-35: Heuristics data for case ◇2

	(Cap)Abilities *Which capabilities were used*	
(CAP)ABILITIES	Imitation	NO
	Object tracking	NO
	Recency monitoring	NO
	Memory recall	NO
	Recognition memory	NO
	Frequency monitoring	NO
	Experience memory	YES

HEURISTIC CHARCTER-ISTICS	**Environmental context** *How uncertainty manifests itself*	
	Dynamics	LOW
	Volume	Unknown
	Inconsistency	LOW
	Substitutionability	LOW
HEURISTIC BUILDING BLOCKS	**Search rules** *Where to look for information*	
	Peer group observed	YES
	Aspiration level set	NO
	Time threshold set	YES
	Cues validity assessed	NO
	Cue validity ranked	NO
	Object recognised	NO
	Object similarity sought	NO
	Stopping rules *When to stop searching for information*	
	Peer group behaviour understood	Unknown
	Aspiration level achieved	NO
	Time threshold reached	YES
	First positive cue identified	YES
	Cue tally conducted	YES
	First object recognised	NO
	First similar object found	NO
	Decision rules *How to decide given the attained information*	
	Best object identified and chosen	YES
	Best object guessed	NO

Diamond quite clearly links the next steps of the decision-making process, convincing others to invest in the spin-off and the launching the spin-off, to the decision under investigation for the case funding a feasibility study. For her the decision is a process within a process which cannot be viewed discretely. The 'decision' she refers to in the interview is quite often not the decision to invest in the feasibility study but on the future investments in the creation of the technology factory spin-off.

"This decision was a long time in the making, I think that we have been building up to this point for the last two years. Certainly for the last one and a half year, we started saying this is what it must be."

Table 4-36: Heuristics additional results case ◇2

Object trustworthiness assessed	YES
Cue credibility assessed	YES
Cue credibility ranked	YES
Process typology	Process within process

In the initial dataset analysis, the found decision process was inconclusive for case 2. During the initial findings interview Diamond elaborated on her decision. She explained that she considered the investment in the feasibility study as one decision of a chain of decisions, even when she would have stopped the process had a manufacturer failed to invest. While making the decision to invest in the study she was already thinking ahead to the actual spin-off itself.

4.6 Conclusions within case analysis

Some inconsistencies have been observed between the statements where the decisionmakers were asked to determine the strategic objectives for IP investments of each case in terms of IP function and temporal position and when they were asked to rank four statements that corresponded to these strategic objectives. It may be possible that the interviewees felt the need to give 'RTO acceptable answers' by stating they were striving to fulfil long term objectives and goals as opposed to pursuing short term goals. It may also be that the decisionmakers have multiple simultaneous objectives. Pursuing a long term strategy will require execution in the short term. Although Figure 4-1 was not shared with the decisionmakers, this model was assumed to be correct in the within case analysis. To determine whether or not the figure was a realistic theoretical representation of the empirical data, the model was put forward to the decisionmakers for corroboration in a third short initial findings interview. In some of the within cases analyses these interviews have been referred to as the 'initial findings' interview. The results of these interviews are discussed in more detail in the next chapter.

During the semi structured interviews all the decisionmakers found it difficult to focus on the case at hand. The scope increased throughout the interviews to encompass other investment decisions on IP creation for the same technology. The decisionmakers structurally indicated that the cases under study were part of a greater chain of interlinking decisions, in some cases decisionmakers spoke in terms of strategies or technology development lines. This would suggest that although the division heads have a decision-making process, or heuristic, on a single investment they experience these single investments as a process within a much larger set of process. The division heads explained the strategies they pursued to position themselves in various recognisable roles. One decisionmakers stated that for her the most important criterion for IP investments is a direct link with the strategic priorities of her division. In both data collection interviews division heads elaborated on how their IP would assist them in gaining a desired position through a recognisable role in the market which could be supported by specific goals for each investment. The decisionmakers elaborated the clearest on this in the first data collection round, during the skype interviews. This observation is consistent with the assumption set out in Figure 4-1.

Heuristics rely on certain capabilities which a decisionmaker has. These capabilities shape a decisionmakers' ability of to process information. Memory and experience are capabilities which were found to be used often. In addition, when processing information all decisionmakers relied on their assessment and ranking of both que credibility and information source, or object, trustworthiness. This

may indicate that when heuristics are used in contexts of perpetual uncertainty, the building blocks for information processing to reach a decision are broader than the current body of literature on heuristics suggests. A different or extended set of inference rules as described in the building blocks may apply than those that have been found in the literature and described in Table 2-2.

5 Cross case analysis

5.1 Introduction

This chapter will start with an identification and analysis of the different contextual uncertainties of the divisions and the cases. It will demonstrate how contextual uncertainty results in various dynamics for the cases. The last paragraph will compare the various heuristics deployed in the cases and the similarities of these heuristics and how these heuristics affect information processing. Additional inference rules which form the heuristic building blocks will be identified. The conclusions of the cross case analysis will be presented in Chapter 6.

5.2 Strategic market objectives

The step 2 skype interviews resulted in a data set. This data set was first coded by means of In Vivo coding, which led to the identification of a number of themes as summarised in Table 5-1. Please see paragraph 3.6 for an elaboration of the coding methodologies used and Appendix B.1 for the list of words, with their frequencies and themes.

Table 5-1: Thematic outcome of Vivo coding

Themes (with colour coding)	# of groupwords	Total # of words of the groupwords
Time (purple)	17	48
Strategy (navy blue)	6	16
Protection (light blue)	20	94
Proof (dark green)	11	23
Money (lime)	25	96
Market (orange)	24	91
Knowledge (sienna red)	22	185
Sub total	***125***	***553***
Unassigned (-?)	40	180
Total	*165*	*733*

Certain themes which emerged from the data were quite expected, such as money, market and knowledge. Money relates to all financial aspects of IP creation and commercial IP exploitation. Market refers to the specific industries the divisions are active in and includes research partners, stakeholders and existing and potential customers. Knowledge encompasses IP, technology, know-how and all intangible resources. Protection is at the heart of IP with a Right, this was expected to be a theme as well. The division heads mentioned their strategies during the skype interviews, it was unexpected that this theme arose in the short and limitedly scoped interviews of step 2. Strategy was expected to become a possible theme when discussing the cases. Two themes were unexpected: 9% of all relevant word counts were related to

time, as in the crucial role that time plays in developing IP, and 4% were related to proof, as in the need to be able to prove technologies to market players via IP.

When these themes were applied to the data set by means of Theming the Data, one set of data blocks immediately caught attention. These were the data blocks that could not be allocated to one single thematic code, as they had mixed themes. An overview of these data blocks is included in Appendix B.2. These data blocks clearly illustrate the dynamics between the themes. All decisionmakers stressed the importance of the market theme. They did this in terms of position in the market, or market attractiveness. Knowledge or IP positioning is a prerequisite to achieve market positioning. An RTO would not have a market position without unique and relevant IP. Having IP attracts funding to create new IP, which Triangle described as follows:

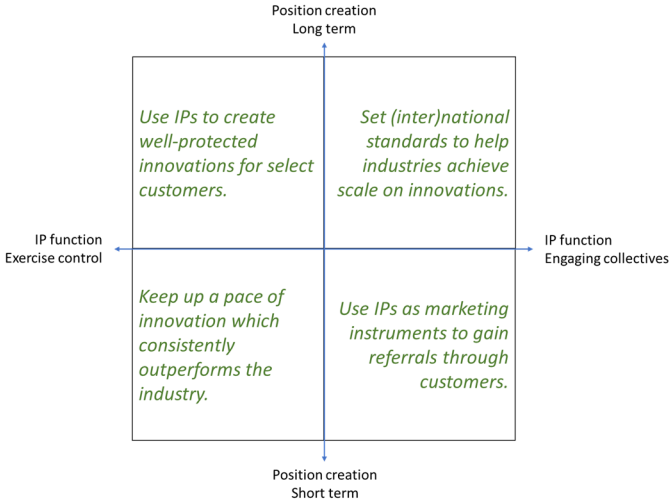
"So we use the IP to be credible to companies which will make them willing to put money in our pockets." *<protection> <proof> <market> <money>.*

The findings derived from the theming of the data indicated that the division heads had a combination of two strategic market objectives which play a role in framing the uncertain industry contexts in which IP investment decisions took place. These strategic market objectives are (i) positioning of the division within a time frame, longer term or shorter term, and (ii) the IP function in terms of exercising control or engaging collectives. Diamond explained this quite clearly.

"We've chosen two specific knowledge-domains in which we are already very capable because it allows us to quickly accelerate our knowledge investments and to increase it … So we can position it in a market very quickly as impact." *<knowledge> <time> <money> <market> <time> <proof>.*

The combination of the two strategic market objectives results in a model presented in Figure 5-1. Each quadrant was initially filled with a statement that was derived from the data set of the skype interviews. Each statement represents the goal of a particular investment-decision in relation to the strategic objectives within an industry context. The figure has already been presented in this study in paragraph 4.1.

Figure 5-1: Strategic market objectives and investment decision goals



The decisionmakers were asked to rank the four statements in Figure 5-1 according to relevance for each case as discussed in the within case analysis, the dynamics resulted in a broader narrative which will be elaborated in Figure 5-3. While discussing the cases the decisionmakers described that they pursue longer term strategies wherein the cases at hand were viewed as one decision-making process in chain of many decision-making processes. In some cases the division heads referred to a strategy they had for a technology development line, of which the case at hand was just one step of many.

Table 5-2: Process typology of the cases

	△1	△2	□1	□2	○1	○2	◇1	◇2
Decision process *How the decision process is experienced*								
Process typology	Process within process	Process within process	Process within process	Process within process	Process within process	Process within process	Process within process	Process within process

The sought temporal position a division heads envisions and the IP function she pursues are linked to various specific investment goals and recognisable roles as summarised in Table 5-3. The full quotes supporting this role and goal identification can be found in Appendix B.3. These goals and roles are an indication that a division head's decision to invest in IP creation is a direct response to the specific contextual uncertainty of their industry and that these industry contexts differ as suggested in Figure 5-1. Only one investment goal is common amongst all the divisions, shaping strongholds. The recognisable roles that the division heads indicated they wanted to fulfil vary.

Table 5-3: Recognisable roles and specific investment goals

		△	□	○	◇
INVESTMENT GOALS	Shaping Strongholds	✓	✓	✓	✓
	Crafting Crowds		✓		
	Rapid Referrals			✓	
	Maintaining Momentum			✓	✓
RECOGNISABLE ROLES	Determined Dominator	✓		✓	✓
	Reliable Relation	✓	✓		✓
	Mass Moderniser			✓	✓
	Agile Ally			✓	

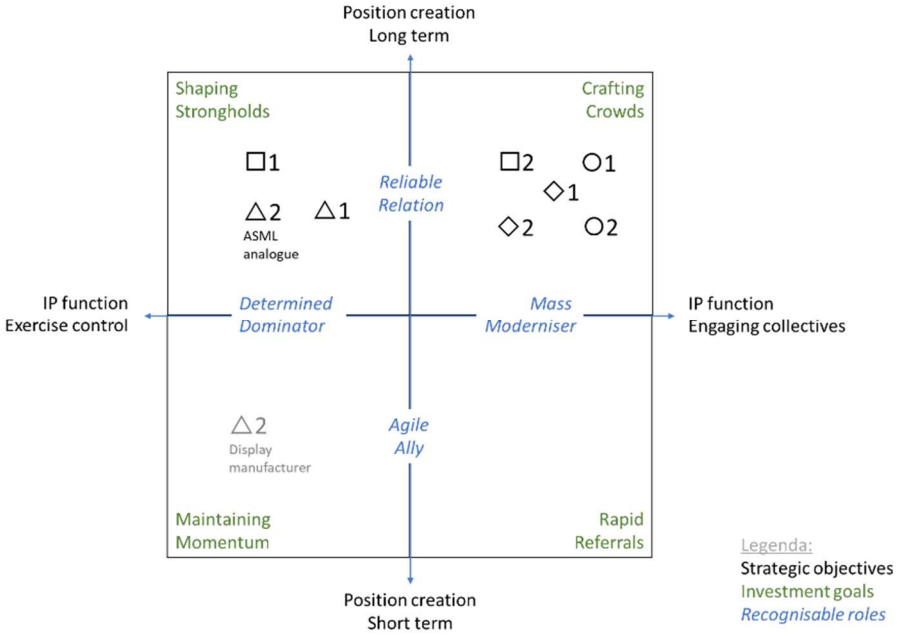
The findings from Table 5-3 were tested per case to a limited extent during the data collection for the individual cases. Decisionmakers were asked to choose an alternative in two sets of statements, to determine what their strategic objectives for the investment might have been.

Table 5-4: Strategic objectives per case

	△1	△2	□1	□2	○1	○2	◇1	◇2
Choose between alternatives								
IP function: exercise control or engage collectives.	Control	Control	Control	Collectives	Collectives	Collectives	Collectives	Collectives
Position creation: shorter term or longer term.	Longer	Shorter	Longer	Longer	Longer	Longer	Longer	Longer

The results from Table 5-3, the identification of the two strategic market objectives and the results from Table 5-4 were combined to form Figure 5-2; a refinement of the theoretical strategic market objectives model presented in Figure 5-1. In Figure 5-2 the quadrant boundaries represent the recognisable roles the decisionmakers expect their divisions to take as a result of a combination of their investment goals and the strategic market objectives. Please note that I have not followed Triangle's own positioning of case 2 since I believe the way she positioned case 2 relates to the customers of the spin-off, the display manufacturers, not the spin-off itself which is an 'ASML analogue'.

Figure 5-2: Strategic market objectives of the eight individual cases



The findings as presented in Figure 5-2 were put forward to three of the four decisionmakers, Square, Circle and Diamond[6] in a third initial findings interview. This third interview was conducted because I wanted to test the validity of the concept that the decisionmakers had strategic market objectives when they were judging IP investments for which they pursued investment goals and recognisable roles. The decisionmaker's comments on the model were that, although they found the strategic market objectives model to be *"quite academic"*, they considered it to be a correct theoretical representation of their reality. The decisionmakers remarked that each division would likely chose their own quadrant in the model since their market or industry circumstances differ from one another. Circle commented

"For my division the role of mass moderniser is the most logical one, but for Triangle it makes absolute sense that she would want to be a determined dominator. Her IP lifecycles are much longer than mine."

Square indicated that the role of reliable relation resonated with her. She recognised the movement she made with the heat storage technology from shaping strongholds in Case 1 to crafting crowds in Case 2. She agreed that it is a role she takes and indicated that she deliberately makes the movement from shaping strongholds to crafting crowds in other IP investments as well. Diamond corroborated the model as well and indicated it was *"a useful mental picture"*, although she pointed out she would not have thought to look at it this way by herself.

While studying the model Diamond wondered if any dynamics in the model *"could go anti-clockwise"*, it seemed unlikely to her. Clockwise seemed the most likely direction to her. Circle made a statement to this

[6] Triangle was unavailable to provide feedback on the initial findings of the study.

extent as well by indicating that once software code is open source you cannot close it up again. Moving from a mass moderniser role to a determined dominator role with the same IP was impossible from her point of view.

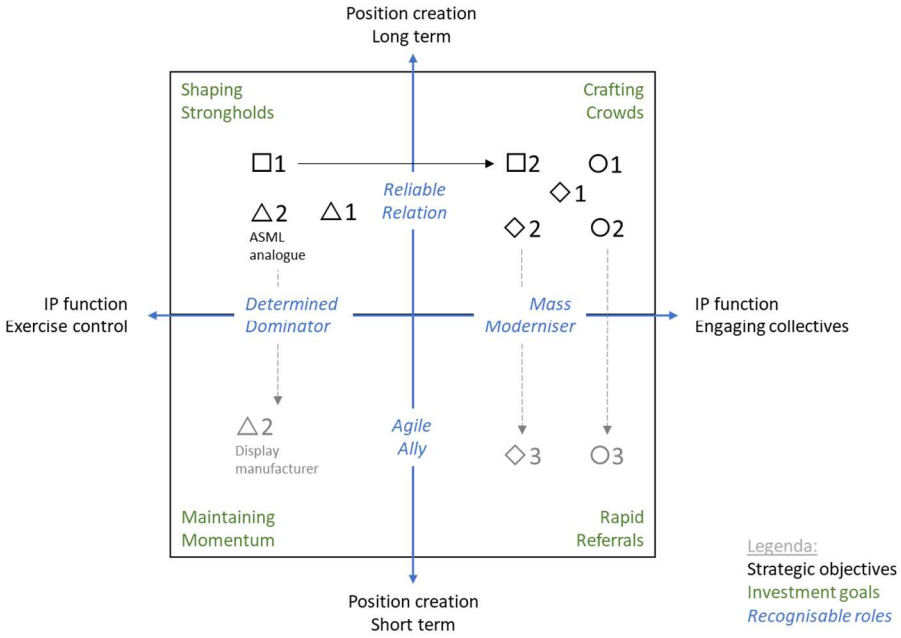
The concept of a one-directional strategic market objective by means of a set of interlinking IP investments is underpinned from a legal perspective. Once code is open source it will remain open source and publicly available at large. From a patent perspective, there is an absolute requirement that a certain[7] technology must be 'novel', or completely new (EPO, 2019). The technology must be kept secret prior to the first filing to prevent loss of novelty. However once a technology has been filed for patent application, the technology *must* be publicized in the patent application procedures after a certain timeframe. Within the EU such publication occurs eighteen months after the first filing (EPO, 2019). Once the technology description is public, it's public even if an applicant were to withdraw the patent application after those eighteen months.

As described in the within case analyses, the division heads often increased the scope of the cases they were discussing to include previous decisions or next decisions. When reviewing the within case data in relation to Figure 5-3, the strategic narratives that the division heads presented on the investment decisions of each case were plotted onto the model. The dynamics which the data illustrates are movements going either down or to the right, corroborating the feedback of the division heads on the preliminary findings and the idea that each investment decision is part of an interlinking chain of one-directional decisions, or strategies. Diamond and Circle both discussed future steps they would take after completion of their case 2 investments, these are visualised as ◇3 and ○3. The narrative of Triangle is put into a clear perspective in this frame, where △2 is the ASML analogue spin-off. The RTO's objective for the spin-off was to create a determined dominator who operates from a stronghold. The spin-off itself however, will be more likely to want to maintain momentum when servicing its customers, the display manufacturers. The spin-off itself will need to keep up a pace of innovation to consistently outperform the market in order to maintain product relevance for the fast moving consumer electronics market.

Another observation can be made from the data. The dynamics are not only from exercising control towards shaping collectives, but also from long term positioning towards short term positioning. The opposite dynamic, form short term to long term was not observed. A possible reason for this was offered by both Circle and Diamond when they commented on how long it takes to build or claim a long term market position based on IP. Market players on the other hand are more interested in short term gains from this IP. The logical dynamic for an RTO seems to be from long term to short term.

[7] The technology should also be industrially applicable and should not be obvious against the backdrop of the state of the art. It should thus encompass an inventive step (EPO, 2019).

Figure 5-3: Dynamics of strategic market objectives for the cases



5.3 Heuristics, memory and information selection

Nearly every type of heuristic seems to have been used by the decisionmakers. In some cases multiple heuristics appeared to have been used to make a decision. The most used heuristics are Take the Best and Similarity. In the eight cases investigated, eleven different types of heuristics were identified. One case was inconclusive.

Table 5-5: Heuristics identified in each case

	△1	△2	□1	□2	○1	○2	◇1	◇2
Smart follower Based on ability to imitate. Social heuristic.						✓		
Satisficing Based on ability of object tracking. One reason decision.	✓						✓	
Hiatus Based on ability of recency monitoring. One reason decision.								✓
Take the best Based on ability of memory recall. One reason decision.			✓	✓			✓	
Recognition Based on ability of recognition memory. Recognition heuristic.				✓				
Tallying Based on ability of frequency monitoring. Trade-off heuristic.					?			
Similarity Based on ability of experience memory. Trade-off heuristic.		✓	✓			✓		

The identified heuristics in Table 5-5 illustrate that memory plays an important role in decision-making under perpetual uncertainty. In six of the eight cases investigated memory was identified as a capability decisionmakers deployed. When the decisionmakers were asked what capabilities they used in making the investment decisions, all division heads answered with a version of *"my own experience"* although they did not indicate this explicitly in all the cases when describing them.

During the data structuring the distinction between validity, credibility and trustworthiness became relevant. Validity is the degree to which any measurement method actually measures what it is supposed to measure. Credibility refers to the plausibility or "believability" of an argument underpinning a decision. Trustworthiness is related to methodology used to create or build the argument. (Lewis-Beck, Bryman & Futing Liao, 2011). In the eyes of the decisionmakers trustworthiness and credibility are information source-related. These distinctions resulted in additional search and selection rules: (i) asses cue credibility and (ii) asses source trustworthiness and an additional stopping rule: rank cue credibility. This is illustrated in Table 5-6.

Table 5-6: Data results on information objects and cues

		△1	△2	□1	□2	○1	○2	◇1	◇2
BUILDING BLOCKS	Object trustworthiness assessed	YES	YES	YES	YES	YES	YES	YES	YES
	Cue credibility assessed	YES	YES	YES	YES	YES	YES	YES	YES
	Cue credibility ranked	YES	YES	YES	YES	YES	YES	YES	YES

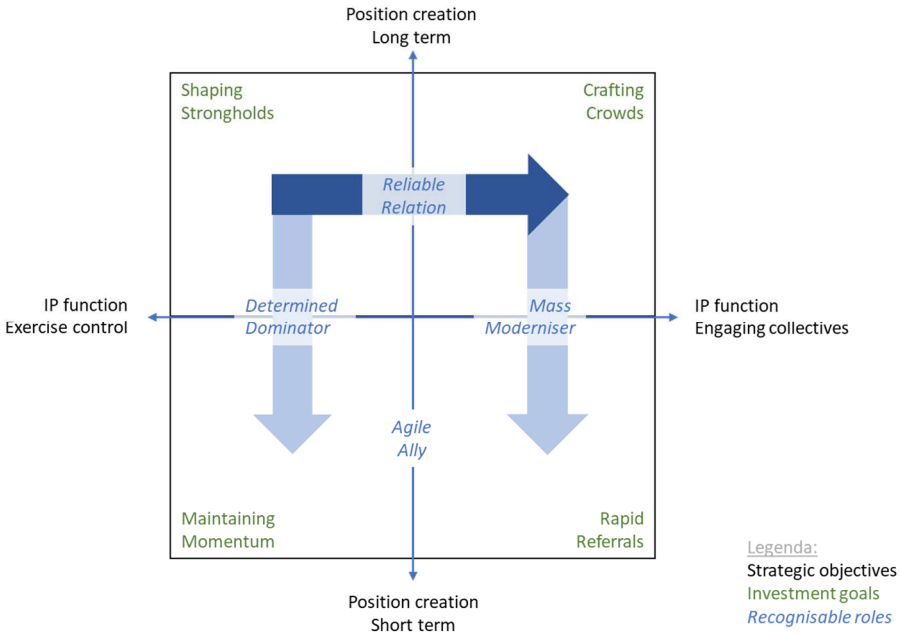
Without exception the division directors indicated that varieties of the question 'how credible is this piece of information and do I trust the source' played a role in their decision-making. When the decisionmakers were asked to provide their feedback during the third initial findings interviews, they corroborated this finding. Diamond explained that what she is doing in Sustainable Technologies is so new that there is no way for her to be able to asses *"if the information given to me is right or wrong"* since the information is about technology that does not exist yet. This insight is contradictory to the current body of literature of heuristics that assumes that information can be validated on correctness by decisionmakers. Circle deemed this academic assumption of cue validity *"an idiotic assumption"* for the kind of investment decisions she makes. It would seem that in contexts of perpetual uncertainty it is difficult, if not impossible, for decisionmakers to assess whether or not information is valid. Square stated that for her it is about *"how useful information is"* in her decision-making process based on credibility of the information and trustworthiness of the information source.

6 Conclusions

6.1 Conclusions from the cross case analysis

The premise that managers would use interlinking decision-making processes to decide upon IP investments in order to execute strategies for a market position is supported in the literature. Other research has demonstrated that longer-term research must be closely aligned to the organisation's strategic objectives, rather than curiosity-driven research (Bounfour, 2003, p.113). These strategic objectives can be driven by past decisions and previous actions to allow an organisation to have a positional capability, or market attractiveness, based on its intangible resources (Hall, 1993, p.610). This concept is backed by the data collected and has been corroborated by Square, Circle and Diamond for their cases. The strategies the division heads pursue to achieve strategic market objectives seem subject to directional dynamics as visualised in Figure 6-1.

Figure 6-1: One-directional strategic market objectives



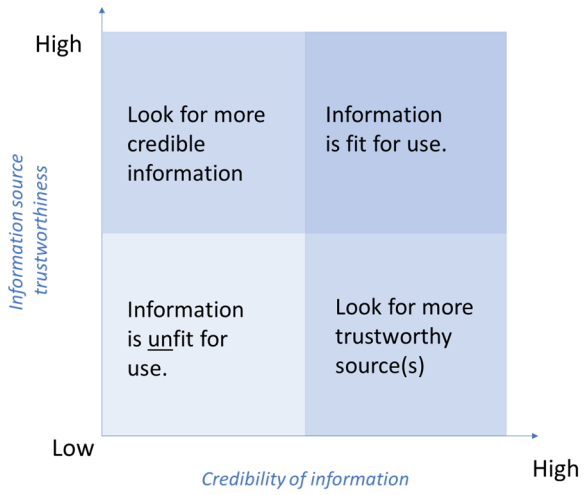
Determined dominator and reliable relation are the most occurring roles identified. Many first investment decisions on IP commence with the goal of shaping strongholds and then primarily move 'right' when a reliable relation role is opted for, allowing for future IP investments to craft crowds and so engage collectives. An investment decision at a later stage may allow the IP to move 'down', when a role of mass moderniser is more appropriate and market dynamics ask for a positioning based on the shorter term. IP investment decisions with the goal of shaping strongholds may also move 'down' from shaping strongholds to maintaining momentum when a decisionmaker opts for a determined dominator role but only with a shorter term positioning objective. While an IP investment objective to shift in goal from maintaining

momentum towards rapid referrals might be possible, this study found no evidence of this particular dynamic.

From the above it is not unreasonable to conclude that in a context of perpetual uncertainty an IP investment decision is an inseparable part of a one-directional strategic process. Further, in a context of perpetual uncertainty, this strategic process is assessed in terms of strategic market objectives, recognisable roles and investment goals which have a one-directional dynamic.

Being part of managerial cognition, heuristics as decision-making processes have been found to exploit structures of environments (Gaissmaier, 2011, p.457). Heuristics allow decisionmakers to anticipate on the consequences of their decisions, permitting them to take action (Helfat & Martin, 2015, p.1285). When reviewing the within case data in relation to Table 5-6 it became apparent that the division heads often relied on their memory and on earlier experiences they had with the people involved in a case. The decisionmakers determined whether or not they would use information based on an assessment of how trustworthy certain sources of information were. They would also rely on their memory built on past experience to determine to what extent they believed these sources would be able to provide credible argumentation. Figure 6-2 demonstrates this principle of determining the usefulness of information based on (i) information source trustworthiness and (ii) the trustworthiness of information provided by that source. This simple principle demonstrated in Figure 6-2 shows that heuristics are decision-making processes leading to outcomes, where the underlying rules can be modelled and made explicit (Bingham et al, 2011, p.1438).

Figure 6-2: Usefulness of information



From the above it is not unreasonable to conclude that in contexts of perpetual uncertainty decisionmakers will use their recollection of previous experiences to assess whether information is fit for use in a decision-making process, based on their trust in the information source and the credibility of information presented by that source.

The process of modelling as demonstrated in Figure 6-1 and Figure 6-2 will allow explicit learning to take place within the RTO under investigation and other organisations operating in environments of perpetual uncertainty (Bingham et al, 2011, p.1438). Heuristics, as IP, have the potential to become key components of an organisation's business processes (Modic et al, 2018, p.5). By having other decisionmakers take note of and learn to use these two robust sets of successful heuristics, an organisation's management could allow their organisation to build a superior organisational capability (Hall, 1993, p.610; Bingham et al, 2007, p.40).

As discussed in the literature review robust heuristics can be used to make predictions (Gigerenzer, 2004, p.78; Artinger et al, p.3). In contexts of perpetual uncertainty decisionmakers must be able to predict which one of a number of objects, for example R&D projects to create IP, scores higher on a specific criterion, for example the expected strategic objectives, and from that decide which action to perform on the selected object, for example to invest in the selected project or not. Sometimes the criterion can be judged based on one or a number of cues. Examples of cues might be: estimated speed of market adoptability of the IP, the technical feasibility of IP creation and the business case underlying the IP.

In a context of perpetual uncertainty the specific rules in the building blocks of the heuristic framework as described in Table 2-2 have been revised to encompass these rules: (a) why to search for information, in relation to the strategic market objectives of the organisation in terms of IP function and temporal positioning, (b) where to look for information in relation to the trustworthiness of the sources and the credibility of the information from these sources, (c) when to stop searching for information and (d) how to decide. Putting these rules into use will allow a decisionmaker to apply the ecological rationality of heuristics to exploit environmental structures (Gaissmaier et al, 2011, p. 457). In other words, it will allow a decisionmaker to adapt her decision-making process to particular contexts of uncertainty as demonstrated in Figure 6-1. Perpetual uncertainty will influence the strategic market objectives of a decisionmaker and as such will assist a decisionmaker in determining how well a criterion can be predicted and whether or not she should invest in a particular project.

What this study has demonstrated is that in contexts of perpetual uncertainty decisionmakers will view their decisions as being part of a grander strategy formed by a chain of interlinking decisions. Some reference to this type of process perception was found in the literature, one study showed that investors in innovative start-ups engage in a process of interaction encompassing multiple decisions (Harrison et al, 2015, p. 530). Although investment decisions under risk and not uncertainty were investigated, the insight offered by Harrison et al (2015) supports my conclusions. The 'validity issue' of heuristics as investigated by Hilbig (2010) arose in this study as well, it was not possible to determine the exact cues under consideration by the division heads in each case. The inability to validate information in contexts of perpetual uncertainty was offset by the discovery of new and modified inference rules for the heuristics' building blocks which have been inserted as ***bold italics*** in the revised heuristics framework in Table 6-1.

Table 6-1: Heuristics Framework - patterns in contexts of perpetual uncertainty

		MANAGERIAL APPLICATION in a CONTEXT OF PERPETUAL UNCERTAINTY						
		Smart follower Based on ability to imitate	**Satisficing** Based on ability of object tracking.	**Hiatus** Based on ability of recency monitoring.	**Take the best** Based on ability of memory recall.	**Recognition** Based on ability of recognition memory.	**Tallying** Based on ability of frequency monitoring.	**Similarity** Based on ability of experience memory.
CHARACTERISTICS	**Type**	Social heuristic	One reason decision	One reason decision	One reason decision	Recognition heuristic	Trade-off heuristic	Trade-off heuristic
	Rule of inference	Infer that the majority of ones peers displays a certain behaviour, engage in the same behaviour.	Infer that the object which positively fulfils the aspiration level, has the higher value with respect to the criterion.	Infer that the object which is less than the set hiatus, has the higher value with respect to the criterion.	Infer that the object which positively fulfils the ***credible*** cue when the other does not, has the higher value with respect to the criterion.	If one of two objects is recognized and the other is not, then infer that the recognized object has the higher value with respect to the criterion.	Infer that the object which positively fulfils the most ***credible*** cues, has the higher value with respect to the criterion.	Infer that the identified object has a higher perceived criterion value than those from a reference class.
	Environmental context	Dynamics: moderate Volume: high Inconsistency: is moderate to high (cues have different weights) Substitutionability: the inter-dependency between cues is unknown.	Dynamics: moderate to high - there is high time-pressure Volume: high (In)consistency: unknown Substitutionability: is high, there is low interdependency between cues.	Dynamics: high - there is high time-pressure Volume: high (In)consistency: unknown Substitutionability: is high, there is low interdependency between cues.	Dynamics: high - there is high time-pressure Volume: can vary. Inconsistency: is moderate to high (cues have different weights) Substitutionability: is high, there is little interdependency between cues.	Dynamics: are characterised by systemic uncertainty Volume: moderate to high. (In)Consistency: unknown. Substitutionability: is low, there is high interdependency between cues.	Dynamics: moderate Volume: high. Consistency: all cues have the quite similar weights Substitutionability: is high, there is little interdependency between cues.	Dynamics: are characterised by systemic uncertainty Volume: moderate to high, but relating to different class of objects. (In)Consistency: known for the 'other' class. Substitutionability: is low, there is high interdependency between
BUILDING BLOCKS	***Objective rules Why to search for information***	***Determine the strategic objectives of the decision: IP function: exercise control or engage collectives. Temporal position: long term or short term.***	***Determine the strategic objectives of the decision: IP function: exercise control or engage collectives. Temporal position: long term or short term.***	***Determine the strategic objectives of the decision: IP function: exercise control or engage collectives. Temporal position: long term or short term.***	***Determine the strategic objectives of the decision: IP function: exercise control or engage collectives. Temporal position: long term or short term.***	***Determine the strategic objectives of the decision: IP function: exercise control or engage collectives. Temporal position: long term or short term.***	***Determine the strategic objectives of the decision: IP function: exercise control or engage collectives. Temporal position: long term or short term.***	***Determine the strategic objectives of the decision: IP function: exercise control or engage collectives. Temporal position: long term or short term.***
	Search rules Where to look for information	Determine the peer group to observe. ***Determine whether peer group is trustworthy and credible enough to consider.***	Set an aspiration level and search through objects (Aspiration level may be fixed or adjusted up or down). ***Determine whether object is trustworthy enough to consider.***	Set a threshold in terms of time and search through objects. ***Determine whether object is trustworthy enough to consider.***	***Determine whether object is trustworthy enough to consider.*** Search through cues in order of their ***credibility*** . Look up the cue values of the cue with the highest ***credibility*** first.	***Determine whether object is trustworthy enough to consider.*** Search for an object that you recognize.	***Determine whether object is trustworthy enough to consider.*** Search through cues in any order. Look up the cue ***credibility*** values. Add positive cues to the tally, and deduct negative cues from it.	***Determine whether object is trustworthy enough to consider.*** Search for an object that is more similar to the target than objects drawn from a reference class.
	Stopping rules When to stop searching	Stop search when it is clear what the (vast) majority of the peers does.	One-reason stopping rule: Stop search when the first object meets the set aspiration level ***with enough credibility*** .	One-reason stopping rule: select the object that falls under the threshold ***with enough credibility.***	One-reason stopping rule: If one object has a positive cue value and the other does not, then stop search and decide. Otherwise exclude this cue and look for more information.	Stop as soon as an object is recognized ***with enough credibility.***	Stop after *n* cues (where *n* can be any number up to the complete set of cues) and determine which object has more positive cue values and decide. If the number is equal, look for more information and search for another cue.	Stop as soon as a more similar object is found ***with enough credibility.***
	Decision rules How to decide given the attained information	Choose this object.	Choose this object.	Choose this object.	Choose the object with the positive cue value. If after searching through all cues there is a draw or no more cues are found, guess.	Choose the recognised object.	Decide for the alternative with the higher tally. If after searching through all cues there is a draw or no more cues are found, guess.	Choose the more/most similar object.

6.2 Final conclusion and propositions

This theory building study has demonstrated that for RTOs uncertainty is perpetual due to the nature of the processes associated with IP creation, the R&D process, and due to the specific industry or market contexts in which the RTO decisionmakers operate. This perpetual uncertainty influences decision-making processes on investments in IP creation in that decisionmakers use heuristics. These heuristics allow a decisionmaker to view decision-making on IP creation investments as a process within a larger set of interlinking processes. This larger set of interlinking processes is one-directional due to: (i) the legal nature of IP which determines the pursued function of the created IP, to protect or to engage and (ii) the time frame in which the RTO expects to position itself in the market with the created IP, long term or short term. The interlinked set of processes allow the RTO to achieve a strategic market position in terms of the IP function and temporal position by means of recognisable roles and investment goals. In addition, the effect of perpetual uncertainty is observable through the deployed simple rules of the heuristics when judging IP creation investments, where decisionmakers will rely on their past experiences to weigh and rank information based on information source trustworthiness and the credibility of information provided by that source.

The conclusions of this study have resulted in the following propositions:

Proposition 1: **In a context of perpetual uncertainty an investment decision on IP creation is an inseparable part of a larger set of interlinked decision-making processes.**

Proposition 2: **In a context of perpetual uncertainty the interlinked decision-making processes form the strategic market objectives for an investment decision on IP creation.**

Proposition 3: **In a context of perpetual uncertainty, decisionmakers will determine the usefulness of information to make an investment decision on IP creation by their level of trust in the information source and the perceived credibility of the information presented by that source.**

6.3 Shortcomings and recommendations

Although the cases were selected from different semi-autonomous divisions, they were selected within one RTO. The external environment, such as the regulatory and subsidy landscape, was very similar for each division. Certain internal environmental aspects, for instance the corporate policies, were identical. This may have impacted the perpetual uncertainty for each case. A study including multiple RTOs each located in different countries may strengthen the reliability of the findings of this study.

One of the study's constructs is a very specific type of intangible resource, IP. Intellectual Property is a legal construct (Midic et al, 2018, p.3). National or regional IP laws vary across the globe (WIPO, 2018). This study limits itself to one country within the European Union (EU). The EU is a multi-sovereign-state

entity with certain specific overarching IP laws and regulations regarding certain aspects and local IP laws and regulations regarding other aspects; and all those may be distinctly different from other countries or regions in the world. This unique legal context may impact the repeatability of the study in another country or outside the EU.

When investment decisions in IP involve significant budget, they become strategic decisions within RTOs. Although one decisionmaker may have the end-responsibility for the investment, the decision-making process typically involves numerous actors over an extended period of time (Kazakova et al, 2016, p.130). In addition the decisionmakers were not observed while making the actual investment decision, but gave a historical account of the decision-making process. I had to reconstruct the characteristics and building blocks of each heuristic from data that was based on recollections after the fact. A longitudinal ethnographic case study may be a suitable method for directly investigating and observing a diverse set of multi-actor decision-making processes over an extended period of time. Such an approach may strengthen the validity of the findings of this research.

7 Literature & references

7.1 Literature

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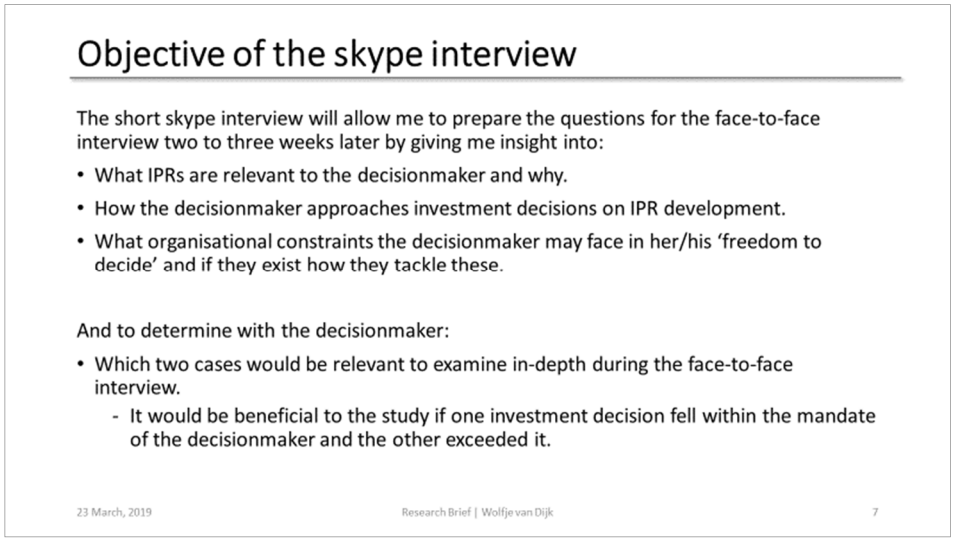
A Research brief, templates and questions

A.1 Research brief

The Research Brief is a power point document that was sent by e-mail to participants in advance of the first interview. The purpose was to introduce myself, to familiarise the participants with the research and to clarify the objective for the skype interview. The slide below lists the four fixed but open questions posed to the decisionmakers during the interview.



A.2 Template Skype interview transcript

Date:		Time:	
Medium:	Skype	Decisionmaker:	
Purpose:	The skype interview allows me to prepare the questions for the face-to-face interview by giving me insight into		
Questions:	(1) What IP are relevant to the decisionmaker and (2) why. (3) How the decisionmaker approaches investment decisions on IP creation. (4) What organisational constraints the decisionmaker may face in her/his 'freedom to decide' and (5) if they exist how they tackle these.		
Purpose:	And to determine with the decisionmaker:		
Question:	(6) Which two cases would be relevant to examine in depth during the face-to-face interview.		

A.3 Questions for the semi-structured interviews

Please note that not every question was literally asked during the interview. Often decisionmakers 'answered' the questions while they were talking.

General introduction (max 5 mins)

- Could you provide me with a brief description of each case – specifying the exact decision you were making.

Slide plotting as a result from Skype interview insights

A. Slide: Your view on IP investments
    a) Which of choice of each pair comes closest to your view on the investment decision you made.
B. Slide: Your objectives for IP investments for cases 1 and 2.
    a) If these were the only four objectives for IP investments you could have, how would you rank them per case?

Introduction

1. Slide: Where would you plot this case in the quadrant?
2. What was the budget involved?
    a) Was the full requested budget assigned?
3. Slide: Where in the generic process would you place this particular decision?

Abilities

4. What personal abilities did you use to draw conclusions (make inferences) from this information?
5. How and to what purpose did you deploy these personal abilities when drawing conclusions?

Characteristics

6. What were the typical dynamics of this context that generated uncertainty?
7. How did you make sense of the environmental context in which the IP was being developed?
8. Discuss these elements and how they were relevant while gathering & filtering information.
    a) **Time** in which to decide
    b) **Volume** of information available
    c) **Weighing** different pieces of information
    d) **Interdependency / Relatedness** between different pieces of information

Building blocks

9. How was this information structured when it was shared?
    a) Please describe the nature of the structure.
    b) If decisionmaker collects own information, how do they structure their information?
10. How did you know where to look for information (or where others should look according to you)?
11. When did you know when you have enough information to make a decision?
12. How did you decide? And if you had to choose between alternatives how did you know what to choose?
    a) How did you use your memory?
    b) How did you use your monitoring skills?

B Coding structure in more detail

B.1 Step 2 In Vivo coding of the data

Word	Freq.	Theme	Word	Freq.	Theme
patent	51	protection	move	2	time
ip	27	knowledge	speed	2	time
software	22	knowledge	scope	2	strategy
important	22	- ?	infringing	2	protection
knowledge	19	knowledge	ownership	2	protection
market	18	market	rights	2	protection
process	18	- ?	contract	2	protection
ideas	13	knowledge	copyright	2	protection
know	13	knowledge	euro	2	money
technology	12	knowledge	enterprise	2	market
strategy	10	strategy	fields	2	market
funding	10	money	investors	2	market
spin-off	10	money	stakeholders	2	market
code	10	knowledge	outside	2	market
different	10	- ?	contribute	2	market
business	9	market	invent	2	knowledge
position	9	market	project	2	knowledge
invention	9	knowledge	coherence	2	- ?
research	9	knowledge	collaboration	2	- ?
topic	9	- ?	counting	2	- ?
quickly	8	time	landing	2	- ?
year	8	time	metrics	2	- ?
ipr	8	protection	streams	2	- ?
budget	8	money	towards	2	- ?

Word	Freq.	Theme	Word	Freq.	Theme
investments	8	money	faster	1	time
revenues	8	money	rapidly	1	time
creation	8	knowledge	ages	1	time
know-how	8	knowledge	timing	1	time
interesting	8	- ?	week	1	time
new	8	- ?	accelerate	1	time
license	7	protection	forward	1	time
valorisation	7	money	goals	1	strategy
build	7	knowledge	objectives	1	strategy
develop	7	- ?	direction	1	strategy
portfolio	7	- ?	focussing	1	strategy
future	6	time	detectability	1	protection
investment	6	money	detection	1	protection
licensing	6	money	enforce	1	protection
invest	6	money	patented	1	protection
customers	6	market	protective	1	protection
domain	6	market	secures	1	protection
companies	6	market	securing	1	protection
change	6	knowledge	security	1	protection
approach	6	- ?	brands	1	protection
certain	6	- ?	trademarks	1	protection
together	6	- ?	demonstrating	1	proof
protection	5	protection	demonstrator	1	proof
show-how	5	proof	evidence	1	proof
money	5	money	proof	1	proof
area	5	market	prove	1	proof
application	5	knowledge	proving	1	proof
choices	5	knowledge	standing	1	proof
situation	5	- ?	earn	1	money
recently	4	time	europe	1	money
demonstrate	4	proof	expensive	1	money
show	4	proof	exploitation	1	money
value	4	money	fees	1	money
costs	4	money	funds	1	money
positions	4	market	investing	1	money
consulting	4	knowledge	pay	1	money
determine	4	- ?	turn-over	1	money
economy	4	- ?	yield	1	money
generate	4	- ?	financial	1	money
open	4	- ?	gain	1	money
operate	4	- ?	marketing	1	market
specific	4	- ?	network	1	market
strong	4	- ?	partners	1	market
early	3	time	positioning	1	market

Word	Freq.	Theme	Word	Freq.	Theme
funnel	3	time	relationship	1	market
month	3	time	community	1	market
patenting	3	protection	industry	1	market
field	3	market	capabilities	1	knowledge
place	3	market	evolve	1	knowledge
relevant	3	market	skills	1	knowledge
concrete	3	- ?	models	1	knowledge
course	3	- ?	curb	1	- ?
explicit	3	- ?	formality	1	- ?
freedom	3	- ?	government	1	- ?
legacy	3	- ?	hr	1	- ?
society	3	- ?	impose	1	- ?
transfer	3	- ?	maintain	1	- ?
agile	2	time	obsolete	1	- ?
			thrive	1	- ?

B.2 Step 2 thematic coding of the data

Step 2 theme based colour coding of data blocks
Time (purple)
Strategy (navy blue)
Protection (light blue)
Proof (dark green)
Money (lime)
Market (orange)
Knowledge (sienna red)

Mixed Theme Data Blocks

Because the research can be conducted quickly, we can valorise it quickly and we can move on quickly. It's all about speed

But in a market in which you must be able to demonstrate very fast – because that is increasingly so – you have to be able to show very quickly that you have an added value

By increasing our science positions by a factor 10. Only a very select number of strategic positions I want to retain for ourselves for the long term

Claiming IPRs are important to us so that we can create value to the innovations we have made with our own funding. That we can give it an added value so that we might be able to earn back a bit of our own knowledge investments so that we can invest that in other things.

Constraints do exist. It is mostly on historical agreements. Last week I was with "stakeholder S" and we were talking about our strategy and how we would link our funding to realising that strategy.

I want a lot of ideas. And which ideas are good – I mean we are not going to set up upfront criteria with a heavy upfront process to filter out ideas. The reason is that it is not always immediately evident how strong a patent is or can be

In all this time[when applying for a patent] it costs a lot of money and I lose my freedom to operate towards customers

It is to support our knowledge position. We must be able to create and sell a lot of new knowledge positions very fast.

Most RTOs want to create and maintain a certain position for a long time. *This does not work for us,* we operate in a market in which technologies evolve so rapidly that they are obsolete after 3 years.

So I did two things I've strengthened the technology side and made more budget available for it – which means on the one hand that we started research into "Topic A". Meaning that we've made substantial investments into our knowledge on processing-technologies to ensure that the foundations we already had there strengthened and directed towards "Topic A".

So this is the time to team up with the right partners, and do the right things.

So we use the IP to be credible to companies which will make them willing to put money in our pockets.

That really is the difficult thing about licensing [on patents] because you can't do that very quickly. It would have been very nice if we already had a patent on the "Technology 3", but we don't have it yet

The moment we make things OS and use an OS license and with this OS license enforce that re-use of the code requires a referral to us. Then we create something like a list of 'forward citations' on our code. So what I want to do is to recalibrate our software strategy with a solid OS foundation in which we take the re-use of our OS as a success demonstrator for our show-how

We can determine how we are going to steer on our strategy and with whom. Instead of choosing for the same partners/stakeholders we can add new or unexpected partners.

We have a certain amount of money that we can spend and how much we spend on what or which patent portfolios we determine ourselves.

We have freed up budget together with two other units for a position in a start-up platform with a major company to collect and bundle all the knowledge within our RTO in one place. Which is a substantial change to how we operated a year ago. So we made a very deliberate choice in that

We've chosen two specific knowledge-domains in which we are already very capable because it allows us to quickly accelerate our knowledge investments and to increase it because we are already capable in it. So we can position it in a market very quickly as impact.

B.3 Quotes indicating each division's Goals and Roles

From the industry context perspective Triangle is clearly interested in shaping strongholds. *"We really want to build a little castle with fortified walls and towers – something like an IP fortress – around that specific way of manufacturing."* Aiming for a recognisable role as a determined dominator and a reliable relation *"The fact that we not only have great ideas but that we also already have patents on these ideas makes us a more attractive partner to team up with"*.

Square is very clear about pursuing the role of reliable relation by following the investment objective goals of shaping strongholds and crafting crowds by creating multiple spin-offs per year. *"... patents are a form of security underpinning the spin-off. If there are no patents in it, the spin-off ends up being loose sand. Patents offer protection to a spin-off to allow it to develop itself and it secures the relationship between our organisation and the spin-off. For me that is also important, that with the license on the patent(s) we are also securing the relation providing us with something we can build on."*

Circle on the other hand describes three investment goals maintaining momentum, crafting crowds and gaining rapid referrals. Circle switches between various roles. The role of determined dominator *"Only a very select number of strategic positions I want to retain for ourselves for the long term"* and *"Copyright will remain important because ownership of the code remains with us, even as the code is open."*. Circle also aspires the role of Agile Ally *"All the other patents I want to valorise in an agile way. What I have done is I've increased our agility – by increasing our science positions by a factor 10"* and lastly the role of Mass Moderniser *"A shift that they [customers] are using open source more and more .., this forces us to develop our own software open source. ... the moment we make things OS ... and with this OS license enforce that re-use of the code requires a referral to us. The value is in the referral, in showing that the code originated with us. That makes us attractive."*

Diamond indicates three goals are important maintaining momentum *"we've chosen two specific knowledge domains in which we are already very capable because it allows us to quickly accelerate our knowledge investments … we can position it in a market very quickly."* Diamond also places importance on the goals of shaping strongholds *"claiming IPRs are important to us so that we can create value to the innovations we have made with our own funding."* She emphasises the role of Reliable Relation *"… in the market there is a perception of 'yes, there is always a lot of R&D being done. But what does it yield? How will this become something concrete? And of what use will this be to me later?' Well – technology that works."* and possibly mass-moderniser *"… together with two other business units [we freed up budget] for a position in a start-up platform … to collect and bundle all the knowledge within our RTO in one place. Which is a substantial change to how we operated a year ago."*

C Patent application formalities in a nutshell

The text in this Appendix has been literally copied from the World Intellectual Property Organisation and Netherlands Enterprise Agency (RVO) website.

A patent is an exclusive right granted for an invention, which is a product or a process that provides, in general, a new way of doing something, or offers a new technical solution to a problem. To get a patent, technical information about the invention must be disclosed to the public in a patent application. (WIPO, 2019). Patent Cooperation Treaty (or PCT) was concluded in 1970 in Washington. This treaty allows a patent to be applied for all over the world by means of a single application procedure. The World Intellectual Property Organization (WIPO) is responsible for implementing this treaty. In contrast to the procedure for granting European patents, the PCT procedure does not directly result in a granted patent. A worldwide patent does therefore not exist. It would be impossible to pay for a patent to be granted in all countries that are affiliated with the Patent Cooperation Treaty and it would not be worthwhile either. The major advantage of the PCT procedure is that you have 30 months to decide in which countries you actually wish to have patent protection. Once these 30 months have elapsed, there are procedures in a number of regions that will allow you to defer payment of costs associated with granting a patent and translation. Patent attorneys are able to offer advice on this matter (RVO, 2019).

The PCT procedure begins by filing a PCT application and paying a number of set fees (including fees associated with filing and carrying out a search). You may file your application with our office, the European Patent Office or the WIPO. An International Search Authority (ISA), such as the European Patent Office, will subsequently carry out an international novelty search. The WIPO publishes the application as soon as possible once 18 months have elapsed since the initial filing date. At your request, a provisional examination can be made, and this may often be the case as a result of documents that you can re-submit with improvements. The results of the novelty search and any assessment are subsequently sent to the national patent-granting authority or the European Patent Office. These authorities are able to complete the process and subsequently grant a patent. At the end of the PCT procedure (i.e. prior to the end of the 30th month, counting from the priority date), you will proceed to the regional or national phase. You will then decide in which countries you wish to establish patent rights (RVO, 2019).