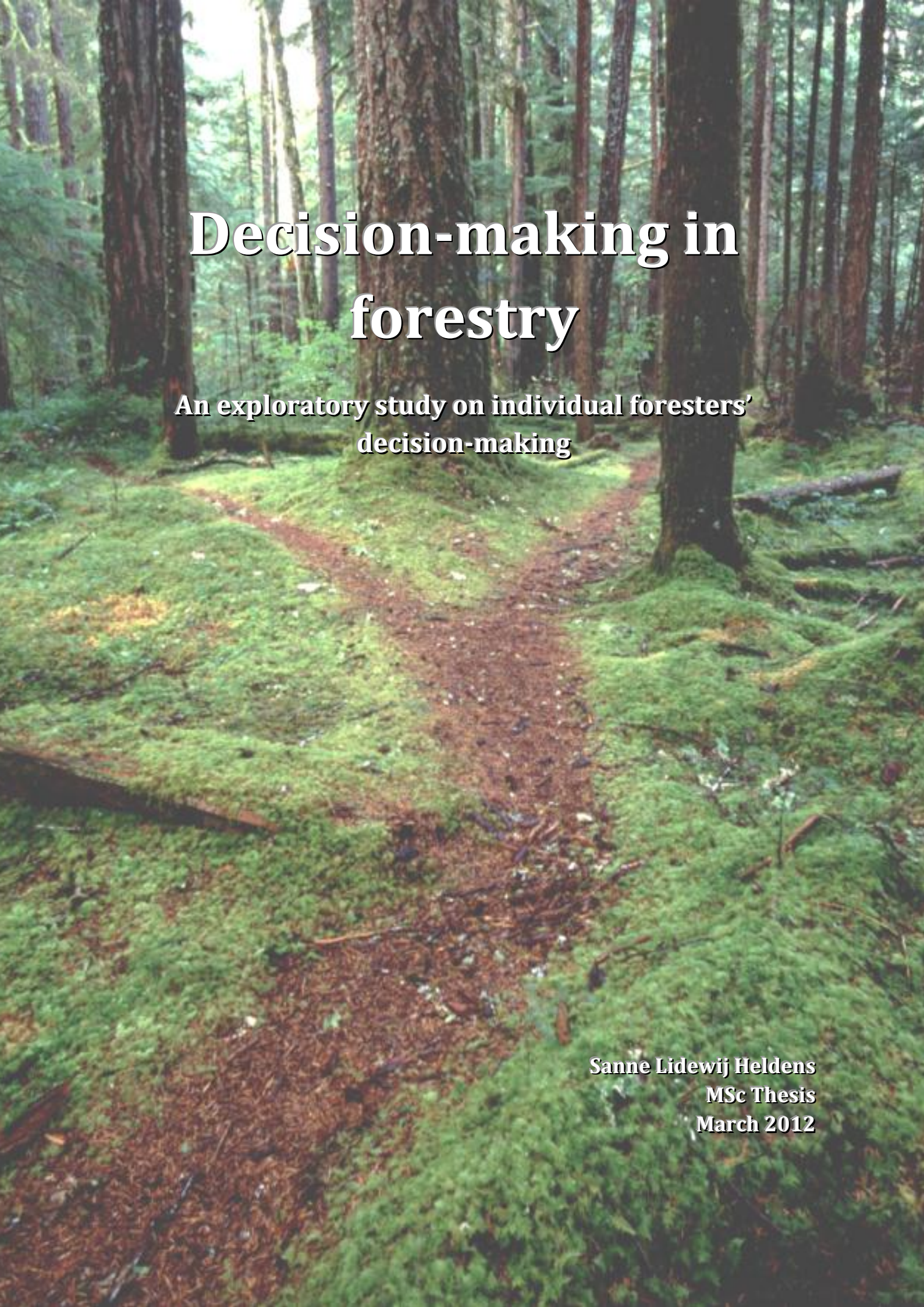

Decision-making in forestry

An exploratory study on individual foresters' decision-making

Sanne Lidewij Heldens
MSc Thesis
March 2012

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SUMMARY

Decision-making is fundamental to all human life. Within decision-making, the rational choice model is commonly used. Rationality, which in general refers to using reason, is by the hyper-rational choice theory described as the behaviour with the most optimal outcome conform a full cost-benefit analysis. In the forestry-community, the rational choice model is also very powerful and forestry research has in general followed this approach. Complete economic efficiency as the objective in forestry resulted in approaches striving for maximization of utilities. Despite its powerful role the rational choice model has been (and still is) heavily criticized. Besides the criticism from social science, also in forestry itself there is an emerging resistance against the rational choice paradigm. During the last decade, in the forestry community there is debated about the way foresters make decisions. On the one hand it is stated that foresters behave completely rational. Others do not agree with this statement and indicate that foresters do not behave rational. The objective of this research is to empirically explore how foresters actually make decisions.

A first step in achieving the objective is the theoretical framework, which consists of: decision-making (DM) models, decision-making situations and the relations between decision-making models and decision-making situations. The theoretical framework was the basis for the eight hypotheses of the research. The hypotheses are to test the assumptions made in theory about correlations of DM-models and DM-situations. Since DM- situations differ, varying DM models may fit the ongoing processes and conditions the best. For this research the following DM models are incorporated: the hyper-rational choice approach, the bounded rational approach and the sensemaking approach. In short, the hyper-rational model describes decisions as acts with the most optimal outcome; the bounded rational approach assumes decisions satisfice decision-makers as selecting the course of action with the most optimal outcome is not possible by humans; and the sensemaking model describes the process of assigning meaning to happenings and how this personal view on the world provides a framework for decision-making.

To test the research hypotheses and achieve the research objective, choices made in forestry must be examined. Ten private forest owners participated individually in the study. Information was gathered through interviews in which some small experiments were carried out. The experiments confronted the interviewees with fictive forest management decision-making situations in which a course of action had to be selected. Besides quantitative information about the decisions made, the interviews give insights in the underlying reasoning and thoughts of the decisions.

The results of the interviews showed that often the choices made differ from the expected ones based on the hypotheses. Many times, the decisions made in the five experiments were not in line with the hyper-rational choice model, even though the conditions of most situations allow this model to describe them. The optimal utility in terms of money was for most participants not the motive behind their choices. Many other motives behind decisions of foresters regarding their profession exist. Natural, cultural, historical and emotional reasons are often involved in the decision-making process.

People act rational, but not based on the provided information. People create their own decision-making situation by their own cognition. This is an ongoing, retrospective, social development resulting in plausible images instead of experiencing the world as the objective truth. Therefore this research shows the suitability of the sensemaking model to explain foresters' decision-making.

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1. INTRODUCTION

1.1 BACKGROUND

In our daily life, we constantly make decisions and these decisions shape our lives. “What study will I follow”, “Where should I live”, and “How should I spend my money” are only a few examples of the many decisions we make on a daily basis. Making decisions is fundamental to all human life. It is therefore not surprising that decision-making has been the subject of research in several scientific disciplines.

Within decision-making, the rational choice model is a commonly used model by many of these disciplines. The model has even achieved a paradigmatic status (Hoogstra, 2008). Rationality described by the rational choice model is different from the way the term is generally used. Most people refer to rationality as using reason. The rational choice model uses a more narrow definition of rationality. The rational choice model assumes actors will behave conform costs-benefits balances to arrive at actions that maximizes personal utility. Actors are assumed to have full information concerning the decisions they make. Thus, conform the rational choice model people can and will make choices which will have the most optimal outcome.

In the forestry community, the rational choice model is also very powerful. Forestry research has in general followed the rational economic approach (Kant, 2003; Schlüter, 2007; Hoogstra, 2008). Since the early years, when forest economics tried to cope with the decision-making difficulties in forestry, the rational choice model was incorporated in their designed theories and models. “During most of the 20th century, forestry has been viewed largely as a technical problem to be solved by gathering data and using linear, rational analyses to choose and implement management strategies” (Smith, 1997). The objective of all models was complete economic efficiency, therefore the models were characterized by maximization of the utility. Smith (1997) stated that the rational decision-making approach has worked well for forestry-notably in producing large volumes of wood fiber.

1.2 PROBLEM STATEMENT

In spite of the powerful role of the rational model in decision-making, it has been (and still is) heavily criticized (Beckert, 1996; Landa and Wang, 2001; Kant, 2003; Hoogstra, 2012). These criticisms arise out of several disciplines. From the social science, critique is mostly based upon the assumption that humans cannot be rational decision-makers due to their cognitive limitations (Simon, 1993). Many experiments have shown a mismatch between the observed irrational behaviour of humans and the rational behaviour prescriptions set by the rational choice theory (Beckert, 1996; Kant, 2003; Landa and Wang, 2001).

Also in forestry there is an emerging resistance against the rational choice paradigm. During the last decade, in the forestry community a debate is raging about the way foresters make decisions (Schlüter, 2007). On the one hand it is stated that foresters behave completely rational (Luzzi, 2001; Schlüter, 2007). Others do not agree with this statement and indicate that foresters do not behave rational (Ekbia and Reynolds, 2006; Kant, 2003). An example of critique on the rational choice model in forestry is given by Kant (2003), who stated that forest economic models based on the neoclassical framework (rational choice model) have serious limitations. He argued that the rational choice model can no longer be applied

to the new forest management which has emerged in the last two decades because the management has changed too much. The new forest management has transformed forest management from timber management (sustainable timber yield) to forest ecosystem management (sustainable forest management) (Kant, 2003). Consequently the rational choice model does not (or no longer) provide an adequate framework for the current forest management practises. Furthermore it becomes clear from Kant (2003) that although in economics in general scientists have already tried to overcome some of the limitations of the rational choice paradigm (e.g. in institutional economics or in evolutionary economics), the field of forest economics has not.

Kant (2003) is not the only scientist criticizing the rational approach in forestry. Ekbia and Reynolds (2006), for example, state that the "basic rational models may not be sufficient to account for the full complexity of situations faced in forestry". Schlüter (2007) has comments on the rational approach too. He argues that because of particular characteristics of the forestry sector, applying a too simplified (neoclassical) theory must be avoided. The by Schlüter (2007) discussed 'deviations' are mostly due to the complexity inherent to forestry. This complexity is, among others, a result of the high level of uncertainty due to the long-time horizons underlying forestry processes (Hoogstra and Schanz, 2008). Throughout the production process of forests goods and products, much can happen in the complex ecosystems. Obtaining full information about possible events and the consequences of actions is in forestry decision-making situations not possible. Consequently, this complicates the decision-making process. Acting rational by maximizing the utility is not possible since full information is a requirement. It appears that the rational choice theory entails many limitations for providing a model which can outline the decision-making process of foresters. Another argument by Schlüter (2007) against the forest decision-maker as a rational actor concerns the fact that nowadays more and more forests are privately owned and forestry provides often just a small proportion of the income of the owner. When the decision to be taken is economically only marginally important, it is not worthwhile investing money and other recourses to increase economic efficiency (acting rational) in forestry. "Instead other goals than economic goals will come to fore" (Kvarda, 2004; Ziegenspeck and Hardter et al, 2004 In Schlüter, 2007).

It can be concluded that there is no mutual agreement in the forestry community about which decision-making model describes the behaviour of foresters the best; both the assumptions of the forester as rational and as not-rational decision-maker have support. For years, the rational choice approach (from neoclassical economics) was seen as a proper way to made decisions and to examine decision-making in forestry, now the critics indicates an emerging opposition of this neoclassical thought. Blum and Hoogstra (2009) suggest however that one should not focus the discussion the appropriateness of the rational choice model in general, but the focus must be on the conditions in which decisions are made in forestry. The conditions of decision-making situations can construct situations in which rational choices can be made (and forecasted by others) and situations in which this is impossible. A precondition of a rational decision-making situation is complete information. This complete availability of information shapes a situation in which all possible options, consequences and events are known and an optimal decision can be made. But in many forestry situations, having full information is not possible and uncertainty arises. As full information is a requirement for an individual to behave rational, there are many decision-making situations in forestry where the rational choice approach is not applicable. This does not lead immediately to the complete exclusion of rational behaviour in forestry. It does show that for certain decision-making situations, other decision-making models need to be examined. It is crucial to know among what conditions people can act rational and with which conditions this is really not possible, as in situations of

non-rational behaviour humans will lose the ability to describe, explain, anticipate and predict on with the use of economic theories (Blum and Hoogstra, 2009).

1.3 Research objective and research hypotheses

The discussion on decision-making models and decision-making situations in forestry has however mainly been a theoretical discussion. By finding *empirical* evidence about the way foresters make decisions, the current discussion about rational or non-rational foresters can be taken a step further. The objective of the research is therefore to empirically explore how foresters actually make decisions in different decision-making situations. The research will go beyond the content of decisions and will examine the theoretical models that can outline the decision-making situations.

So far, no theories have been developed about the way foresters decide in different decision-making situations and as a consequence, it is inevitable that this research necessitates an explorative approach. To do this, this research will first of all begin with developing a sound theoretical footing that will generate the research hypotheses to be studied.

1.4 Structure

This research consists of six chapters. The first chapter introduces the importance of an investigation on decision-making of foresters by describing the current debate on how foresters decide. Besides, this chapter outlines the main problem and the main objective of the study. The second chapter contains the theoretical framework necessary for the research. The theoretical framework is divided in three parts, each about a main element of the research: decision-making models, decision-making situations and the last part is about the relations of these two elements. The research hypotheses are also given in the second chapter since these hypotheses enrolled from the theoretical framework. To continue, chapter three describes the methodological part of the research. In this section the research approach and the data collection methods are explained. In addition, this section will elaborate on how the collected data is analysed. In the fourth chapter the results of the research are presented. The fifth chapter is the discussion of the research. Here, a reflection on the results, theories and the research methods is given. Finally, chapter six consists of the conclusion concerning the objective of the research and provides suggestions for further research.

2. THEORETICAL FRAMEWORK

As stated in chapter 1, a sound theoretical framework is needed to guide the empirical research. This chapter describes this framework, which is based on the main elements of this research: (1) decision-making models (section 2.1), (2) decision-making situations (section 2.2) and (3) the relation between decision-making models and decision-making situation (section 2.3).

2.1 DECISION-MAKING MODELS

2.1.1 HYPER-RATIONAL DECISION-MAKING

As mentioned, the rational decision-making theory has been (and still is) remarkably successful in recent decades. It has been applied in many disciplines, from economics to philosophy and sociology. Despite its success, there is no widely accepted definition of rational choice theory (Ulen, 1999). In a way, this success might just be the reason for the variety of definitions and assumptions of the rational choice concept.

But even though there is no general agreement as to what the specific content of the theory is, there appears to be a basic model of relational behaviour that can be considered the common denominator of the many versions of the rational choice model (Vanberg, 2002). In this basic model, rational behaviour consists of selecting that course of action which leads to the most preferred outcome. Since people wish to achieve more things than can be done, they have to make choices. Among all the possible alternatives, people will choice the best option for them. In the hyper-rational decision model, this best option will be the one that optimizes the utility (Beckert, 1996; Kant, 2003). According to Joas and Beckert (2002) the rational choice model assumes that *"*actors enter a situation with preferences between different bundles of goods and choose the bundle that maximizes their utility*"*. Conform Aldrich (1993), rational choice theory is about just how those preferences determine behaviour as "rational choice theories are theories about how the (expected) utility associated with outcomes generates or induces preferences for the particular actions in hand".

The rational choice model is based on an analytical action framework, which focuses on means and ends (Joas and Beckert, 2002). This means that human behaviour is intentional; "humans possesses goals and apply means to achieve these goals while they take constraints on their possible courses of action into account" (Joas and Beckert, 2002). Humans do not make choices randomly, but their choices are purposefully aimed at achieving their goals and thereby solving problems that are encountered. In order to make decisions according to the rational choice approach, "Individuals compare expected benefits and costs of actions prior to adapting strategies for action" (Ostrom, 1991). Following Schlüter (2007), actors taking economics decisions know about the costs and benefits associated with the different choices. With this knowledge, actors choose in accordance with their preferences the strategy which provides maximization of their own benefits. The rational choice approach is meant to provide an explanatory account of this intentionally and purposeful human action (Vanberg, 2002).

Everybody agrees that the rational choice approach is about the human behaviour. But there is some disagreement as in what way the approach deals with human behaviour. Some assume the hyper rational choice theory is purely descriptive, describing certain regularities in human behaviour, with the purpose to predict human behaviour (Sugden, 1991). Others do not agree, and in their view the rational choice

theory is a normative theory prescribing human action (Ostrom, 1991; Sugden 1991). So there is a separation in views of the theory describing how humans should act and about how humans really act. Theories to describe how humans act, or how decisions are made in real, are mostly classical theories, as these "classical theories of choice emphasise decision making as the making of rational choices" (Dillon, 1998). Keren and Wagenaar (1985) state that much of the research conducted during the sixties advocated the position that human beings are by and large rational. Rational choice as theory for describing human action is derived from this assumption. The opposing conclusion, the view of rational choice as normative theory is, among others, supported by Landa and Wang (2001) who state: "rational choice theory is a normative theory of the average of representative individuals making choices; it is not a descriptive theory of actual behaviour in specific environments". Tarter and How (1996) agrees and mention that the classical model (rational choice model) is an ideal rather than a description of how decision-makers function. In accordance with Sugden (1991) the relational choice theory also has a normative content since it tells us how we as rational agents ought to choose. Sugden (1991) adds that if the theory also has predictive power, this is because human beings have some tendency to act rationally. Ostrom (1991) sees the rational choice theory as theory of advice that informs individuals, or collectives of individuals, about how best to achieve objective, whatever these objectives may be.

Besides rational choice as a normative of descriptive theory, other interpretations of the concept exist. A whole other position concerning the rational choice concept is for example provided by Harford (2008). In accordance with Harford (2008), everything is the result of a rational process, and despite the unpleasant of horrible happenings in life, life is logical after all. Examples as murdering someone, using drugs, smoking or acts of racism does not seem to be rational decisions. But Harford (2008) explains that human decisions are always taking account of future costs and benefits. Resulting in the compliance of decision-making with economic logic and the rational choice model.

For this research the concept of hyper-rational decision-making will follow the definition of the basic model of rational choice, in which actors with certain preferences choose the option that maximizes their utility. The next section is about the assumptions belonging to this specific approach of looking at rational choice. Subsequently criticisms about the rational choice approach, and how these comments induced other decisions making models, are discussed.

Assumptions

To achieve optimization of the utility, as the proposed goal in the rational choice model, this model has some integrally linked assumptions of complete information, clear goals and cognitive capacity of people. Actors are assumed to possess the knowledge that they need to make optimal choices (Vanberg, 2002). Since making optimal choices is only possible in situations of full understandings, complete information is required. According to Vanberg (2002) the hyper, or "perfect", rational choice approach "implies that there is no relevant difference between objective data and subjective knowledge that economic agents act upon". Complete knowledge of means-end relations ensures the clear goals. Even in complex situations, actors can deduce their actions from a clear preference ranking and thereby maximize their utility (Beckert, 1996). Uncertainty is not incorporated in the perfect rational choice approach, as following Beckert (1996): "The structural characteristics of uncertainty do not allow for rational decisions in the sense of economic theory for the achievement of given ends". Another assumption is about the cognitive capacity of people. The rational choice theory assumes people are mentally able to seek for the optimal alternative. Beside these views concerning the information, goals and cognitive capacity, the framework of the rational choice theory is underlined by the assumption of individual economic actors,

or 'the economic man', who operate in a static world without transaction costs and institutions (Landa and Wang, 2001). According to the theory, actors are not influenced by others (culture, social, ethnic or institutional) in their decision-making process. Society is a mathematical aggregation of homogeneous rational agents and there is no role for any institution other than the market (Kant, 2003). Moreover, in this rational world there are no transaction costs, meaning that there are no costs associated with obtaining information about costs and benefits of possible alternatives.

Critics

Despite the paradigmatic status of the rational choice model, it has long been and continues to be a target of criticism. First of all, in decision-making literature much criticism is about the rational choice theory not describing actual human behaviour. A mismatch is identified between the observed irrational behaviour of humans and the rational behaviour prescriptions set by the rational choice theory. Beckert (1996) states that the observation that actors do not live up to the behaviour prescriptions set by the theory, but behave irrational, is used as the central argument for rejecting orthodox economic theory by sociology. Kant (2003) talks about "a gap between theoretical models and practices", concern the rational model. This mismatch or gap makes that many doubt the rational choice model. Landa and Wang (2001) do also mention about this mismatch by referring to some psychologists and economists who challenge the theory of rational choice by demonstrating, with the use of empirical evidence drawn from behaviour decision-making situations, that "individuals make choices in violation of the expected-utility theory" (rational choice theory). Vanberg (2002) state that rational choice concept informs about what would be the case if the world were populated by perfectly rational agents. Yet what useful information this may provide, "it does not produce empirically testable conjectures about real human actions in the world as it is" (Vanberg, 2002). In literature, many other examples of individual decision-making behaviour which do not comply with the rational choice theory are identified. These critics may not reject the rational choice theory as normative theory, as despite the criticisms, normative theories could still prescribe how humans should act in certain situations according to the rational choice approach.

Another point of criticism concerns again in how far the rational choice approach really covers actual human behaviour. However, now the focus is not *if* the rational choice approach does describe real human decisions making, but *to what extent* the approach includes the different aspects of the decision-making process. To make it more clearly, it can be stated that the rational choice model does not describe the whole decision-making process of an actor. In accordance with Oliveira (2007), rational decision-making seeks to optimize the value of the outcomes focussing on the process of choosing rather than emphasizing on the selected alternative. Decision-making itself incorporates more than choosing, which is the only focus point in the rational choice theory. Mostly, decision-making consists of finding and attending to problems, thinking about alternative solutions which might deal with the problem and finally choosing among the alternatives. According to Simon (1993), rational choice theory focuses only on the substance of choice, and it really deals with only a third of the three parts of the choice process. Economic theory does not deal with focus of attention of emphasis, or with where alternatives of choice come from, it does only deal with the question of how to choose among the alternatives (Simon, 1993). Because the rational choice approach does not describe the whole decision-making process, some features of actual behaviour are not incorporated. This may in some part clarify the existence for a 'gap' between the rational choice theory and actual human behaviour that is often noted.

The main focus of critique against the hyper-rational decision-making model is not about the action-model itself, but concerns the underlying assumptions that actors can, even in complex situations, deduce

their actions from a clear preference ranking and thereby maximize their utility (Beckert, 1996; Blum and Hoogstra, 2009). In real world situations the causal relations of action and effect are too complex and the actual effects of decisions cannot be fully anticipated (Hoogstra, 2012). In face of uncertainty, defined by Beckert (1996) as a situation in which actors cannot predict outcomes and cannot assign probability distributions to possible outcomes, the maximizing assumption of the rational choice is in dispute. In accordance with Beckert (1996) situations of uncertainty "challenge the capacity of actors to allocate scarce resources in a way that their utility is optimized". In addition, Tarter and How (1998) also discuss this criticism by mentioning that "uncertainty makes maximizing an impossible choice" and conclude that individuals are incapable of making completely rational decisions on complex matters since actors do not have the knowledge, ability and capacity to maximize. The hyper-rational choice theory makes demands on human cognition that cannot be met (Tarter and Hoy, 1998). Humans are mentally not able to perform according to the assumptions of the theory. Simon, for example, saw, already in the 1950s, the cognitive limitations of humans as rational problem solvers. For the human cognition, there are too many options, consequences, and uncertainties to take into account. Besides, the timeframe in which a decision must be made it often too short for considering all the effects. Following Beckert (1996), rational choice theory can serve as a normative theory for determining how scarce resources are allocated by rational agents in order to achieve optimal outcomes, provided under the conditions of perfect and complete markets. However, in the real world these conditions for this perfect market do not exist. To conclude it can be stated that rational choice approaches are justified in situations where mean-end relations are clear, but that these conditions are not always there (Hoogstra, 2012).

As consequence of the many critiques on the rational choice model other models covering human decision-making are established. Other models may overcome the problems and limitations of the rational choice model. Some scientist have argued that due to the uncertain complex world, in which individuals do not know what to choose as they do not know what is best to choose, the cognitive processes that individuals rely upon when eventually making a decision, must be incorporated (Beckert, 1996; Hoogstra, 2012). In the remainder of the chapter alternative decision-making models, other than the hyper-rational choice model, are discussed. The cognitive processes may have a larger role in these models. Besides, it is possible that other decision-making models overcome the limitations of the rational choice approach in describing decision-making in the real world.

2.1.2 Bounded rational decision-making

An alternative to the hyper-rational decision-making model can be found in the notion of bounded rationality. The bounded rationality approach was introduced by Simon in the 1950s (Hoogstra, 2008). The bounded rational decision-making approach takes into account the limited available information, the limited processing capacity of the human mind and the limited time to make a decision that characterize real decision environments (Fiori, 2011; Ponisio, Eck and Riemens, 2008). People cannot know all options and consequences of their actions, and people often have limited time and money (Hoogstra, 2008). Therefore individuals will select the option which seems like the best one at that time, in their cognitive capacity. In this way, humans will look for courses of actions that are satisfactory (Simon, 1993). Following Tarter and Hoy (1996) people "seek to satisfice because they do not have the knowledge, ability or capacity to maximize". So the bounded rational decision-making theory assumes people will make decisions which satisfice their goals, due to their cognitive limitations of making the optimal choice. Humans will simply choose a course of action that in their own view 'seems' good enough for them. For this research the bounded rational decision-making approach is defined as intentional and reasoned

behaviour, where the decision-maker aims at selecting satisfactory alternatives that matches the personal goals (goal-seeking) (Fiori, 2011).

The bounded rational decision-making model copes with the critiques of the hyper-rational decision-making model in some ways. First, the much criticized aim of maximizing utility of the hyper-rational choice model is modified by focussing on satisfaction in the bounded rational choice model. Choosing an action that satisfies the needs or goals of an actor is a more likely representation of real decision-making because conditions in which choosing the best option is possible do not occur that often. In accordance to Simon (1993), the maximizing utility incorporated in the hyper-rational choice model is no resemblance of what human beings actually can do: "The idea that we even have a conception of what would be optimal behaviour in the complex situations of live is unbelievable from the beginning". Others support Simon's statement. Like Tarter and Hoy (1996) who mention "Simon introduced the strategy of satisficing to describe a realistic version of rational decision-making". Empirical evidence showed actual decision-making conformed reasonably well with the assumptions of bounded rationality but not with the assumptions of perfect rationality (Simon, 1979).

Second, the bounded rationality approach focuses on subjective rationality instead of an objective one. Unlike the objective view incorporated in the hyper-rational choice model, the bounded rational decision-making approach incorporates personal values in the decision-making process. Personal values will influence the decision-making process since the (satisficing) choices are based on personal expectations, our own experiences and the experiences of others about what is attainable (Simon 1993). Personal values cannot be subjected to a rational calculus (Simon 1993), like applied in the hyper-rational choice model. Despite actors are not objective rational beings in the bounded rational approach, it does not assume actors to be irrational. The approach considers actors to be intentionally rational, but only to a limited extent due to their cognitive limitations (Hoogstra, 2008). According to the bounded rational decision-making approach, an individual's decision is rational if it is consistent with the values, alternatives, and information that were analysed in reaching it (Tarter and Hoy, 1996). So the bounded rational choice model strives for rational choice making. The involvement of personal values in the bounded rational approach may be an improvement towards giving a more realistic representation of decision-making in the real world (VanBerg, 2002). It would certainly contribute to the elimination of the main critique of the hyper-rational choice model of not describing actual human behaviour.

Critics

The bounder rational choice model is not free of criticism. The analytical frame of the approach explaining decision-making in terms of goal-seeking is questioned by some . The bounded model assumes that actors have certain goals and make calculations of the consequences of actions in order to achieve these goals (Beckert, 1996). Schwarz and Thompson (1990; in Hoogstra, 2008) argue that such approaches not include what the personal goals of the particular actors upon which their decisions are based are exactly. Therefore the mystery of how actors act as the do remains undescribed by the bounded rational choice model. In order to know personal' interests and goals that determine a decision, one must know these personal' interests and goals in advance. Another mentioned shortcoming of the bounded rational choice approach is also about the goal-seeking behaviour of humans. Luhman (1968, in Hoogstra, 2008) states that humans cannot fully understand the relations between means, actions and goals because of the complexity of social situations. Thereby rejecting the idea that predetermined goals provide an explanation for selecting certain actions. VanBerg (2002) considers Simons' contribution of bounded rationality is about explaining the system of human rationality itself. The approach provides no

explanation for the human behaviour (the content of decisions). VanBerg (2002) points out that Simon (1979; 1993) his essential argument about the notion of bounded rationality is that "as soon as the assumption of perfect rationality is given up and the subjectivity of human rationality is acknowledges, we can no longer pretend to be able to explain human purposeful behaviour without an empirically contentful theory of how humans acquire knowledge about the world and how they employ such knowledge in their efforts at solving problems they face". In Simon's view the bounded rational choice approach assumes matters are overly complex because of a multitude of partly conflicting and not measurable goals and because the possible alternative choices are not known in advance (VanBerg, 2002). What these goals and alternative choices are depend on capacities and knowledge of the actor, and these change of time (by learning) and among persons. So to analyse or describe decision-making in terms of the bounded rational choice model one must obtain knowledge of the particular decision-maker. Just like Simon (1987 in VanBerg, 2002) points out that such explanatory accounts must pay attention to the personal constitution by focussing on the process of learning by experiences in which behaviour routines are shaped, and to the processes that generate the actors subjective representations of the decision-problems.

Beckert (1996) criticized the concept of bounded rationality for not explaining when an actor will stop looking for actions to perform by noticing that: "the weakness of the notion of satisfying is that Simon cannot operationalize at what point decision-makers stop the search for further alternatives". Conform the bounded approach, the process of selecting an action 'ends' by mentioning that an actor will act "once they have found an alternative that satisfies their aspirant level" (Beckert, 1996). The time a decision-maker takes to make a decision is not defined specifically by the bounded rational choice approach.

2.1.3 SENSEMAKING

Sensemaking is not a rigid, widely recognised model in decision-making, but is accepted as a term and has been dealt with by a wide range of researchers from various fields of research (Nielsen, 2006). The concept of sensemaking was introduced by organisational and information science. In organisational science, Weick had made many contributions to the field of sensemaking (Nielsen, 2006). But sensemaking occurs at all levels of a social system, from the individual to the industry or cultural level (Sneddon, 2008 from Weick, 1995).

The concept of sensemaking literally means 'the making of sense' (Weick, 1995). In accordance with Weick (1995), 'sense' is the meaning ascribed to an event, and 'making' is a creation or construction activity. Accordingly, sensemaking is about how people think and act in the world (Hoogstra, 2008). Sensemaking describes the process of "assigning meaning" (Weick, 1995) and "how that enacted reality provides a context for action" (Choo, 1996). Individuals form unconscious and conscious anticipations and assumptions, which serve as predictions about future events (Louis, 1980). Thus, sensemaking involves the retrospective development of plausible images that rationalize what people are doing (Weick et al., 2005). Others emphasis on the cycle process of sensemaking, like Peraira (2002) who defines sensemaking as the cyclical process of taking action, extracting information from stimuli resulting from that action, and incorporating information and stimuli from that action into the mental framework that guide further actions. Despite the different definitions of sensemaking, Weick (1995) suggests that all studies concerning sensemaking involve the consideration of how active agents give structure to the unknown (Waterman, 1990).

The concept of sensemaking is often employed in studies of accidents, crises and mishaps (Heldal et al., 2009). Examples are the studies of a forest fire with many human losses: The Mann Gulch disaster (Weick, 2001) and the space shuttle disaster the Challenger (Starbuck and Milliken, 1988). In these studies attempted are made to understand how individuals and groups try to make sense of events that challenge their preconceptions (Heldal et al., 2009). Sensemaking comes into play when people encounter disruptions or discontinuities to their own knowledge and experiences. Discrepant events or surprises trigger a need for explanation and interpretation (Louis, 1980). Weick et al. (2005) stated that sensemaking tend to occur when the current state of the world is perceived to be different from the expected state of the world, or when there is no obvious way to engage the world. Such circumstances do also occur in situations of uncertainty and ambiguity (Hoogstra, 2008). Figure 1 shows graphically how the discontinuities (ecological change) are the first step of the sensemaking process. This ecological change requires actors "to attempt to understand these differences and to determine the significance of these changes" (Choo, 1996). The reciprocal relationship between ecological change and enactment includes sensemaking activities of sensing anomalies, enacting order into flux, and being shaped by externalities (Weick et al., 2005). In the process of enactment, actors begin to order the environment by selectively bracket actions and texts, labelling them and look for relationships (Choo, 1996). In the selection process the raw data generated in the previous step will now be ordered further. The resulting data of the enactment step could still mean several things, but the number of possible outcomes gets reduced in the process of selection (Weick et al., 2005). "Selection involves the overlaying of various plausible relationship structures on enacted date in an attempt to reduce their equivocality" (Choo, 1996). In the retention process, the outcomes are retained for future use. It is through the process of enactment that the sensemaker constructs an environment that makes sense to them. These outcomes of the sensemaking process can now be used as a source of guidance for further action and interpretation (Weick et al., 2005). Through this obtained subjective view on the environment and corresponding actions, actors shape, create and change their environment. An actor over time influences the environment, and is influenced by it because the environment is a source of stimuli (Seligman, 2006). This explains the feedback steps in figure 1.

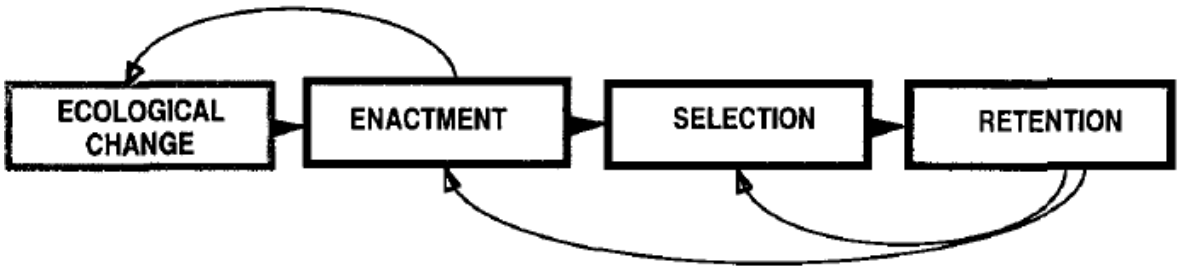

Figure 1: Sensemaking processes (Choo, 1996; adapted from Weick, 1979)

Other than in the rational decision-making process which is about strategic rationality (goal-seeking, intentional behaviour), sensemaking is about contextual rationality (Weick, 1993). In situations where people cannot rely on their experiences and knowledge, as they do not have them or these experiences cannot be applied to the specific situation, people first have to make sense of the situation before making a decision. The assumption of contextual rationality does not require people to be rational processors of information; they may impose their own meaning upon experience, and use the ascribed meaning as a basis for subsequent understanding and action (Choo, 1996). Sensemaking is therefore not about truth and getting it right (Weick et al., 2005). It is driven by plausibility rather than accuracy (Weick, 1995). As can be seen in figure 1, sensemaking is about shaping plausible meaning. People have to make sense

based on inaccurate or incomplete information, so the sense that is made is not necessary formed into a belief in what would happen (a probability belief), but rather an understanding of what could happen (a plausibility belief) (Seligan, 2006). Weick et al. (2005) highlight that plausible beliefs are not the same for all groups: "what is plausible for one group, often proves implausible for another group". This is due to the different identities of al actors. Who we thing we are (identity) shapes what we enact and how we interpret (Weick et al., 2005). As everybody is different, everybody will perform in the sensemaking process differently. The outcomes of the sensemaking process will again have influence on how actors will give meaning to next changes (figure 1).

Sensemaking is characterised by a circular system. Sensemaking describes more than just explaining unexpected events, more that the single step from thinking to acting. It is an ongoing and active process (Weick, 1995), having no single point of departure and no permanent point of arrival (Dougherty and Drumheller, 2006). The sensemaking view assumes people are continuously trying to understand what is happening around them (Choo, 1996). Pereira (2002) states that the ongoing characteristics of sensemaking is explained by the cyclical nature of the process. People are constantly making actions, making sense of these actions, and then act again. Here we touch upon another characteristic of sensemaking, namely the retrospective character. Sensemaking is done retrospectively since we cannot make sense of events and actions until they have occurred and we can then glance backward in time to construct their meaning (Choo, 1996). Nielsen (2002) highlights that people are in a continuous flow of experience. During this flow it would be impossible to separate elements of it to make sense of them. "Only after having lived the experience can we decide upon its meaning, and the relation we attribute it to have with the rest of the flow" (Nielsen, 2002). Heldal et al. (2009) call the retrospective character of the sensemaking concept "unconventional", as the common usage of the term 'to make sense of' implies reaching an understanding, or to make clear what was not. Glanz, Williams and Hoeksema (2001) do also mention that the sensemaking concept would suggest a more direct "anticipatory adjustment" instead of the retrospective character it has.

Sensemaking may seem like an individual process. After all, making sense of situations is done mentally and, unless shared, cannot be observed by others. From an explanation of sensemaking from Weick (1995) it becomes clear that sensemaking goes beyond the individual actor since sensemaking is defined as "the ongoing process in which people give meaning to events by learning from their own actions and the actions of others". Individuals do not only learn from their own actions but they also learn by acting and reflecting upon actions of others (Pereira, 2002). The individual sensemaking is merged with others, through conversations and interactions (Sneddon, 2008; from Wiley, 1988).

To conclude, the definition of sensemaking will for this report follow the seven, already discussed, characteristics according to Weick (1995). In that way sensemaking is: grounded in identity construction, retrospective, enactive of sensible environments, social, ongoing, focused on and by extracted cues and driven by plausibility rather than accuracy (Weick, 1995). Each of these aspects is integrally linked and separable only for the purposes of exploration and explanation (Heldal et al., 2009). With this delineation of the concept, sensemaking is seen as: the "ongoing" (Weick, 1995; Weick et al., 2005) "retrospective development of plausible images" (Weick et al., 2005) resulting in cognitive and behaviour response, supported by "learning from cues from actors own actions and the actions of others" (Weick, 1995) and from general and individual "anticipations and assumptions" (Louis, 1980).

Decision-making and sensemaking

Making sense of a situation allows the actor to act in some way. Sensemaking is therefore intimately linked to decision-making in all its different stages (Hoogstra, 2012). In the first phase of decision-making, information about the situation is gathered to detect the problem and shape expectations of the next developments. In this phase, "sensemaking provides an initial account to explain a situation" (Hoogstra, 2012). Subsequently, the knowledge gained is subjected to the personal values, assumptions, thoughts and beliefs to value en judge the situation. In the third phase of decision-making the actor chooses the option that in their eyes is the best thing to do in the situation. Sensemaking is therefore understood as the activity where an actor develops an understanding of the situation to select the best option founded by that understanding (Weick, 1995). Choo (1996) sees sensemaking as the process which examines the behaviour of choice-making and serves as a "reasonable, plausible guide for action". Clearly decisions are resulting from the sensemaking process. However, making a decision is not the end of sensemaking and sensemaking is not only "the generator of decision-making and action" (Hoogstra, 2012). Sensemaking and decision-making are in a simultaneous relationship where sensemaking is the input for decision-making and decisions and actions are again the input for sensemaking (Weick, 1995). Just like Pereira (2002) stated that the justification of a decision will be developed afterwards, confirming the retrospective character of sensemaking. Following Pereira (2002), the sensemaking model suggests that the individual has been engaging in adoption-related or rejection-related activities all along, and will continue to do so once the decision is made.

Critics

Since sensemaking is a relatively new approach, criticism did not have that much time to evolve. However, some critiques are drawn. Like Weber and Glynn (2006), who state that the sensemaking approach appears to neglect the embeddedness of sensemaking in social space and time. Weber and Glynn (2006) their main critique focuses on the sensemaking theory overlooking the role of institutional contexts in explaining human cognition. According to Weick (1995), institutional theory and the sensemaking approach are connected because institutions are transformed by or emerge from sensemaking processes. Moreover, Weick (1995) calls sensemaking the "feedstock for institutionalization". Weber and Glynn (2006) do not deny this roll of institutions, but claim that this view does not take into account the complete role of institutions in sensemaking processes; "This is only a part of the story" (Weber and Glynn, 2006). Institutions "play a broader role in sensemaking than making some things unthinkable and un-sensible" (Weber and Glynn, 2006). Weber and Glynn (2006) strive for a view in which sensemaking and institutions are more entangled, as institutions not only prime sensemaking, but they also edit sensemaking through social processes and pose to trigger sensemaking processes. The sensemaking perspective would by this critique need more elaboration to include the contextual influences institutions have on sensemaking processes.

2.2 DECISION-MAKING SITUATIONS

This section focuses on classifying different decision-making situations. A classification of these different situations can be made upon the forecasting abilities of the decision-maker. Or to be clearer, it is possible to base a classification on how much people in advance know about the outcome of their decisions. These conditions of the predictive capacity can vary significantly depending on the decision situation. Regardless of the multiple approaches of systematic classification of decision-making situations, categorization along

the concepts certainty, risk, uncertainty and ignorance is the most convincing as it consist of manageable and clear definitions (Blum and Hoogstra, 2009).

Blum and Hoogstra (2009) have defined different decision-making situations based on these four concepts (table 1). These concepts indicate various scales of the ability to forecast on outcomes, since the concepts are constructed with use of the two parameters 'possible outcomes' and 'the availability of information about the probability of their occurrence'(Blum and Hoogstra, 2009). Combining the parameters provides knowledge of different potential DM situations defined by one of the concepts of certainty, risk, uncertainty and ignorance. For each of those four concepts, the knowledge level of the actor is not the same due to the variations in the parameters. This results in situations where there may or may not be information regarding the outcomes, and these possible outcomes can in some cases be expressed with the likelihood of occurrence. Together, the possible outcomes and corresponding probabilities will result in a forecasting level. Since humans take into account the possible consequences of their actions in their decision-making process, understanding of different decision-making situations will help to clarify these processes. Thus, understanding the decision-making situations humans face could be of help in providing a first insight in the decision-making processes of humans as it describes the conditions persons have to deal with.

Table 1: Classification of DM situations (derived from Blum and Hoogstra, 2009)

Certainty:	**Risk:**	**Uncertainty:**	**Ignorance:**
Outcome of a decision known	Outcome of a decision known with a certain probability	Range of outcomes of decisions known. No knowledge of the precise probabilities	No knowledge of outcomes of a decision
Action A will result in outcome B A -> B	Action A will lead in outcome B1 or B2. Both have a 50% chance of occurring. A - > B1 (50%) B2 (50%)	Action A will lead in outcome B1 or B2. Probabilities are not known A -> B1 (?%) B2 (?%)	Action A will lead to unknown outcomes with unknown probabilities A -> B1 (?%) B? (?%)

Although the given classification of decision-making situations is generally applicable, for this research it is applied to forestry decision-making situations. This has been done before by Blum and Hoogstra (2009), who describe the applicability of the rational choice model in different forestry situations with use of the classification of decision-making situations of certainty, risk, uncertainty and ignorance. The different forestry situations are, besides classified by the more general classification of the four concepts (certainty – ignorance), based on two systems which are more specific for forestry. Both systems are of importance for decision-making in forestry. These two systems are defined by Blum and Hoogstra (2009) as the trivial system and the non-trivial system. Trivial systems refer to non-human systems with stable inner relationships of causes and effects (Blum and Hoogstra, 2009). The input can be a result of human decision-making, but the inner systems and outcomes are the effect of a stable non-human natural system, driven by natural laws. Trivial systems are non-reflexive systems, meaning that the system is not capable of giving physical reflections. Four different trivial subsystems can be defined. The opposite situations of trivial systems are found in non-trivial systems. Non-trivial systems are constituted by

humans. Instead of the effect as a result of determined action as in trivial systems, here the mental state of a goal oriented actor is included (Blum and Hoogstra, 2009). So, the systems reactions may be shaped by the free will of people. Besides, non-trivial systems are known for their reflexivity; humans can and will incorporate previous experiences of themself and others in their behaviour. There are several types of non-trivial systems. Since both systems are included in forestry DM situations a narrow examinations of the systems is needed. In the next chapters, both the types of trivial and non-trivial systems are described (2.2.1 and 2.2.2).

2.2.1 TYPES OF TRIVIAL SYSTEMS

Below the trivial subsystems are set out. The trivial systems will be discussed based on situations of one single decision-maker who does not have to cope with others in his decision-making process. So in each trivial system, there is just one individual human actor involved. This makes is possible to provide a proper explanation of the fundaments of trivial systems.

Mechanistic system

The first trivial subsystem is the mechanistic system, characterised by decision-making situations of certainty. This system implies a single input-output system (figure 2). This means there is a causal relation between action and result of which the functional relationship between the action and the result, as consequence of interaction of action and system, are completely known. For decision-making this means that if a certain outcome is desired, a known action can be performed to achieve this desired result causal (Blum, Hoogstra, 2009). In the mechanistic situation, one action (or decision) will result in one outcome. The likelihood of occurrence of an output, after action taken, is in the case of mechanistic situations one (100%), since it is certain the event is going to happen. For example, when men cut off a branch of a tree, this branch will certainly no longer be attached to the tree. The certainty character of the mechanistic system implies the availability of complete knowledge of causal relations of input and output.

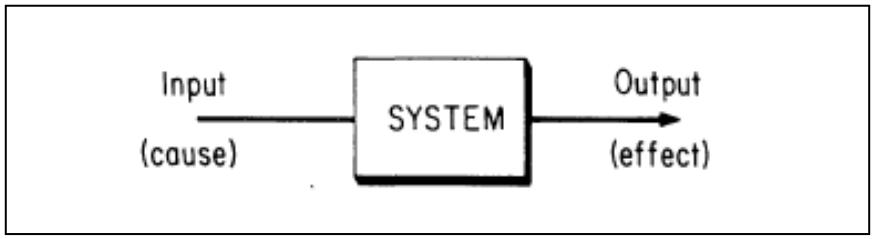

Figure 2: Mechanistic system (Patters and Odum, 1981)

Machineries can be classified as mechanistic systems. Humans steer the machinery and this system produces, through some internal processes, a known outcome. For example, a timberjack steered by humans is used in harvesting trees. The timberjack cannot do anything by itself. Human input is needed for the machinery to work. Besides machines as mechanistic systems, nature elements can be covered by this system. For example, the view of ecosystems as a mechanistic system is a very dominant one. In this view, an element of an ecosystem has direct influences upon the other elements (Pattern and Odum, 1981). Like when a tree wins the competition for sunlight, by growing faster than the other trees, the result is that there is less light available for the other, smaller trees. The causality in ecosystems is, like in all mechanistic systems a certain one; the result of an 'action' (for example growth or survival), will lead to a known outcome. Nevertheless the view of ecosystems as mechanistic systems is not a widely shared

view. Opponents of the ecosystems as mechanistic systems state that ecosystems are too complex to be explained and analysed as mechanistic systems.

Cybernetic system

Like in the mechanistic system, the cybernetic system is known for a causal relation between action and result. The difference lies in a feedback mechanism in the cybernetic system, what makes the input-output model more complicated than in the mechanistic system. Feedback is information about the results of a process, a portion of the outcome, which is used to change the process. In figure 3 this feedback mechanism is labelled secondary subsystem, as it evolves from the initial flow from input to output named the primary subsystem. The input of this system is, at least in part, determined by output (Patters and Odum, 1981). According to Blum and Hoogstra (2009) there is no complete knowledge about the structure of the internal loop of cybernetic systems. Consequently they state that the not fully known internal loop, or feedback mechanism, in such systems makes the functional relationship between action, (as input) exerted on the system, and outcome, as result of interaction of action and system, not fully known. Though, making decisions in a cybernetic system is not a completely unknown task. Despite the causal relation of action and result is not certain in a cybernetic system, based on empirical knowledge of different outcomes, either in terms of probabilities of possible outcomes or a bandwidth of possible outcomes, decisions can be made to possibly achieve the desired outcome. The decision-making situation in which the probabilities of occurrence are known are situations of risk and a possible bandwidth refers to situations of uncertainty (Blum and Hoogstra, 2009).

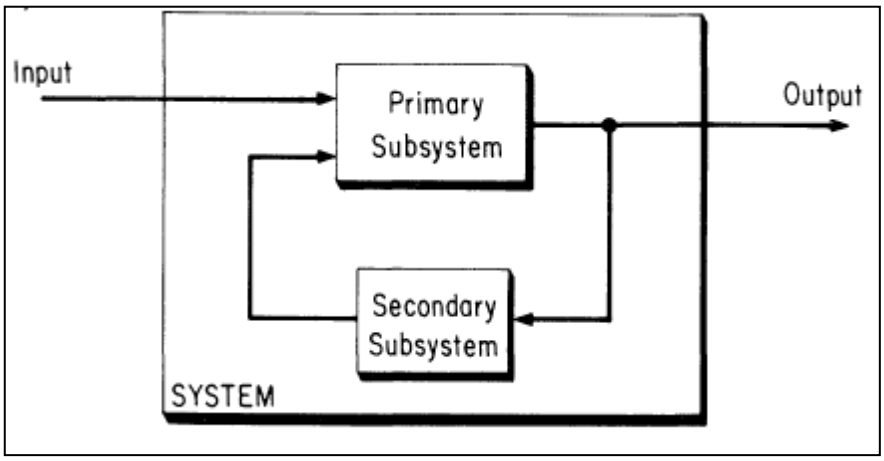

Figure 3: Cybernetic system (Patters and Odum, 1981)

Ecosystems are often considered to be cybernetic systems. Thus, besides the already mentioned view on ecosystems as mechanistic systems in the previous paragraph, others define ecosystems as cybernetics systems. From a cybernetic view, actions by the ecosystem causes shifts in the environment, and those shifts causes changes in the way the system will behave. For example, in case of a forest fire, the area can shift from a forest to grassland, or again a forest. Ecosystems are known for their multiple possible states and changes in the system can result in shifts between the states. The interplay of material cycles and energy flown generates the feedbacks (Pattern and Odum, 1981). But what this internal feedback is and how it fully operates is, following the assumptions of a cybernetic-system view of ecosystems, not known. Another, perhaps easier to imagine, example of a cybernetic system is one leaf of a tree. This leaf will, if the circumstances allows, grow. But how (direction, size and shape) this 'growth' will take place is not for

certain knowable in advance, making anticipation more difficult. The movement of the leaf by following the sunlight demonstrated one of the feedback mechanisms in this example.

"Managing complex forest ecosystems is burdened with types of uncertainty" (Thomas, 2005). But with empirical knowledge, though measuring more trees, and constructing formulas and building models, some uncertainties and risks can be reduced and better managed. In cybernetic system concerning forestry, there is often some information about the possible outcomes of decisions and corresponding actions. For example, the grow rates and likelihoods of surviving of different tree species on certain soil types are known, which is of help in selecting tree species to plant on your property. It is also possible to obtain information concerning bandwidths (absolute minimum and maximum) of temperatures on particular locations as result of very long time series. Therefore weather aspects like the amount of rainfall or the temperature can be categorized as cybernetic systems (Blum and Hoogstra, 2009).

Chaotic system

In contradiction to what the name of this system indicates, the interaction between input and output are clear in this system. The chaotic effect is due to the extreme sensitivity of the system, which even with minimal changes in initial conditions results in extreme diverging and unexpected outcomes (Blum and Hoogstra, 2009). This leads to the unpredictability of many deterministic under certain conditions (Hilborn, 2003). Due to the extremely sensitivity of the system, humans are not able to precisely choose the action that leads to the desire outcome. Effective action, for desired results, remains unknown (situations of ignorance) (Blum and Hoogstra, 2009).

The behaviour in chaotic system is often captured in the term the 'butterfly effect'. This term refers to the essence of chaotic behaviour in dynamical systems: the sensitive dependence on initial conditions (Hilborn, 2003). The smallest change in ignition conditions can lead to dramatic changes, as the small movement of a butterfly wings flapping can produce a tiny change in the state of the atmosphere which can eventually lead to the emergence of a tornado.

An example of a chaotic system is the weather. Weather conditions are constructed by numerous influences. Small shifts in those conditions cause different weather situations. Despite the many attempts and techniques to predict weather conditions, it is impossible to predict the weather accurately. The forestry industry is, in the production of trees, largely dependent on the weather conditions. Another example of situations where predictions often fail due to the extreme sensitive character are situations of appearance and disappearance of certain red list species in protected areas. These situations can also be classified as chaotic systems (Blum and Hoogstra, 2009).

Terra incognita system

Decision-making situations following the terra incognita systems are characterized by absence of knowledge. This absence of knowledge concerns not only the lack of information about possible outcomes and the likelihood of occurrence, but also the complete unknown of the system itself. Terra incognita refers to all other systems (possibly not explored), distinguished by lack of information about initial conditions, internal connections and empirical knowledge of possible outcomes (Blum and Hoogstra, 2009). Because of this information lack, anticipating decision-making is not possible. The system is characterized by ignorance. Outbreaks of insects or epidemics are examples of forestry situations in absence of knowledge; "No amount of data could have predicted it" (Thomas, 2005). So actors were unable to make anticipating decisions in advance to prevent such outbreaks.

2.2.2 TYPES OF NON-TRIVIAL SYSTEMS

In contrast to the stable inner relationships guiding non-human (trivial) situations, situations constituted by humans (non-trivial) are not regular. Humans will over time learn and adjust their behaviour to anticipate on future events; humans will develop better strategies to manage problems and to achieve their goals. Thus, the behaviour of a person is not based on natural laws, but the result of a process of constant accumulation of knowledge (Blum and Hoogstra, 2009). The non-trivial systems can, such as the trivial systems, be classified in subsystems. All non-trivial subsystems assume the individual actor to take decisions, but they do indicate different levels of influences of other actors in the decision processes of the individual. The non-trivial subsystems will now be shortly described.

Non-competitive system

The first non-trivial subsystem is the non-competitive one. In a non-competitive system the individual actor will make decisions solitary, unaffected by other people (Blum and Hoogstra, 2009). This means that the actor will not make decisions in collaborations and is also not influenced directly by other decisions of other persons. So in this 'isolated' decision-making process the actor does not have to deal with others directly. Only in the learning process there are some indirect influences of others, since the individual actor extracts knowledge from experiences from others without having to experience such actions itself. This knowledge might be applied in following decision-making processes.

Co-operative system

The co-operative system distinguishes itself from the above system by the interaction of the individual actor with other people. In the co-operative system, the individual actor will anticipate what others will do before making a decision. This strategic behaviour can be included in a sort of game, in which the crucial features of the situations are mathematically captured (Camerer, 2003). Although people have the freedom to determine their own actions, it may be possible that co-operation with others may result in the most effective action for the individual actor.

Innovative competitive system

In an innovative competitive system, again interaction between people exists. But in this subsystem the game, created by the strategies of the players, does not provide a situation in which there is equal benefit for all players. Instead a zero-sum game situation exists, in which one individual does better at another's expenses (for example the profit of player A is the loss of player B and vice versa). The decisions to be made by the individual actor in this system will depend on the choices of others, and they again will take into account decisions of others. For a player to gain benefits, innovation is needed to 'defeat' the other players. In this system the most thoughtful choice for the actor (keeping in mind the aim of striving for maximizing own utility) is not an 'old' already performed one, but efficient new strategies will be the focus since competitors can not anticipate on these strategies.

Many markets can be classified as innovative competitive systems. Since there are often more producers within certain markets, competition between the players for reaching as many consumers as possible exists. As mentioned, innovative ideas are required to avoid being driven out of the market by these competitors. Examples of innovations to distinguish yourself from others are moving to sustainable or 'fair' production (with certification schemes as FSC, PEFC, fair-trade), focussing on other customers or just invent products of production methods before others do. Innovative strategies do not always, but in most

cases it will, have to imply a new designed strategy. An innovative strategy can also be copying the strategy of other players, as long as your competitors can not anticipate on the strategy.

Traditional competitive system

Just like above system, in a traditional competitive system several people are involved in the decision-making situations of the individual decision-maker. Although the system is characterised by the zero-sum game, the difference is that not all players strive for their own highest benefits, but the choices made provide the highest subjective benefits. In the traditional competitive system, the alternative to be chosen is not based at maximizing personal benefits, but one for which the greatest support is found. In this system there is no creativity, need or courage to apply innovations. Examples of the traditional competitive system are decision-making situations of (groups of) people which are related to some of their traditions, religions and beliefs.

2.2.3 Trivial and non-trivial systems

In the previous chapters, the subsystems of the trivial and the non-trivial systems are described. The two systems are important for decision-making in forestry, because decision-making in forest and nature conservation and management include both non-human and human aspects. For simplification reasons the trivial systems will for this research be seen as 'nature', so the entanglement of trivial and non-trivial systems will display the human actor in relationship with nature. To construct real human-forestry situations in which decisions must be taken, a framework of the four trivial systems against the four non-trivial systems is constructed (table 2). The result is a scheme with sixteen decision-making situations with different characteristics.

Table 2: Human-forest relation situations (derived from Blum and Hoogstra, 2009)

Human-forest situations		Trivial systems			
		Mechanistic	Cybernetic	Chaotic	Terra incognita
Non-trivial Systems	Non-competitive				
	Co-operative				
	Competitive (innovative)				
	Competitive (traditional)				

2.3 The relation between decision-making models and decision-making situations

This chapter will describe the relations between decision-making models (paragraph 2.1) and the decision-making situations (paragraph 2.2). Since decision-making (DM) situations differ, varying decision-making models may describe the DM processes of specific situations the best. Of interest for the research is to investigate if, or to what extent, the often used and highly popular rational choice approach can describe how foresters actually behave in certain forestry DM situations. It can be questioned of the rational choice approach describes decision-making in varying circumstances that can occur in forestry (paragraph 2.3.1). Besides examining theories of the rational choice model, the potential of other DM models is incorporated in the composed hypotheses (paragraph 2.3.2).

2.3.1 APPLICABILITY OF THE RATIONAL CHOICE MODEL

Blum and Hoogstra (2009) describe in their research the applicability of the rational choice approach in the different forestry situations. They made a theoretical examination of the rational choice approach in the different situations which evolve from the scheme shown in table 2. Since the application of the rational choice approach is the same for some fields of the matrix, these can be combined in clusters. Each cluster and the consequences for the rational choice theory is shortly described below and represented in table 3. Also added in the framework for clarification reasons are the four concepts (certainty, risk, uncertainty, ignorance) that describe decision-making situations of trivial systems and the corresponding anticipation possibilities for both non-trivial and trivial systems.

Table 3: Human-forest relation situations with clusters (derived from Blum and Hoogstra, 2009)

Human-forest situations			Trivial systems			
			Mechanistic	Cybernetic	Chaotic	Terra incognita
			Certain => Anticipation possible	Risk/uncertain =>(interpreted as) anticipation possible	Ignorance=> Anticipation not possible	Ignorance => Anticipation not possible
Non-trivial Sys-tems	Non-competitive	Anticipation possible	Rational DM D,A,E -> P	Rational DM D,A,E -> P	No rational DM	No rational DM
	co-operative	Anticipation possible	Rational DM D,A,E -> P	Rational DM D,A,E -> P 1	No rational DM	No rational DM
	Competitive (innovative)	Anticipation not possible	Rational DM D,A,E	Rational DM D,A,E 2	No rational DM	No rational DM
	Competitive (traditional)	Interdisciplinair anticipation possible	Rational DM D,A,E -> P (interdisciplinary)	Rational DM D,A,E-> P (interdisciplinary) 3	No rational DM	No rational DM 4

Cluster 1

In situations of cluster one, the individual decision-maker does not have to cope with other decision-makers who will harm the individuals' utility as the actor is in a competitive free situation or in a situation of cooperation that is beneficial for both players. In the co-operative system, not only the individual actor will benefit from the cooperation, but both players do. So to play the game the best, cooperation is the outcome. Since maximizing the own utility can be accomplished by cooperation, the choice for cooperation will be the optimal rational choice for both (Blum and Hoogstra, 2009).

Moreover, the individual decision-maker possesses complete knowledge because of the characteristics of the mechanistic or cybernetic systems. In mechanistic systems, decisions have completely known outcomes. In cybernetic systems of situations of risk and uncertainty there is information about outcomes of actions, although the knowledge is always not totally complete. But thanks to the available information human anticipation in decision-making is possible. Compared to situations of uncertainty, in situations of risk there is a higher information level (e.g. known probabilities) making the decision-making process better grounded. In situations of risk the probability distribution will be of help in making a decision; it is assumed the action with the highest probability for a particular (desired) output will be chosen. In case of a decision-making situation characterized by uncertainty, the outcomes of each alternative are known, but the corresponding probabilities of the possible outcomes are unknown. The final decision made is now based on the character of the decision-maker.

So, in a cybernetic system with a situation of uncertainty, the final decision depends, besides the available information, upon the character of the decision-maker itself. This can be clarified with an example (see figure 4) from Blum and Hoogstra (2009). The example consists of three actions (A1-A3), with an increase in time and costs, and three outcomes (B1-B3). The desired outcome for now is B2. Both alternative A1 and A3 offer the possibility to achieve B2, but the highest certainty to reach B2 is by choosing A3 as in this case outcome B2, or even higher, is achieved. But this option will cost you more than the other options. To take advantage of the chance B2 may be reached with the least effort, A1 is chosen. However, option A1 does not provide the certainty that B2 will be the outcome. Which option to go with depends on whether the actor is considered to be an optimist or a pessimist. The pessimist will assume the worst scenario is going to happen and will rather choose option A3 so he is certain of the outcome B2 (or higher) while the optimist dares to take the chance and chooses option A1 since in his 'positive' opinion this option will also lead him to the desired outcome of B2 but with minimal input of time and money.

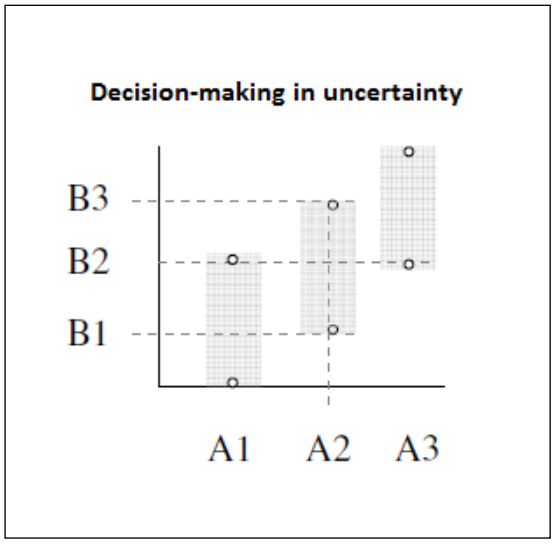

Figure 4: Decision-making in uncertain situation (Blum and Hoogstra, 2009)

To conclude, the conditions of situations of cluster one allow actors to act rational. Besides the ability for humans to act rational, the decisions can be described, analysed, explained (D, A, E) and ultimately predicted (P) in accordance with the rational choice model, although in cybernetic situations of uncertainty an interdisciplinary approach is needed to identify rational routines of actors (Blum and Hoogstra, 2009).

Cluster 2

Just like in cluster 1, the human actor has the knowledge in terms of a mechanistic or a cybernetic system. Only this time the actor is in an innovative competitive situation in which more actors will compete within a zero-sum game. This means that in a mechanistic system, the individual actor will find the strategy with is most beneficial, and in a cybernetic system the strategy that promise the largest expected utility (Blum and Hoogstra, 2009). To win the zero-sum game, efficient strategies are always innovative ones (Blum and Hoogstra, 2009). Thus, the zero-sum game provokes innovative actions by all involved parties. Because the actions of the involved parties are dependent on each other, predicting the complete set of actions is not possible. However, the single actions of the parties, or an individual actor, might be rational in a particular situation. Therefore in the best case, describing, analysing and explaining (D, A, E) behaviour by the rational choice model can be done.

Cluster 3

The level of knowledge of the actor is in this cluster the same as in cluster one and two, as the situations are covered by mechanistic or cybernetic systems too. Solely, the actor is in this cluster in a traditional competitive situation. Different from the innovative competitive system, in which players will adopt innovative actions, in a tradition competitive system actors not act innovative but traditional. In accordance with the rational choice approach, the behaviour in this system is irrational since maximizing utility does require new radical practices which are not applied in this system (Blum and Hoogstra, 2009). This traditional irrational behaviour might provide the opportunity to predict on decisions of the actor as the actions are based on culture or traditions. According to Blum and Hoogstra (2009), an interdisciplinary approach of the individual rational choice theory and sociology (to identify traditions of the reference group) can create conditions to describe, analyse, explain (D, A, E) and even to forecast (P) behaviour in situations described by cluster three.

Cluster 4

Due to the absence of knowledge of consequences of actions in situations described by the chaotic and terra incognita systems, decisions making cannot be described by the rational choice model (Blum and Hoogstra, 2009). The individual actor can in this case not solve problems or accomplish a certain goal based on rational DM. Moreover, explaining, analysing and predicting decision-making by the rational choice theory is not possible (Blum and Hoogstra, 2009).

2.3.2 Focus of the research and hypothesis

Due to the time frame of this research it is not possible to incorporate the complete set of the sixteen DM situations (shown in table 2 and 3) in the investigation. Therefore the focus will be on the decision-making situations derived by the non-competitive systems versus the four trivial systems; or rather the first row of the matrix. The focus on the fields of the first row will also contribute to the reliability of the research since, compared with the other situations displayed in the matrix, examining these situations can be done the most transparent. Despite all the fields of the matrix assume the individual as decision-maker, only the fields of the first row (e.g. the non-competitive system) are about the individual actor making decisions without having to deal with other people. Situations in which the conditions are as similar as situations according to the non-competitive system are able to be constructed the most transparent, since including conditions concerning 'dealing with other people' in the investigation will be too difficult. Next, the fields of the first row of the matrix are discussed. Since the clusters are already discussed, some repetition is inevitable. The division in DM situations is made by the four concepts describing DM situations, and not by the four trivial systems. The result is one mechanistic system (certain), two cybernetic systems (risk and uncertainty) and one situation of chaotic and terra incognita systems (ignorance). The descriptions of these four different situations do also generate the research hypotheses of this research, which are given after each single description.

DM Situation 1: non-competitive mechanistic system (certain)

In this situation an actor can make an optimal choice of action (Blum and Hoogstra, 2009). Information about a certain choice leading to a certain outcome is completely known, making a full cost-benefit calculation possible. Besides, the actor can make a decision solidary and is not hindered by others in maximizing personal utility. Thus, situation one offers a decision-maker a situation in which one can act in line with the hyper-rational choice model. Among the alternatives, the actor will choose the course of

action which leads to the optimal outcome. Based on these assumptions concerning the applicability of the rational choice approach in this situation, the first hypothesis is developed.

To test the assumptions hypothesis one is:
H1: *In non-competitive mechanistic situations individuals act according to the hyper-rational choice model.*

To also test the bounded rational choice approach in this situation hypothesis two is:
H2: *In non-competitive mechanistic situations individuals act according to the bounded rational choice model.*

DM Situation 2: non-competitive cybernetic system (risk)
In situation 2, again there is just one actor, who does not have to take into account actions of others in the DM process. In a situation of risk, the probabilities of the outcomes are known. Despite the existence of more outcomes in a situation of risk, the information about the likelihood of occurrence causes a situation where a rational decision can be made. The outcome of a cost-benefit balance in which the outcomes and probabilities of possible decisions are incorporated, results in a final (hyper) rational decision. Apart from the absence of secure knowledge (certainty) that an action will have a particular outcome, the rational choice theory can be applied appropriately, because of the assumption that the option with the highest expected utility is selected (Blum and Hoogstra, 2009).

Hypothesis three is therefore:
H3: *In non-competitive cybernetic situations of risk individuals act according to the hyper-rational choice model.*

Again to also test the bounded rational choice approach in this situation hypothesis four is:
H4: *In non-competitive cybernetic situations of risk individuals act according to the bounded rational choice model.*

DM situation 3: non-competitive cybernetic system (uncertain)
In a decision-making situation characterized by uncertainty the highest expected utility cannot be 'calculated' as the probabilities of outcomes are not known. With the bandwidth of the possible outcomes, balancing the effects of a decision in light of the rational choice model is impossible. Actions in situations of uncertainty crosses the borders of what can be analysed, explained and predicted by economics on the basis of the pure rationality assumption (Blum and Hoogstra, 2009). In situations of uncertainty, knowledge of the actor itself must be incorporated in order to make predictions about choices of the particular actor. The decisions of the actor will not completely be based on a rational cost-benefit analysis, but more on the personal preferences of the actor. Actors will have different views or interpretations, based on their character or due to their (perhaps changing) mood. Examples are pessimistic conditions, assuming the worst outcomes are going to happen, and the optimistic conditions, a view in which it is assumed optimal outcomes will occur. These differences of preferences influence the choices of an actor, e.g. the pessimist is more cautious in his decisions and the optimist will take the more risky decisions. For examining decision-making in uncertain situations, information of the specific actor is needed. Psychology may be of help here.

Based on the assumptions of the applicability of the rational choice model in non-competitive cybernetic situations of uncertainty the fifth and sixth hypotheses are:
H5: *In non-competitive cybernetic situations of uncertainty individuals do not act in accordance to the (hyper or bounded) rational choice model.*

H6: *In cases of non-competitive cybernetic situations of uncertainty the sensemaking approach describes how actors act.*

DM situation 4: non-competitive chaotic and terra incognita systems (Ignorance)
In decision-making situation characterised by ignorance (chaotic and terra incognita systems), the solidary actor missed the ability to act rational. Blum and Hoogstra (2009) indicated that peoples decision-making process in situations of ignorance can perhaps be explained and analysed, possibly even forecasted, by other disciplines like human science (psychology). Perhaps the sensemaking approach may be applied to these situations, as it involves psychological aspects.

This means that both in the non-competitive chaotic system and the non-competitive terra incognita system actors behave not rational. Hypothesis seven is therefore:
H7: *In non-competitive chaotic and terra incognita systems of ignorance individuals do not act in accordance to the (hyper or bounded) rational choice model.*

To test the applicability of the sensemaking approach in this situation, the eighth hypotheses is:
H8: *In cases of non-competitive chaotic and terra incognita systems of ignorance the sensemaking approach describes how actors act.*

3. METHODOLOGY

Collecting data for the research needs proper planning, as the conclusions are founded by the obtained data. Thus, the design of an appropriate research approach is very important. This chapter first describes the 'how' and 'why so' in section 3.1 - research approach. In the next sections (3.2 and 3.3) the way the data was collected and analysed is explained.

3.1 RESEARCH APPROACH

The research is built around the research objective of exploring how foresters make decisions, or more practical: which decision-making models can outline the choices made in forestry situations. Since there are no previous studies about this subject, this research uses an explorative approach. The research is established with use of mostly qualitative methods, as it aims to gather an in-depth understanding of human decision-making and the reasons for actions. Because of the qualitative character, smaller but more focused data of individuals is needed. However, where appropriate basic quantitative analysis will be applied.

3.2. DATA COLLECTION

In order to achieve the research objective, there is a need to obtain information about choices made in forestry. The choice was made to gather this information with the use of interviews in which some small experiments are carried out. In the experiments, foresters are confronted with fictive forest management decision-making situations. The experiments consisted of explaining particular forestry situations, based on the different decision-making situations discussed in this research, in which the interviewee must make a decision. In this way decision-making can be examined in context. By constructing fictive situations the conditions of the decision-making situation could be adapted to the objective and research questions of this research. This increases the validity, as the experiments measure what the research set out to measure. Another advantage of the fictive decision-making situations is that it provides the opportunity to examine the choices an individual forester make by them self. In real forestry situations, the choices are usually made in cooperation. Decisions made in a corporation of more people, will not reflect a person's own opinions. Therefore, the data collection of this research is focused on fictive decision-making situation and not on real, already made joint decisions. This ensures the production of data of individual choices.

Besides gathering data about which decisions are made in the experiments, it is necessary to know why these choices are made. Since decision-making is constructed in mental processes, there is the need for in-depth interviews. The interviews give insights in the underlying reasoning and thoughts of the decisions made by foresters. A difficulty can be located in the fact that a large part of the decision-making process is done mentally. In order to gain knowledge about this mental decision process, these mental processes and thoughts have to be put into words. This might cause difficulties, as it is not transparent and cannot be checked.

The interviews and experiments were carried out with individual persons, as the focus of the research is individual decision-making. The type of respondents will be described latter on (3.2.2). For reliability

reasons, the conversations were recorded with use of a voice recorder. In addition, the interviews have been typed and can be accessed. Some interviewees felt not at ease speaking when the voice recorder was on. Therefore in some interviews pen and paper was used in order to note down the conversation. As it is not possible in these cases to make an exact transcription of the interview, it was made sure attention was paid to note the most important answers and quotes. The transcripts of interviews where a voice recorder was applied will produce the precise words used by the interviewees and the interviewer.

3.2.1 METHODS

Interviews

The interviews were held alongside the experiments. The aim of the interviews was obtaining knowledge about the underlying reasons and thoughts for choosing particular decisions. There were no interview questions set in advance but the questions have been led by the choices made by the respondents in the fictive situations of the experiments (for example when the interviewees were asked to elaborate on their choices). This made the interviews semi-structured, a type of interview in which the researcher had some control over the responses (keeping the aims of the interviews in mind). With this type of interview, the researcher sets the agenda in terms of the subjects covered, but the interviewee's responses determine the kind of information produced about those topics (Green and Thorogood, 2009). As the interviews did not have a structured form, it was possible to use probing in order to obtain the information needed in cases the underlying reasons and thoughts (of particular decisions) remained unclear. However, the qualitative interviews must not have a 'testing' character, but an explorative one. So an appropriate interview technic which facilitates the exploring of beliefs and thoughts of the respondents was needed. "The qualitative research interviewer does not assume that there is one version of the truth that can be uncovered, but that the interviewee's story will be valid as their account of events" (Green and Thorogood, 2009). Judgemental and leading questions were avoided in all interviews in order to put the respondent at ease, and to generate useful information. Despite the lack of set interview-questions, the respondents were asked to elaborate on the characteristics of the forest area they own. Characteristics, as the management objective, tree species present and the size of the area, have consequences for the choices made in the experiments. As these forests characteristics vary for the respondents, not incorporating these differences in the analysis will be disadvantageous for the research. Knowledge about the differences in features will contribute to the reliability of the analysis and through this it will benefit the dependability of the final conclusions.

Experiments

The decision-making situations set out in the experiments were about forest management situations. Despite being fictive, these forest management situations are reality-based, meaning that forest managers can encounter them in real life. Each participant of this research was confronted with five different forest management decision-making situations, each one based on one of the four concepts describing a decision-making situation (certainty, risk, uncertainty and ignorance). Chosen is for two fictive decision-making situations of certainty, in order to give more accurate and reliable data about such situations. The outcomes of the decision-making situations are in most cases presented in sums of money in order to meet up to the rational choice approach that assumes maximizing personal utility as peoples aim. The experiments were kept simple to remain the analytical tractability, but they are realistic enough to use as source of making statements about actual decision-making situations. After testing on a few persons and some adjusting the following experiments were set up for this research:

Experiment 1: certainty

The first experiment is about timber harvesting. In this fictive situation, the forester is confronted with the choice to harvest the trees himself, so a buyer can collect the timber near a main road, or to sell the standing timber, a so called stumpage sale (buyer has to harvest the trees itself). Experiment 1 is described as a mechanistic system. The outcomes of the decision are certain.

Circumstances:
- No employees
- Harvest machines available for free
- Hours of work included in the revenues
- Known outcomes
- Fixed expectations

	Harvest himself	Stumpage sale
Net revenues	110,-	90,-

In accordance to the rational choice model, both the bounded and the hyper version, 'Harvest himself' will be chosen because of the higher revenue.

Experiment 2: certainty

The second experiment is again about a mechanistic system with a decision-making situation of certainty. In the second experiment the respondents must choose one of three tree species to plant on their land. Each tree species has different net revenue.

Circumstances:
- No employees
- Known outcomes
- Fixed expectations
- Rotation periods are the same for every tree species
- Soil is suitable for the species
- Trees have to be planted here

	Beech	Oak	Pine
Net revenues	150,-	120,-	105,-

In accordance to the rational choice model, both the bounded and the hyper version, 'Beech' will be chosen because of the higher revenue.

Experiment 3: risk

The third experiment is about a cybernetic system, characterized by a decision-making situation of risk. The situation related to a situation in which the climate changes which has consequences for the growth of the trees and therefore for the net benefits. It is not certain how high the temperature will rise, but thanks to investigations the probabilities of these risings are known. On that account, the probabilities of which tree species will grow best in the Netherlands in the future are known. The following experiment is again about which trees to plant in a certain area in the Netherlands. This time the outcomes are not certain, but probabilities of the possible outcomes are.

Circumstances:
- Known outcomes
- Known probabilities
- Rotation periods are the same for every tree species
- Soil is suitable for the species

Probability	Beech	Oak	Pine
50%	150,-	50,-	100,-
50%	150,-	300,-	210,-

In accordance to the rational choice model, both the bounded and the hyper version, 'Oak' will be chosen because of the higher expected revenues.

Experiment 4: uncertainty

In experiment 4 foresters must make decisions which tree species to plant, again in light of the future climate change. Experiment four is almost similar as experiment three in terms of the subject, only the known probabilities of outcomes occurring are replaced by bandwidths of probabilities. In this situation it is assumed that fixed probabilities cannot be constructed, as the predictions of the temperature risings are too uncertain. But, research about climate change has come up with a set of bandwidths of the possible temperature rises, which evolve in the following set of net revenues of three tree species. Just like experiment 4, experiment 5 is about a cybernetic system only now with a DM situations of uncertainty.

Circumstances:
- Known outcomes
- Known bandwidth
- Temperature rise of 2 or 3 degrees
- No probabilities of occurrence
- Net revenue depends, besides temperature, on climate and soil type

Bandwidth of outcomes	Net revenue beech	Net revenue oak	Net revenue pine
temp rise of 2 degrees	80,-	300,-	90,-
temp rise of 4 degrees	150,-	50,-	200,-

Here due to the incomplete information, a decision cannot be made based on the rational choice approach.

Experiment 5: ignorance

In this experiment the respondent is confronted with a situation with scarce information. In this fictive situation, the respondent became the owner of a piece of land. On this land, trees will be planted. However, there is now information about the characteristics of the location, soil or revenues. The question will be asked which tree species to plant in this unknown area. This DM situation can belong to a chaotic or a terra incognita system as both are characterized by situation of ignorance.

Circumstances:
- Unknown area in the Netherlands
- Trees must be planted there
- No info on net benefits

Beech	Pine	Oak	Birch	Larch

Again, due to the incomplete information, the rational choice approach cannot identify the rational choice here.

3.2.2 Respondents

The Dutch forest is owned by many different parties. Next to this high diversity of forest owners, there are other groups of people who are also involved in decision-making concerning forestry, like policymakers and managers, making the group of people who makes decisions concerning forestry even larger. Incorporating all these parties in this research will not be very effective. First of all, the parties are too diverse, which will give problems in making comparisons between decision-making processes; it will not lead to a solid construction of obtained data. Second, the amount of total respondents necessary to incorporate at least a few people of each 'party' will be too many.

To overcome these problems, this research will focus on one party: the private forest owner. A requirement in selecting respondents was that the private forest owner did not only own a forest, but must be responsible for the management of that area too. Recognizing and selecting different parties in decision-makers concerning Dutch forests improve the reliability of the final outcomes of the research, since the different parties can have different ways of decision-making. Besides the benefits of focussing on one 'cluster' of forest decision-makers as is provides better matching data, the subject of decision-making of individual foresters matches the private forester the best; a private owner will usually make decisions concerning this forest property alone. In spite of the fictive decision-making situations, in which everybody can make a decisions solidary, incorporating respondents who in their daily live have to make decisions alone will benefit the obtained data and the later drawn conclusions as the conclusions concern decision-making beyond these fictive situations. Besides the advantage that the private forest owner is 'used' to make choices by himself, the subject of the experiments is consistent with the subject of the decisions made by the respondents in real life: namely forest management situation. The decision-making situations proposed by the experiments are like the situations that managers can encounter in real. So by focussing on forest managers (who are in this case the owners too) the data will be most realistic.

For this research a total of ten foresters participated (for a list of participants: see appendix 1). The combination of experiments and interviews were administered to these foresters individually since the focus of the research is on decision-making of the individual forester. Due to the time frame is was not possible to reach more interviewees. The interviewees where randomly selected.

3.3 Data analysis

To access foresters' choices in forest management situations, a quantitative and qualitative analysis is carried out. Per experiment, first the number of individuals making particular choices concerning the fictive situations is examined (= quantitative). These numbers may give a representation of the choice

distribution of the participants. Here already it can be noted how many respondents choose the option that is consistent with the stated aim of the rational choice theory of maximizing personal utility (in terms of money), and so how many respondents will make a hyper-rational choice. Provided the situations allow selecting a rational option, as not all situations of the experiments permit. But, a remark must be given. Although a person can select the option which is in accordance with the rational choice theory, the underlying thoughts may indicate that the aim of the particular choice was not maximizing utility (in terms of money) at all. The qualitative data analysis does in this case provide as a control mechanism to verify the aims. Despite the number of respondents is not that high, the quantitative representation of decisions made gives a useful overview for an explorative research.

Next to the quantitative data analysis, the reasons and thoughts behind the choices made in the experiments were analysed. For this qualitative part of the research analysis the transcripts of the interviews were used, as the transcripts contain data concerning the underlying beliefs of the respondents' decisions. From the whole set of transcripts, these thoughts were identified and discussed. Also associations between the attitudes, experiences and behaviour (the decision) in different situations were explored. But the aim of the research implied to go beyond reporting those accounts, so a classification of decision-making and underlying thoughts as final result is not sufficient for this research. The next part of the qualitative analysis consists of linking the findings with existing decision-making models. Since the characteristics of decision-making models were already set out in the theoretical framework, it became possible to locate correlations between the thoughts and reasons behind the choices made in the experiments and the characteristics of the decision-making models. Hereby examining the hypotheses was possible.

4. RESULTS

4.1 EXPERIMENT 1: CERTAINTY

In the first experiment, the participants were presented a situation concerning timber harvesting. They had to choose between harvesting the trees themselves or stumpage sale. The participants were assured of a situation of complete certainty, with defined net revenues. The answers of the participants are presented in table 4. The row 'monetary reason' indicates how many of the participants selected a particular option because that option was the most satisfying based on monetary returns.

Table 4: Outcomes experiment 1

Options	Harvest trees themself (highest revenue)	Stumpage sale	Other
Participants (10)	6	3	1
Monetary reason	5	0	1

According to the hyper-rational choice theory, the rational choice in this experiment is the option with the highest revenue: the choice of harvesting the trees themselves. However, table 4 shows that only six of the ten participants chose this option. Three interviewees selected the stumpage sale and one person chose neither of the two options, but proposed a combination of the two. Of the six persons that decided to harvest the trees themselves, five indicated that this decision was based on the returns. So five participants made a hyper-rational decision by selecting the option with the maximum return. This does not mean that the participants who did not base their decision on returns did not act rational in this situation. The logical reasoning behind the choices demonstrates that they do act rational but their decision-making process is not the result of a monetary cost-benefit analysis. For example, the interviewee who decided to go for harvesting the trees themselves for non-monetary reasons did so as they (the family) had the knowledge and the experience to harvest the trees themselves. The revenues never played a role in the decision-making process of that particular person: "The price (costs and returns) is irrelevant; the revenues of timber are so low that the costs cannot be covered. The whole process of harvesting will cost you more than you will get in return. So we do not look at the returns". Other reasons then monetary ones mentioned in this experiment were: the absence of knowledge to harvest trees themselves and the ease of a stumpage sale. Stumpage sale was also preferred because of the small scale harvesting (custom work) this method can entail, as one of the interviewees stated, "Less return, but better precision work. It is another value that you must maintain". Even interviewees who selected option one because of the corresponding highest returns had some additional non-monetary considerations for their decisions, for example the advantage of keeping everything in control: "In this situation I go for the highest price; harvesting the trees myself. Then I also have the advantage that I can lay the logs along the road however I like. I am in control. I can select a harvester for the work." Five participants indicated the importance of not damaging the surrounding trees during the harvesting; for example one told: "It is also important how they work. I prefer a little less income, when I know the harvester will do a neat job, then a higher price but with an operator of the harvester who is racing through the forest". The interviewee who chose for a combination of both options did so because of a cost-revenue calculation in order to select the option with the highest return. Depending on the amount of time the employees would need to cut down the trees, the choice will vary: "Assuming the employees would be busy with the harvesting for two days, then we would cut down the trees ourselves. But when

the harvesting would cost more than two days of work, other tasks will not be done and other people must be hired for these tasks which will cost me more".
It can be concluded that even in situations that clearly appear to be an assessment of monetary costs and benefits, other motives are included in the decision-making process. Based on the first experiment, the hyper-rational model can be rejected in situations of certainty.

4.2 Experiment 2: certainty

Experiment two focused on planting trees. Here, a decision must be made which of the three species to plant. The information provided consisted of the fixed returns of each species in 75 years. The outcomes of this experiment are set in table 5. Half of the participants decided to go for beech, two selected oak and the response of three persons is covered by other. As for 'other', two of the three interviewees choose more than one species for different reasons. The third participant stated to never plant trees as the seeds will come naturally in the forest, and this person did not make a decision in this experiment.

Table 5: Outcomes experiment 2

Options	Beech (highest revenue)	Oak	Pine	Other
Participants (10)	5	2	0	3
Monetary reason	5	0	0	0

In this experiment, beech would be the rational decision as this option has the highest return. The five persons who decided to go for beech all indicated the highest return as the main reason for their choice. So, five participants made a rational decision in accordance with the hyper-rational choice theory in selecting a tree species in this experiment. But even for them, other values, like living, aesthetic values and managements aims were important too. For example, one of the participants who selected beech would make another choice when the forest in question was next to his house: "I go for the highest price. If I would live next to it, it will be different". Another interviewee who chose beech explained that under the conditions of the experiment, the planting of beech would be limited to the production forests, which are focused on generating income. Other forests on the property had historical and natural aims and here values other than income rule the decision-making process. A third example concerned the beauty of beech forests. Although the decision was made to select beech due to the highest returns, the additional advantage was that: "beech forest is actually a beautiful forest. Large old beech. Dark forest. No undergrowth". Thus, although these non-monetary reasons are not mentioned as main reason, these motives could still be involved in the decision-making process where ultimately a hyper-rational decision is chosen (for monetary reasons). So it is important to describe all motives in order to acquire knowledge of complete decision-making processes. The reasons behind the choices for 'oak' and 'other' were all non-monetary ones. Here the focus was on other values than revenues. Natural, historical and landscape values were mentioned as reasoning for the decisions. For example, beech would result in bare undergrowth and suppression of other tree species, and was therefore not chosen in some cases. Another argument concerning natural values was the interesting micro flora and fauna oak trees would bring to a forest. One participant stated concerning returns that: "It is not about the money, but about beautiful trees and nice pathways". Another example indicating the unimportance of income can be derived from the quote of one interviewee who explained: "I would not look at the prices. I look at nature itself. Just in 100-years you get the returns. In this stage the returns play not role". Despite that returns were not directly incorporated in the reasoning for the choices oak and other, one example did show the

involvement of revenues. One interviewee indicated that flexibility is essential in decision-making concerning forest and nature management. Despite the fixed returns defined in this experiment, for this interviewee it was important never to focus on one thing as things can and will change: "I would never bet on one cow. I know how quickly things change and you need diversity to maintain flexibility. The focus will change. But the integrity will remain the same… With the construction of the new building, I will now have a loss in this generation, but it is a perfect guarantee for the next generation to be used for whatever activity is needed than socially." The reason behind being flexible is to always be ensured of an income. Here, monetary reasons are interwoven with other, non-monetary, reasons and values.
To conclude, despite the certain returns set in this experiment, still not all participants decided for the option with the highest utility for monetary reasons. Just as in experiment one, other non-monetary values are also of importance for balancing the options. Based on experiment two, again the hyper-rational theory can be rejected, supporting the finding of experiment one.

4.3 Experiment 3: risk

In experiment three, the same situation as in experiment two is presented. Again a decision must be made which tree species to plant. Only now the revenues are not certain due to expected climate change, but probabilities are known. The results of experiment three are presented in table 6.

Table 6: Outcomes experiment 3

Options	Beech	Oak (highest expected revenue)	Pine	Other
Participants (10)	4	3	1	2
Monetary reason	0	1	0	0

Different than the beech which has a fixed revenue, the oak and pine both had two possibilities with related probabilities. With use of the probabilities the expected revenue of the species could be calculated in order to find out which option had the highest expected revenue, which is the oak. Only one interviewee chose for oak because of the highest expected monetary returns. This person was interested by the huge contrast between risk and return. About this risk and the possibility to get the lowest price that person explained that "it can happen" and that "the risk is inherent to forestry". Both the uncertainties and the revenues of the three tree species were not incorporated in the decision-making process of the two other persons selecting oak. They selected oak for non-monetary reasons like the beauty, the nice flora and fauna and because of historical and cultural perspectives. The motives for the option beech were mostly about the certain characteristic of this option. Although the beech had the lowest expected revenue, the certain return made it the most attractive choice for them. For example, one person indicated that with the small difference in returns of the options in mind, the beech is the least complicated option because of the certainty of return: "You can say that with this small difference, I take beech as I am sure that I have fewer problems then. I do not want to think about risks". Another example indicating the certain character of beech as the main reason for the decision was: "I would go for beech, lots of certainty". Besides beech also the pine was chosen for the less risky outcomes of that option. The person who selected pine reasoned that this species does not have the lowest nor the highest possible outcome and the pine has an average expected return compared to oak and beech. It can be said that the certainty to end up with a fixed return (beech) or less risky outcome (pine) outweighs choosing for the highest expected revenue in this experiment. Not in all cases the logic behind the decision was about returns or risks. For a few decisions made, natural and landscape values and forest composition

were much more important than money. For example one of the participants decided to plant beech and oak because there was already enough pine at the property. A variety of tree species was very important for this particular interviewee: “All plots must contain three or more tree species”. For another person the decision was based on the beauty of a species: “I love a beautiful beech because the beech is light green in spring, dark green in summer and brown in autumn”. There was also reasoning in light of the proposed climate change of experiment three. For example one interviewee decided to plant beech and pine, because oak cannot handle temperature rise well: “In recent years it is shown that oaks are affected by climate change. There will be more caterpillar’s pests and diseases on oaks, making it more likely they will not survive”. Despite the logic behind most of the decision, the arguments for the choices were generally not in accordance with the hyper-rational choice model. Only one interviewee indicated the highest expected return as the reason for the decision. Thus, because just one person made a hyper-rational decision in this experiment, it can be concluded that the hyper-rational model can be rejected in situations of risk.

4.4 Experiment 4: uncertainty

The fourth experiment is again about a plot where trees must be planted. Just as in experiment three, due to the expected climate change the revenues of the tree species could not be known for sure. What is known in this experiment, is that in 75 years the average temperature will be two or three degrees higher than nowadays. There are no probabilities of occurrence for the two options. The outcomes of this experiment are presented in table 7.

Table 7: Outcomes experiment 4

Options	Beech	Oak (highest average revenue)	Pine	Other
Participants (10)	0	4	4	2
Monetary reason	0	2	0	0

Since the probabilities of the outcomes are not known in this case, indicating the option with highest expected return is not possible. So assessing the effects of a decision in light of the rational choice model is impossible. However, it is possible to indicate the option with the highest average by assigning the scenarios with a fifty-fifty chance, with the result that the oak is the choice with the highest average in experiment. Only two interviewees decided to employ this method, en choose for the oak because of the highest expected average. These two made a hyper-rational decision, under the condition that the expected returns are calculated without assured (certain) probabilities set by the experiment. The logic behind most of the decisions made in this experiment was not based on the highest expected return.
The majority of the participants incorporated the possible returns and the risks (regarding revenues) of the options in their decision-making process. Accordingly, pine was seen as a safe option (no extreme outcomes) with a low risk and this option was in general chosen to “mitigate risk” and “secure income”. Although income had a significant role in the decision-making process of these participants, the oak as the option with the highest average, was seen as a too risky choice because of the high chance to end up with a very low return. One interviewee appointed the oak as a “ticket to a failure” because of this high risk. Another person also noticed the oak to be too risky: “In case of two degrees you would say go for the oak and with three degrees go for the pine. I am not font of extremes. So I go for the pine”. Besides monetary matters, other reasons were incorporated in decision-making processes regarding this experiment. Just as in the previous experiments, historical, cultural and natural reasons were important for some interviewee.

For example one participant mentioned that he wanted “forests of a certain quality, from a cultural and historical perspective”. Money was irrelevant in his decision-making since income would be generated by subsidies. Yet for other participants, the temperature change was an incentive in their decision-making. Like decisions for pine (possibly in combination with beech) were backed up by the argument that these species can stand high temperatures well and are thus a safe bet. For one participant, long term thinking of forestry and the expected climate change were very important and are incorporated in the management plans of the property. This person told: “We need to look 80 or 100 years ahead. I heard a prediction of an expert who stated that we will get the climate what is now the climate in Bordeaux”. Not all persons were concerned about climate change. Some just knew too little about the effects to incorporate climate change or were sceptical about the generation of knowledge of the influences of climate change. For example, one participant stated that “No one can say anything about how it is in 20 years with the knowledge of today”. With the result that this person did not make a decision in this experiment. Furthermore, another interviewee stated trees of all species will just adapt to temperature increases since they rise slowly.

It appears that in order to make the situation clear, the known information (the options and the corresponding outcomes) were processed first before making a final choice by some participants. This decision-making situation was more complicated than the previous ones, since information concerning the probabilities of the outcomes was lacking. Participants applied different decision-making strategies in order to understand the situation. One strategy was to calculate the average of the three options. Others looked at the highest or lowest possible returns to base their decision on or made an aggregation of the average and the possible outcomes. Yet others incorporated non-monetary reasons as nature and historical values. One participant made no decision in this experiment because this experiment was too hypothetical to make a choice. Altogether it has appears that in situations of uncertainty it is possible to act in accordance with the hyper-rational choice model provided that the average return is considered as the expected return. But generally, logic reasoning did not concern expected returns of the options, but other values and reasons are incorporates in the decision-making process in situations of uncertainty. Based on the results of this experiment, individuals do not act in accordance with the hyper-rational model. Striving for the highest expected return is not commonly performed in situations of uncertainty. Personal preferences and knowledge are much more relevant.

4.5 Experiment 5: ignorance

In the last experiment, the participants were asked to decide which of five tree species to plant in an unknown area in the Netherlands. They received no further information to base their decision on.

Table 8: Outcomes experiment 5

Options	Beech	Birch	Oak	Larch	Pine	Other
Participants (10)	0	1	1	0	2	6

Since the returns of the species are unknown, expected utilities cannot be calculated. Making it impossible to select the hyper-rational decision in this situation. In this experiment birch and oak were chosen once and pine twice. Six participants could not select one of the five species and choose for more than one or made another decision. The reasons for the choices made were mostly about the chances that certain species will grow. Pine and birch were both chosen because these species are likely to grow

well regardless of soil properties. For example one person told that: “Pine if the safest to plant, because it is a strong species, a pioneer species. It can grow on many soils. Larch is also a pioneer species, so that is also a possibility. The oak is a too risky”. Thus, the participants who selected pine and birch did so to reduce the risk as much as possible in this situation of ignorance. Also to reduce the risk, some interviewees decided to plant all the species as at least some of them will start to grow in the unknown area. An additional advantage of this decision is the possible establishment of a mixed forest, a very desirable forest type for some participants because of natural and aesthetic values. Another reason to plant all five species was the lack of information, like one participant stated: “If I have no information, I cannot make a decision. I plant some of all five”. Possible returns of species were only mentioned a few times. Since returns are not provided by the experiment, the interviewees based there argument on personal knowledge concerning returns of certain timber. One participant argued that planting will cost money, so in return the trees must also generate money at the end, to cover the costs. Or else it is not a good investment. Since “beech has never generated money” there is no reason to plant beech for this particular interviewee. Others focussed on the high quality timber of certain species, and therefore concentrate on a high return of the trees despite not appointing these high returns as the main focus. Accordingly, oak was selected twice for the good quality of the wood, despite the high risk resulting from a lack of information about the site. Other motives mentioned in this experiment concerned natural and historical values. For example, beech would for sure not be planted by one interviewee, as in beech forests there is no undergrowth. Therefore, oak would be planted by this interviewee, for the rich flora and fauna. Another decision concerned historical values was the choice for beech or oak to plant near the house because these species are old English park trees which would fit this area the best.
In short, the participants had various reasons for their decisions. Usually the reasoning consisted of an aggregation of multiple values, where nature, beauty, history, returns and risks all played a role. What can be concluded from experiment five is that the lack of information prevented the participant to make a rational decision conform the hyper-rational choice model, although each person made a logical rational decision for themselves by their own motives. Due to the lack of information the interviewees had to make considerations based on their personal knowledge.

4.6 Summary of results

The experiments provided an insight in the decision-making processes concerning forest and nature management situations. The results of the experiments showed that often the choices made differ from the expected ones based on rational choice theory. Many times, the decisions made in the five experiments were not in line with the hyper-rational choice model, even though for most situations it was possible to make a full cost-benefit analysis. Still the optimal monetary revenue was for most participants not the motive behind their choices. Accordingly, it is found that acting rational was not always focused on obtaining the highest (expected) revenues. Many other motives behind decisions of foresters regarding their profession exist.

5. DISCUSSION

This chapter discusses the findings, the theory and the methodology of the research and thereby places the research in a broader perspective. The first part of the discussion is about the outcomes of the question how foresters make decisions, compared with findings of other studies. The second part is a reflection of the research approach, including recommendations about how to develop and apply experiments in equivalent investigations.

5.1 THE WAY FORESTERS MAKE DECISIONS

Like all people, foresters are forced to make decisions. For this research, interviews and experiments based on certain theories were used to investigate the way foresters make decisions. The results revealed rational behaviour performed in the situations of the experiments. It appeared foresters make rational decisions when defined as acting logically. Foresters think logically about the decisions to be made. But, the rational decision-making is often not based on the information provided by the experiment. Instead, people create their own situation composed by personal knowledge and perceptions. Their own knowledge is the foundation for their decisions. During the decision-making process, people are targeting for the most optimal outcome. This optimal outcome does not need to be a financial one. It can also be a decision that optimizes a natural, historical or social outcome, or satisfy a composition of multiple values. The specific objective depends upon the personal view and preferences of the decision-maker.

Consequently, cognitive processes play a more significant role in decision-making in forestry than defined in the hyper-rational choice approach where personal preferences are not involved. As also stated by Hoogstra (2008), actors make their own interpretation of situations instead of basing their decisions on the 'one objective truth' as described in the hyper-rational model. This shows the inability of the hyper-rational choice model to provide an explanation for actions of foresters. This difference in decision-making in practice and the behaviour set out by the hyper-rational decision-making model is also the result of several other studies (Beckert, 1996; Kant, 2003; Landa and Wang, 2001). Specifically in the field of forestry Kant (2003) mentioned this inability to explain decision-making of foresters by the hyper-rational choice model by arguing that the current forest management depends of the specific situation (and involved people) and is no longer only focused on harvesting the maximum amount of wood in order to maximize monetary revenues. Nowadays, forest management incorporates many more values than before and is not only focussed on highest returns. Foresters pay attention to social, cultural, historical, natural, recreation and landscape values. With the result that the rational approach is not applicable anymore for most current foresters' behaviour. That nowadays a wide range or values are taken into account in decisions and therefore rejecting foresters as hyper-rational actors is also stated by Schlüter (2007). According to Schlüter (2007) decisions in forestry are financial just marginal important because forestry provides a small proportion of the income of private owners. Therefore other goals than economics ones can become important too. From the findings of this research it appeared that income from forestry is important, but the emphasis is on combining multiple values.

Much can happen in forestry. This complex and uncertain character leads to foresters base their decisions on personal thought and ideas as they are unable to know the results of their decisions exactly. Foresters rely on knowledge obtained throughout their lives. The complex and uncertain characteristics of forestry as reasons for rejecting the hyper-rational choice approach to describe the way foresters make decisions

is something argued by many others (Schlüter, 2007: Hoogstra, 2008; Blum and Hoogstra, 2009) and in this research empirically tested. Also for Ekbia and Reynolds (2006) found out that the hyper-rational choice model is not sufficient to explain the very complex and uncertain situations that can occur in forestry. A clear action-result relationship can usually not be defined and analysed in forestry, making rational choice approaches not justified in these situations (Beckert, 1996).

Compared with the hyper-rational choice approach, the bounded rational choice model provides a more proper description of the decision-making processes since it incorporates subjective rationality, rationality based on personal views and focused on satisfaction of goals instead of maximisation of utility. But this subjective rationality of the bounded rational model is not sufficient enough to explain the way foresters decide; decision-making of foresters extends beyond what the bounded rational approach explains. Decision-making in the sensemaking approach is also based on a personal self-outlined framework but unlike the bounded rational choice model, sensemaking describes the composition of a personal foundation for decisions as an retrospective, ongoing process in which individuals learn from own actions and actions of others. People constantly try to make sense of the situations they are in to create a context for behaviour. Just like the research of Hoogstra (2008) revealed the similarities in decision-making of foresters and the seven characteristics of the sensemaking model of Weick (1995) with use of case studies, this research has the same outcome but now based on experiments. This research especially revealed the ongoing, social, retrospective, plausible nature of sensemaking that is driven by personal cues and cues from others. The results show that foresters make decisions based on what they know from their own actions in the past of from what they heard about actions of others. At the same time of this retrospective development of looking back at what happened in the past, a subjective 'plausible' image of the future is created. Since knowing the future precisely is impossible, composing the most likely happenings is the best option foresters (and decision-makers in general) can do. In sensemaking a context-specific rationality is applied (Vaara, 2000 in Hoogstra, 2012), instead of the "overall" rationality set by the hyper-rational model. In experiment five, the experiment with the lowest level of information and the one that is most close to real life (except for the unknown area) participants really had to make sense of the situation and relied upon personal ideas and experience before making a decisions revealing the three phases of decision-making in sensemaking (perception, weighing, deciding).

Although it is shown by the experiments that in general foresters decision-making can be explained by the sensemaking model, in some situations actors did make a hyper-rational decision. In these cases the highest return was the most important. Though, making these rational decisions was only possible in experiments one till three because of the complete information provided in these situations, something required for using the hyper-rational model. Conditions of situations determine which DM-model has the capability to explain the decision-making in question. Therefore, just like Blum and Hoogstra (2009) state, it is important to explore the conditions in which decisions have to be made in forestry. But only knowing the conditions of the DM situation is not sufficient to forecast and explain the behaviour with DM-models since it has been found that actors still can make "non-rational" (in accordance to the hyper-rational theory) decisions in situations of full information where selecting the option with the highest utility is expected. Thus, knowledge of the aims of single actors is always needed. Knowing the DM situation, together with information of the particular objectives of the decision-maker will contribute the issue which DM-model describes and perhaps forecast the specific decision-making.

Perhaps the rational choice model was able to help guide the decision-making process in times when forestry was focussed on sustainable exploitation of natural resources. Namely because at the core of

applying the rational approach in forestry was the prevention of a shortage of natural resources (Arnscheidt, 2009). The rational approach could be used as a method to get some 'grip' on the large areas of forests. The rational choice model provides the decision-maker with "basic necessary tools for dealing with situations such as those in sustainable forestry" (Ekbia et al., 2007). But nowadays the situations in forestry are different, especially in the Netherlands where there is not much forest left and the remaining forest must fulfil many wishes and values. Maybe the changes that went on in forests and forestry have contributed to the un-usefulness of the rational choice model for explaining foresters' behaviour and let to the rise of other DM models. Anyhow, the sensemaking approach steps in at the time the rational choice model falls short in describing, explaining and perhaps forecasting foresters' decision-making.

5.2 Reflection on research

5.2.1 Theoretical framework

In general, there are many theories and views about the rational choice concept. The amount of theories on rationality is much more abundant that that of the sensemaking approach. In this research, the framework of the hyper and the bounded rational choice theories could be more extensive, although most significant components are incorporated. But for this research the complete theoretical framework is kept in proportion with the entire report. Besides this difference in the abundance of theories, the thoughts on sensemaking are not that contradictory and there are fewer discussions, opposite from the rational approaches. But the exploratory characteristic of this research may just contribute to more insights in sensemaking, since "almost any kind of empirical work will contribute to a better understanding of sensemaking" (Hoogstra, 2008).

The fundament of the research is the theoretical framework that was used. Naturally, this framework has an effect on the outcomes. Especially the research of Blum and Hoogstra (2009) had a large impact on defining forestry decision-making situations and the research hypotheses, and therefore also on the final results. Since the statements Blum and Hoogstra (2009) make are well-founded, not all outcomes of this research are that surprisingly. More so because the theoretical findings of Blum and Hoogstra (2009) are also supported by others, increasing the credibility of their research. Despite this, not all hypotheses founded by the scheme "human-forest relation situations" (table 2 and 3) appeared to be true. Where the scheme (e.g. the first row) sets rational decision-making will be performed, this research found out that this is not done in forestry practice. Though, the findings supported the particular behaviour where the scheme noted "no rational DM". The use of another scheme of human-forests DM situations might have led to other hypotheses concerning the application of DM theories, and perhaps therefore also other final outcomes. But the overall conclusion about the DM of foresters will not be that different, since the final outcomes are taken one step further that just summarizing the outcomes of the hypotheses.

An idea for the next time can be to not focus the definition of decision-making situations on trivial and non-trivial systems, but only on the four concepts that indicate the amount of information (certain, risk, uncertainty and ignorance) available in the situation. This approach is actually already performed in this research (the experiments are based on these four concepts), only for the completeness the trivial and non-trivial are also part of the theoretical framework. In addition is can be questioned if it is necessary to have experiments and hypotheses based on the different divisions of DM situations (certain-ignorance as well as trivial and non-trivial) since this research showed that the majority of the decision-makers always

guide their choices on personal preferences en knowledge, regardless of the characteristics of the DM situations they are in.

5.2.2 Experimental design

Till now, the issue around the degree of rationality of decision-making in forestry was only dealt with in literature. An empirically exploration with use of experiments of how foresters make decisions in different decision-making situations was never done before. The idea of confronting foresters with reality based forest management situations to research decision-making was already proposed by Hoogstra (2008). Composing fictive decision-making situations in experiments is performed on a small scale in other fields of research, like in the military sector (Jensen, 2006; St John et al., 2000). It was unclear *if* this method could be put in practice for forestry-research and *how* these experiments must be designed. This research made a first step in researching the suitability of decision-making experiments for forestry-research.

From this research it is found that experiments provide knowledge of which decisions foresters take in fictional situations, and what the underlying reasons for these choices are. Of all the situations proposed to the participants for this research, just one person decided to not make a choice in two of the fictive situations. But even in the case a participant will not make a decision, knowledge about the values and reasons that play a role in the decision-making process concerning the in the situations proposed questions or issue can be obtained. It appeared that when DM situations are appealing and recognizable for the forestry profession, it will result in useful knowledge on DM considerations. About the question what the content of the experiments must be this research contributes with a reflection of the experiments applied. As DM experiments were not performed before in forestry-research, this investigation makes the first exploratory effort. The shortcomings of the experiments-content revealed during and after the interviews are discussed by nominating important characteristics for composing successful and useful DM experiments. As appeared from this research, fictive DM situations in experiments can best comply with certain characteristics listed below:

- The composed situations must not be too extensive. Short stories with clear conditions are necessary for the participant to understand the situation. The situations must be quickly understandable or else there is the risk participants will get lost in all the details and will not conceive the situation in the same way the other participants do. Another risk of experiments with much information is that participants are going to make their own correlations between choices and outcomes in experiments were this is not the intention. This is consistent with the idea of Shmaya and Yariv (2008), who stated that in such settings “subjects are free to frame the experiments however way they like”. Clear experiments, with keeping the objective of the experiment in mind, are necessary for obtaining proper data.

- The conditions of the situations should be as close to reality as possible. When the situation is realistic for the forest profession, it is easier for the participant to identify with it. This results in for the research useful information about DM processes that are close to real DM processes. Lipshitz and Strauss (1997) also proposed research on decision-making must be carried out in naturalistic settings because decision-making is characteristically driven by the assessment of situations (Hoogstra, 2008). This research revealed some misconceptions about the fictive components of situations, expressed by remarks about the provided information. For example, a couple of times the returns and turnover times of the trees were questioned by the participants, which made the DM process more complicated (to understand and research) as now the

participants could possible rely upon own knowledge or on the information provided by the experiments. Another example of lack of clarity which raised questions is caused by the aspect of planting trees, something not commonly done in the Netherlands. One can conclude that actions or techniques not often applied in forestry and a too narrow focus must be avoided in the experiments. By designing the experiments in a way close to reality, remarks and misconceptions can be reduced to a low level. This will also increase the research results validity. As these experiments will stay fictive for practical reasons, the conditions will never reach to the truth, but they must be as real as possible.

- Completeness is also an important aspect. The completeness of situations, assures the view and the interpretation to be the same by all participants. In case the participants can give their own interpretation to a situation due to lack of details, the results will not match and the comparing the outcomes will be more difficult. An example is given by an issue concerning the size of the area or the amount of trees that must be harvested in experiment one, where for one person the amount of time that would be spent on the harvesting was an important aspect for the DM process. Composing complete situations is especially important for situations of certainty, as here total knowledge is required. Although, also in situations other than that of certainty the point of composing complete situations must be taken into account.

The fact that only ten private foresters owners participated in this research could be considered a shortcoming of the research. After all, more participants mean more results and therefore a more complete picture of the issue researched. Yet when taking the explorative character of the research in mind the number of participants already enabled a proper first analysis. The ten participants provided the research with an extensive amount of data to base decisions on.

5.2.3 Research analysis

For the research analysis, a combination of quantitative and qualitative methods is applied. The representation of numbers on choices made (=quantitative) gave an image of the preferences of people. But the emphasis was on the contents of the underlying reasons of the choices because these are the foundation of decision-making. With this the view of Weick (1995), who is considered to be the “father” of sensemaking (Hoogstra, 2008), is followed. Weick (1995) stated that research on sensemaking needs to mobilize a set of methodological tools that enables them to deal with meanings rather than frequency counts. Resulting in the focus of research on sensemaking to be studying the created meanings that people attach to their experiences (Allard-Poesi, 2005), which will ultimately affect the decisions to be made. In this research, also for investigating the decision-making process in the rational choice approach this method to extract reasons was applicable, as now it becomes possible to see if the reasons “fit” this model.

Furthermore, the qualitative methodology of this research contains finding coherence in the thoughts of the participants and the characteristics of the DM models, after which it was possible to discuss the questions of which DM-model explains decision-making. It has become clear that linking the findings of the research concerning underlying thoughts and reasons with existing decision-making models could be carried out. This made the analysis of the hypothesis verity possible.

6. CONCLUSIONS AND RECOMMENDATIONS

This chapter closes the research by describing the final conclusions and contributions of the question how foresters make decisions in forestry situations. Also some suggestions for further research in the field of decision-making of foresters are provided.

6.1 CONCLUSIONS

There is no agreement about how foresters make decisions. This research performed an empirical investigation to take the discussion about foresters being rational or non-rational a step further. Though various fictive decision-making situations empirical evidence is gained about the way foresters make decisions, outlined by different decision-making models. Now in the end it is possible to verify the eight hypotheses about the applicability of the DM-models in different DM- situations and give answer to the question how rational or not-rational foresters behave.

H1: *In non-competitive mechanistic (certain) situations individuals act according to the hyper-rational choice model.*

Reject, because from experiment one and two, both representing situations of certainty, it appeared participants did not act in accordance with the hyper-rational choice model. Despite the situations where a consideration of completely known net benefits, other courses of actions then the one with the highest revenues were also chosen. In both experiments just around half of the interviewees chose to receive the highest possible return, falsifying the first hypothesis.

H2: *In non-competitive mechanistic (certain) situations individuals act according to the bounded rational choice model.*

Reject for same reasons as for the first hypothesis. In spite the bounded rational choice model assumes actors to choose options that satisfy instead of maximize and the model incorporates subjective rationality instead of objective rationality, the characteristics of experiment one and two (full information) enabled the choice for the maximum revenue. Experiment one and two showed that still other reasons than maximum revenues are incorporated in the decision-making process, making the bounded rational model not sufficient in describing human decision-making in these situations.

H3: *In non-competitive cybernetic situations of risk individuals act according to the hype-rational choice model.*

Reject. In experiment three, representing a situation of risk, only one person decided for the option with the highest expected utility for monetary reasons. So in situations of risk the rational choice model cannot describe how individuals act.

H4: *In non-competitive cybernetic situations of risk individuals act according to the bounded rational choice model.*

Reject. Here again (just like hypothesis two), the satisfying characteristic of the bounded rational choice model is not relevant since the known probabilities of these situations make the expected utility of the options known. So the most satisfying option will be the option with the highest expected utility. Because it appeared from experiment three that just one person went for the

highest returns, the statement that in these situations actors act according to the bounded rational choice model is rejected.

H5: *In non-competitive cybernetic situations of uncertainty individuals do not act in accordance to the (hyper or bounded) rational choice model.*

True. The experiment to verify hypothesis five (experiment four, about uncertainty) had a rather unexpected outcome. As supposed, decisions of actors will in situations of uncertainty not completely be based on a rational cost-benefit analysis (Blum and Hoogstra, 2009), yet in experiment number four two participants did base their decisions on such calculations and both selected the option with the highest expected return because of that. However, in general decision-making was in situations of uncertainty not led by maximizing utility (in this experiment monetary returns) but by other values. The decisions made depended on the individual persons, by personal knowledge, preferences and values, and cannot be described by the hyper-rational choice approach. The bounded rational choice model also not described human action in this experiment as despite the actors do not have full information and will rely upon the most satisfying option, this most satisfying option is the oak which is just chosen twice. Thus, hypothesis five not falsified.

H6: *In non-competitive cybernetic situations of uncertainty the sensemaking approach describes how actors act.*

True. It appeared from experiment four that in uncertain situations, choices depend on the specific person. The sensemaking model can describe how persons act since here information of the specific actor is incorporated. With the result that hypothesis four is not falsified.

H7: *In non-competitive chaotic and terra incognita systems (ignorance) individuals do not act in accordance to the (hyper or bounded) rational choice model.*

True. Experiment five showed that in situations of ignorance information to locate the option with the highest expected return (hyper) or the most satisfying option (bounded) is lacking, leaving no option to act rational.

H8: *In non-competitive chaotic and terra incognita systems (ignorance) the sensemaking approach describes how actors act.*

True, since experiment five demonstrated that decision-making is totally depended on personal values and knowledge, something incorporated in the sensemaking decision-making model. So in situations of ignorance only the sensemaking approach can describe how actors behave.

It has been found that in all situations, most of the foresters did not act in accordance to the rational choice theory. People appear to be rational thinkers and performers, but based on their own personal interpretations. Foresters strive for the highest outcome in their decision-making process, but the desired result varies per person and does not need to been related to money. In case a decision (and underlying reason) does meet up to the rational choice model it can be explained by the aims of these persons in certain situations. When the objective of a single person is aimed at profit, and the situation allows making rational choices, the hyper-rational choice approach can be a DM-model to describe human decision-making.

The objective of the research, to empirically explore how foresters actually make decisions in different DM-situations is completed. The research showed that foresters do act rational but not always in accordance to the rational-acting set by the rational choice model (both the hyper and the bounded versions). Forests found their choices on personal knowledge and preferences, and are constantly trying to logically make sense of the DM-situations they are in. A focus in this act of structuring meanings and actions is the optimizing of personal values. The outcome of decisions we make must have the highest possible results. Regardless if the focus is on nature, social, economic or cultural values, logical thinking is conducted. In forestry, decision-making can be outlined by the sensemaking approach, although the behaviour is rational, only in a personally logical way.

6.2 Recommendations future research

This research takes a step in finding empirical knowledge about decision-making of foresters. Providing suggestions for further research enables the progress of research on DM in forestry. Besides the already mentioned recommendations about the content and analysis of experiments in future research with a similar structure, this chapter provides suggestions for further research on DM in forestry. The investigations suggested will contribute to a more complete understanding of how foresters make decisions.

- The focus of this research was on the individual foresters as decisions maker, described by the non-competitive system. Here the individual does not deal with others directly. The experiments were adjusted to this non-trivial subsystem. But foresters may also act in situations described by other non-trivial systems as foresters do not always make decisions solidary. In order to contribute to the investigation of foresters DM, future research should focus on the other non-trivial systems explained by Blum and Hoogstra (2009). This will result in a more complete picture of how foresters in all sort of situations make decisions.

- Besides increasing the focus to other systems, a higher diversity of target groups should also increase the knowledge level of foresters DM. This research concentrated on private forests owners, but the Dutch forest is owned by many different parties. Besides, the diversity of the people who are involved in decision-making concerning forestry is larger than solely owners. These parties may all have different values to take into account, which makes in interesting to investigate. Suggested groups to include in future research are: policy makers, forest managers and organizations that own forests.

- To make research on foresters DM even more truthful, research on real life DM must be performed. Single decision events set in DM experiments do not reflect complex decision-making that occurs under real world conditions (Hoogstra, 2012). Following the knowledge gained through DM experiments, knowledge on real DM concerning forestry will be a logical step in forestry DM research.

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APPENDIX 1: LIST OF RESPONDENTS

Dhr van Asch van Wijck	Landgoed Prattenburg
H. van Beuningen	Landgoed Anderstein
J.W.H. van der Goes-Petter	Landgoed Maarsbergen
G. van Heemstra	Landgoed Verwolde
K. van Hovell	Landgoed Grootstal
Fam. Laporte	Landgoed Het Kombos
F. Mohren	Landowner
B Th W Notten	Landgoed Huis te Maarn
C. Rauwenhoff	Landgoed Tongeren
J. Thate	Landgoed Huis Den Bosch

APPENDIX 2: EXPERIMENTS (IN DUTCH)

Situatie 1:

U bent de eigenaar van een bos. De houtprijzen zijn enorm gerezen en u heeft daarom besloten een aantal bomen te oogsten.

Omstandigheden:

- Alle kosten en inkomsten zijn bij de netto opbrengsten inbegrepen (ook werkuren en materiaal/rooimachine)

U heeft twee keuze mogelijkheden:

- Zelf oogsten en de koper haalt het op langs een weg:

  Netto opbrengst **€ 110,-** per m3

- Op stam verkopen:

  Netto opbrengst **€ 90,-** per m3

Situatie 2:

U bent in het bezit van een (leeg) stuk grond waarop bomen gepland gaan worden. De opbrengsten van het hout van de drie soorten over 75 jaar is bekend. Welke boomsoort gaat u planten?

Omstandigheden:

- Kosten en inkomsten zijn bij de netto opbrengsten inbegrepen
- Er moeten bomen gepland worden
- Rotatie periodes zijn hetzelfde voor de soorten (fictief)
- Aanname dat de grond geschikt is voor de soorten (fictief)
- Opbrengsten van het hout zijn zeker

U heeft drie keuze mogelijkheden:

• Beuk: netto opbrengst in 75 jaar **€ 150,-** per m3 	• Eik: netto opbrengst in 75 jaar **€ 120,-** per m3 	• Grove den: netto opbrengst in 75 jaar **€ 105,-** per m3 

Situatie 3:

U bent wederom in het bezit van een stuk grond waarop bomen gepland gaan worden. Als gevolg van de verwachten klimaatverandering is het niet zeker wat de opbrengsten van bepaalde boomsoorten in de toekomst zullen gaan zijn. Dankzij wetenschappelijk onderzoek is het wel mogelijk om de waarschijnlijkheden van bepaalde opbrengsten te bepalen. Welke boomsoort gaat u planten?

Omstandigheden:

- Kosten en inkomsten zijn bij de netto opbrengsten inbegrepen
- Er moeten bomen gepland worden
- Rotatie periodes zijn hetzelfde voor de soorten (fictief)
- Aanname dat de grond geschikt is voor de drie soorten (fictief)
- Netto opbrengsten met bijhorende waarschijnlijkheden (kansen) zijn bekend

U heeft drie keuze mogelijkheden, met de volgende bijhorende netto opbrengsten en waarschijnlijkheden:

• Beuk:	• Eik:	• Grove den:
100% kans in 75 jaar op **€ 150,-** per m3	50% kans in 75 jaar op **€ 50,-** per m3 50% kans in 75 jaar op **€ 300,-** per m3	50% kans in 75 jaar op **€ 100,-** per m3 50% kans in 75 jaar op **€ 210,-** per m3
		

Situatie 4:

U bent wederom in het bezit van een stuk grond waarop bomen gepland gaan worden. Net als de vorige situatie is het door de verwachten klimaatveranderingen niet mogelijk om te weten te komen wat de verwachten opbrengsten van bepaalde boomsoorten in de toekomst zullen zijn.
De wetenschappelijke onderzoeken naar klimaatverandering hebben aangetoond dat er twee mogelijkheden van temperatuurstijging zijn, namelijk dat er een temperatuurstijging van 2˚C verwacht kan worden of een van 3 ˚C. De bijhorende kansen dat het een stijging van 2 of 3 graden wordt zijn niet bekend. Welke boomsoort gaat u planten?

Omstandigheden:

- Kosten en inkomsten zijn bij de netto opbrengsten inbegrepen
- Er moeten bomen gepland worden
- Rotatie periodes zijn hetzelfde voor de soorten (fictief)
- Aanname dat de grond geschikt is voor de drie soorten (fictief)
- Netto opbrengsten zijn bekend, maar de bijhorende waarschijnlijkheden (kansen) niet

U heeft drie keuze mogelijkheden, met de volgende bijhorende netto opbrengsten horende bij een stijging van 2 graden of van 3 graden:

- Beuk:

2˚C ↑ **€ 80,-** per m3 over 75 jaar

3˚C ↑ **€ 150,-** per m3 over 75 jaar

- Eik:

2˚C ↑ **€ 300,-** per m3 over 75 jaar

3˚C ↑ **€ 50,-** per m3 over 75 jaar

- Grove den:

2˚C ↑ **€ 90,-** per m3 over 75 jaar

3˚C ↑ **€ 200,-** per m3 over 75 jaar

Situatie 5:

U bent de eigenaar van een stuk grond waarop bomen gepland gaan worden. Er is in deze situatie geen informatie beschikbaar oven de eigenschappen van de locatie of de bodem. Het is wel bekend dat het om een stuk grond in Nederland gaat. Welke boomsoort gaat u planten?

Omstandigheden:

- Onbekend stuk grond in Nederland
- Er moeten bomen gepland worden
- Er is geen informatie over de netto opbrengsten van de boomsoorten

U kunt kiezen uit vijf boomsoorten:

- Beuk

- Berk

- Eik

- Lariks

- Grove den