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„Intuitive and Analytical Types of Thinking and their Effects on Decision Making in Confidence Judgments "

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Table of Contents

List of Figures

List of Tables

1 Introduction

Today there is a large number of scientific literature on the study of cognitive processes in decision making. Researchers come to the conclusion that rational thinking in decision making is increasingly limited by the complexity of tasks, the uncertainty of conditions, the dynamics of the environment, and either limited or overloaded information. In these current conditions, the studies of intuition are of a particular interest.

The growing number of studies devoted to the intuitive type of thinking has been caused by the new requirements for human abilities and skills in the modern dynamic information society. These requirements include an increase in the effectiveness of decision making under conditions of constantly accelerating pace of life, the development of non-stereotypical and creative thinking, as well as the growth of human potential in general. The development of intuition today is considered as a key solution for meeting these requirements. In order to develop intuition and learn how to apply it in the most effective way, it is important to understand its nature and sources as well as the reasonable limits of its use.

Since ancient times, scientists have been trying to understand the concept of intuition. Back then it has been mainly based on a ‘mystical’ understanding and ideas. Nowadays, there are a huge number of works, studies, doctrines in the intellectual disciplines as psychology, mathematics, neuroscience regarding this concept. Eventually, ‘mystical’ explanation of intuition has been mostly replaced by the understanding of intuition as the result of functioning of various cognitive mechanisms. However, the new concepts still do not give an exhaustive full-fledged answer to the question of what intuition is after all.

Studies of intuition in management have already appeared at the beginning of the last century. However, the recognition of the significant role of intuition in management and of the importance of manager’s reliance on the intuition when making decision are results of the latest decades.

Based on the most recent studies, both mental modes, intuitive and analytical, are needed for solving different managerial tasks. Moreover, along with these two mental modes, researchers have identified a third one, which is based on the integration of intuition and analysis. Therefore, the

importance of careful study of various types of managerial tasks to determine the most effective cognitive mode for solving them is emphasized.

In general, managerial tasks are more conceptual than technical, are more associated with estimates and forecasts, and mostly are aimed at the long-term perspective, which, in turn, is characterized by uncertainty. Therefore, in this study, the confidence-range type of judgment, associated with estimates and forecasts under uncertainty, has been selected as an inherently related to managerial tasks.

The main goal of this study is to examine the effectiveness of intuitive and analytical types of thinking when making decisions in confidence judgments. Moreover, this study is aimed to analyze the influence of the phenomenon of overconfidence, which, based on the scientific literature, is inherent in a given type of task, on the intuitive and analytical decision-making processes.

To date, studies comparing the analytical and the intuitive types of thinking already exist. There are also many studies on confidence judgments and overconfidence. However, the novelty of this thesis lies in studying these research objects in the aggregate. Studying them in this way is important to gain a deeper understanding of factors that influence the decision-making process in management and to increase the productivity of this process. Consequently, this could bring some significant results in increasing productivity for both, managers and organizations.

Chapter 1 introduces the main idea of the thesis, its relevance, and also presents the structure of the thesis. Chapter 2 is the theoretical basis of the thesis. It presents a review of the scientific literature on the topic. Chapter 3 introduces the research design. Its purpose is to outline the author's goals and objectives, as well as to illuminate the research process on this topic based on the scientific literature studied in the previous chapter. Chapter 4 describes method selection for this study, as well as the study design. Chapter 5 presents the evaluation and analysis of results of the experiment conducted as a part of this thesis. Chapter 6 summarizes the work done when writing this thesis, presents the results of the analysis of the data obtained as a result of the experiment, as well as the limitations of the study. The chapter also includes ideas for the future related research.

2 Literature Review

This chapter is the theoretical basis of the thesis. It presents a review of the scientific literature on the topic. It consists of 4 sections. Sections 2.1 provides information about the vision of intuition in antiquity. Sections 2.2 presents the historical overview of intuition research in management. Sections 2.3 reveals the concept of overconfidence as of an important factor influencing the decision-making process. Sections 2.4 consists of information about confidence intervals as type of judgmental task, involved in this study.

2.1 Intuition in Antiquity

"The intuitive mind is a sacred gift and the rational mind is a faithful servant. We have created a society that honors the servant and has forgotten the gift"
– Albert Einstein

Since ancient times, philosophers have tried to explain the intuitive cognition. One of the most significant doctrines of intuition is the Plato's work "Republic". Plato has divided intuition into supernatural and natural (rational) types, defining the concept as "the immediate perceiving of ideas" (Piętka, 2015, p.23). *Supernatural intuition* (primary intuition), based on Plato, is "the cognition of ideas during the journey which souls make between death and successive births" and *Natural intuition* (secondary intuition) is "a type of cognition used by people in their worldly life and … consists in evoking an idea" (Piętka, 2015, p.29).

Plato has believed that everything that is in our mind should have some reason. That is, since a person is able to judge what is good, what is beautiful, he must have knowledge of what kindness and beauty are. Thus, according to Plato, a human is born with some "faint knowledge of ideas through concepts" (Piętka, 2015, p.29), on the basis of which "evoking an idea", or, in other words, the understanding of things essences, takes place.

Based on Plato, "natural intuitive cognition consists in associating an idea with the fuzzy content of a concept" (Piętka, 2015, p.29). Thus, the essence of secondary intuition is to connect 'fuzzy concept' with a right idea. Thereby, we are able to know the ideas of the world, since we are already born with

an unconscious knowledge of these ideas. And the secondary knowledge of these ideas, or in Plato's terms, "a recall of that which we have already learned in the spiritual world" (Piętka, 2015, p.30), comes through the cognitive effort, as for example observation and intellectual analysis.

Plato has also drawn an interesting relationship between sight and mind: "the sight perceives things, whereas the reason perceives the essences of things" (Piętka, 2015, p.30). Thus, there is a division into the sight of the body and the sight of the soul. It is important to note here that in Greece vision was given the role of the most important of all human senses. Thereby, by calling intuition 'the eyes of the soul', Plato has emphasized that intuition is "a purely intellectual act of grasping the essence of a thing […] variety of direct cognition […] the most perfect method for intellectual cognition" (Piętka, 2015, pp.30-31). Thus the idea of good, associated with the sun, has appeared in the "Republic". That is, as the Sun makes it possible to see with the 'eyes of the body', so the good makes it possible to see with the 'eyes of the soul', causing intellectual cognition (Piętka, 2015).

At the same time, Plato has discerned a fully rational cognition as indirect, seeing in it a lower cognitive value. Since the 'eyes of the body' are the key to the best sensory cognition, then the 'eyes of the soul' are the key to the best intellectual cognition. And "since rational cognition is more perfect than sensory cognition, intuition is the most perfect way of cognition available to humans" (Piętka, 2015, p.31).

2.2 Intuition Research in Management

"Intuition is a very powerful thing, more powerful than intellect, in my opinion. That's had a big impact on my work"

– Steve Jobs

This section includes a historical review of intuition research in management and gives a general idea of the development of the concept of intuition in management.

2.2.1 1930s.

One of the first who has written about intuition and its nature from the perspective of management is Chester Irving Barnard – American business executive, who has worked almost 40 years

at the American Telegraph and Telephone (AT&T) Company, having made a career path from the Department of Statistics to the President of the New Jersey Bell Telephone Company (Akinci and Sadler-Smith, 2012; Encyclopedia Britannica, n.d.).

Observing how managers, including him, process information, Barnard has divided mental processes into two categories: 'non-logical' and 'logical'. By 'logical' processes he has meant "conscious thinking, which could be expressed in words, or other symbols, that is, reasoning" and by 'non-logical' processes have been meant the processes "not capable of being expressed in words or as reasoning, which are only made known by a judgment, decision or action" (Barnard, 1938, p.302).

It is important to say that the very concept of intuition has not been 'mystical' for Bernard. He has identified it with *knowledge and experience*. However, he has also argued that these unconscious processes cannot be analyzed due to their complexity and transience (Akinci and Sadler-Smith, 2012; Barnard, 1938).

Bernard has also divided the types of work based on the degree of requirement of one or another mental processes. In Bernard's opinion, for example, managers belong to the type of profession where 'non-logical' processes predominate, as in conditions of constant need for fast response to difficult situations it is almost impossible to make decisions based on a leisurely and thorough rational analysis (Barnard, 1938).

2.2.2 1940s. – 1970s.

Based on Akinci and Sadler-Smith (2012) the first scientific analysis of intuition in management has been made by Herbert A. Simon. At this time, the key doctrine in management has been the idea of global rationality of 'economic man', whose decision-making process is based on the desire to maximize utility. Simon, however, has studied uncertainty in organizational decision making and has identified that decisions are making under such constraints as limited time available; limited information on possible consequences; and limited human's ability to process available information (e.g. it is beyond of human abilities to compute maximizing utility (Simon, 1967)).

Thus, the Simon's concept of 'bounded rationality' has been formulated, which implies that "human behaviour in the environment of business organisations is 'intendedly' but not wholly rational,

i.e. organisational behaviour is 'boundedly' rational" (Akinci and Sadler-Smith, 2012, p.7; Simon, 1947; Simon, 1957). Simon's work on bounded rationality in a certain sense has laid the foundation for the *Behavioral Decision Theory (BDT)* (Akinci and Sadler-Smith, 2012).

Some time later, as a result of series of experiments aimed at the study of intuitive judgments, Simon has come to a vision of intuition as a *pattern-recognition* (Simon, 1955). According to Simon, intuition is nothing more than a process of rapid recognition of familiar signals collected over time and stored in the long-term memory (Akinci and Sadler-Smith, 2012).

Thereby, Simon has defined intuition as "analyses frozen into habit and the capacity for rapid response through recognition" (Simon, 1987, p.63). He has characterized the intuitive decision-making process as quick, unresponsive to detailed reasoning and based on *experience*. Simon, same as Bernard, has seen intuition, due to the distinctive rapidity of reaction, as an important manager's quality, which over a time, as a result of the accumulation of knowledge and experience, keep getting more effective in decision making (Akinci and Sadler-Smith, 2012).

2.2.3 1970s.

This decade is primarily distinguished by the heuristics and biases research by Daniel Kahneman and Amos Tversky (1973). Together they have explored the biases arising from judgments based on intuitive decision making. As a result, Kahneman and Tversky have come to the conclusion, that "heuristics are neither irrational nor rational", but "natural assessments […], based on sophisticated underlying processes (e.g. retrieval and matching) in response to simple questions rather than to complex judgmental problems" (Gilovich and Griffin, 2002, p.3). They have believed that errors are inherent in the human information processing. Intuition, based on their opinion, occupies a place somewhere between automatic processes of perception and intentional processes of reasoning (Kahneman and Tversky, 1973).

Akinci and Sadler-Smith (2012) in their study argue that the Behavioral Decision Theory has been largely developed by Daniel Kahneman and Amos Tversky. Based on BDT, *heuristics* has been considered as the basis for intuitive judgments, which, in turn, have been considered error prone (Hodgkinson et al., 2008).

At the same time, the *'split-brain' concept* in organizational behavior theory has appeared based on the results of a series of experiments by Roger W. Sperry, which has proved the functional specialization of different cerebral hemispheres (Akinci and Sadler-Smith, 2012). Thus, the researcher Henry Mintzberg (1976) has stated that depending on the development of the left logical and analytical or the right creative and intuitive cerebral hemispheres, it can be determined, whether a person is a 'planner' or 'manager', respectively (Mintzberg, 1976).

The 'split-brain' concept has been dominating in organizational behavior theory till 1990s, when researchers have started to be skeptical about this theory. Some time later, the concept of 'right' and 'left' information processing has been replaced by the concept of the complex neuropsychological networks influencing the intuitive and analytical decision-making processes (Akinci and Sadler-Smith, 2012).

2.2.4 1980s.

The next decade is characterized by the development of several directions in the study of intuition. The BDT continues to accumulate evidence in its favor. The concept of 'split-brain' also continues its existence in management. At the same time, the role of intuition in making organizational decisions starts increasingly being studied (Akinci and Sadler-Smith, 2012).

Particular attention during this period is concentrated on the study of *intuition in practice*. For example, Isenberg (1984), as a result of his research, concludes that most successful senior managers rely not only on analysis, but on a *combination of intuition and analysis* when making decisions. Moreover, he argues that often, especially when solving difficult, new or complicated problems, managers prefer not to go into a thorough analysis. If analysis is used, then in conjunction with intuition. In his study, Isenberg (1984) provides 5 ways senior managers use intuition:

1. Intuition helps managers *sense that there is a problem*.

2. Intuition is a tool for *fast performing of well-trained actions*, that is, without conscious effort. Here, Isenberg also emphasizes the significance of the analysis before actions become automatic, saying that "early on, managerial action needs to be thought through carefully" (Isenberg, 1984). That is, Isenberg sees intuition as the *rational result of practical experience* that forms skills. Here the

connection with the ideas of Barnard (1938) concerning intuition based on *knowledge and experience* can be traced.

3. Intuition performs the *function of synergy*, uniting in an *integrated picture* all data and experience. A similar in certain sense idea can be traced in the Plato's works. Piętka (2015) in his research cites the analogy that Plato has drawn between cognition through 'the sight of the body' and 'the sight of the soul': "just as with the sense of sight we perceive a corporeal object in a direct way and in its entirety, so too we perceive a non-extensible (incorporeal) object with the eyes of the soul in a direct and *comprehensive* way" (p.31).

4. Intuition is using as a *tool for checking the outcomes* of rational analysis and vice versa. Many managers are distrustful of systematic decision-making methods and prefer to also listen to their own "sense of the correct course of action" when making decisions (Isenberg, 1984). At the same time, the very existence of systematic analysis methods, in general, indicates a controversial trust of managers in their own intuition. That is, in reality, managers seek to reach a *consensus* between their own intuition and analysis. Thus, one of the managers studied by the Isenberg (1984) has said the following: "Intuition leads me to seek out holes in the data. But I discount casual empiricism and don't act on it".

5. Intuition is using when a *time is limited*. It helps to quickly find solutions based on recognition of patterns for solving already familiar problems. Here it is possible to see the connection with the ideas of Simon (1987) about intuition based on *pattern-recognition*. One more manager studied by the Isenberg (1984) has commented: "My gut feel points me in a given direction. When I arrive there, then I can begin to sort out the issues".

It can be concluded that based on Isenberg (1984) intuition in management is associated with *rationality*, is formed on the basis of *experience* in analysis and decision making and is used by managers together with analysis throughout the problem solving process.

Another study of this period on how top executives makes their decisions has been conducted by Agor (1986). Agor has based intuitive decisions on "capacity to integrate and make use of information coming from both the left and the right sides of the brain" (Agor, 1986, p.6). One of the interesting findings of the study by Agor (1986) is that intuitive abilities have been characterized by a higher level

with increasing managerial level, which later has also been confirmed in other empirical studies (Matzler et al., 2014). It has been also found that different managers have used intuition at different stages of the decision-making process: at primary exploration stage, at the final stage of integration or during all the process.

The one of the most important results of the research conducted by Agor (1986) is the identification of decision-making conditions under which the use of intuition is the most beneficial:

- if decision is making under the high uncertainty level;
- if there is no significant precedent or similar circumstances and analysis is not useful;
- if only limited or ambiguous information is available;
- if several equally favorable alternatives are possible;
- if decision is making under pressure of time;
- if decision making involves a high risk degree.

Moreover, the feelings experienced by managers before they have been making the right or wrong decision have been identified by Agor (1986) and are presented in Table 1.

Table 1 Feelings Experienced by Managers Before Decision Making

Sense of the right decision	Sense of the wrong decision
Growing sensation between excitement and euphoria somewhere in the stomach	Feeling of anxiety and an upset stomach
Feeling of complete harmony	Feeling of discomfort
Feeling of completeness	Sleepless nights
Internal flash "this is it, this is the solution"	Mixed signals about the solution correctness

Based on: Agor, 1986, pp.9-10

The feelings described in Table 1 have appeared to be the clear signals for the examined in the study managers, signifying whether the right option is going to be chosen. However, despite a clear understanding of this signals by managers, mistakes when making decision have been still presented.

The main reason for the mistakes, recognized by managers in the study, has been not a mistake of intuition, but inability to follow intuition in certain conditions, which are presented further in Table 2 together with the effects they cause.

Table 2 Conditions that Impede the Use of Intuition

Conditions	Forms	Result
Stress	Physical tension	Fatigue, illness
	Emotional tension	Rush, impulsivity, carelessness, anger
Self-Distrust	Internal effect	Anxiety, fear, confusion, misbalance, disharmony
	External effect	Accommodation of someone's visions, despite own
Reality distortion	Dishonesty	Self-deception, pretense
	Attachment	Unacceptance of things the way they are; attempt to make them the way we would like them to be

Based on: Agor, 1986, pp.10-12

This conditions, presented in Table 2, do not necessarily mean that a wrong decision is going to be made, but they are clear signals that for the better outcome, if possible, it is better to delay the decision-making process until the comfort feelings with the possible solution appear.

Thus, the study by Agor (1986) has shown that the examined managers have been aware of based on intuition decision making due to received specific signals, including somatic ones. The managers have acknowledged that all decisions based on intuition recognized by these signals have been their best decisions.

However, sometimes the signals of intuition have been blocked by the involvement of managers' own ego in the decision-making process, which has entailed erroneous decisions. In order to avoid distortion of intuitive thinking when making decisions and increase the efficiency of its use, psychologists developed the following basic principles presented in Table 3 (Agor, 1986).

Table 3 Guidelines for Developing Intuition for Decision Making

Principles	Definitions
Intention	Value intuition and have the intention to develop it
Time & Daily Practice and Record	Devote time to intuition and create a special space for developing it; practice paying daily attention to intuition and keep a record of intuitive insights
Relaxation & Mind Silence	Let go of physical and emotional tension; learn to quiet the mind (e.g. meditation)
Nonverbal Play	Produce nonverbal expressions (e.g. drawings, music) without a specific goal in mind
Receptivity & Sensitivity & Openness	Learn to be receptive; tune in to both inner and outer processes and open to all outer and inner experiences
Courage	Be willing to experience and confront your fears
Honesty	Face self-deception and be honest with yourself and others
Trust	Trust yourself and your experience
Acceptance	Have a nonjudgmental attitude toward things as they are
Nonattachment	Be willing to accept things as they are
Support Group	Find friends with whom you can share your intuitive experiences and who do not judge you
Love	Practice love and compassion
Enjoyment	Find intrinsic satisfaction from expanded consciousness

Adapted from: Agor, 1986, p.11

Thus, this decade is distinguished by the *recognition* process of intuition in management as a "powerful tool guiding executive decision making" (Agor, 1986, p.5). However, this period, in comparison with the subsequent ones, is characterized as a period of stagnation in the study of intuition in management (Akinci and Sadler-Smith, 2012).

2.2.5 1990s.

During 1990s, research on the nature, role and applicability of intuition in management continues. The following Table 4 presents the basic concepts of the intuitive decisions established during this period (Burke and Miller, 1999).

Table 4 Intuitive Decisions Concepts

Concepts	Definition
Experience-based	Intuitive decisions are based on *experience*. Intuition is considered as a 'mental map', created based on *practice*.
Affect-based	Intuitive decisions are based on *feelings* and *emotions*. Intuition is considered as a 'gut feeling'.
Cognitive-based	Intuitive decisions are based on *knowledge* and *skills*. Intuition is considered as a result of trainings, workshops, courses, books, etc.
Subconscious-based	Intuitive decisions are based on *subconscious*. Intuition is considered as an *automatic* subconscious mental processing.
Value-based	Intuitive decisions are based on human *values*, moral codes. Intuition is considered as an outcome of personal introspection.

Based on: Burke and Miller, 1999, pp.91-92

Based on Table 4, it is possible to see that intuition is no longer seen as a 'mystical' phenomenon. Most researchers and managers explain intuition as a result of *experience* or *affect*. Burke and Miller, as a result of their study, have concluded that intuition can be defined as "a cognitive conclusion based on a decision maker's previous experiences and emotional inputs" (Burke and Miller, 1999, p.92).

Burke and Miller (1999) have also identified conditions, under which managers tend to trust intuition in decision making, which are consistent with previous studies:

- in conditions of limited time;
- unforeseen or completely new circumstances;
- uncertainty;

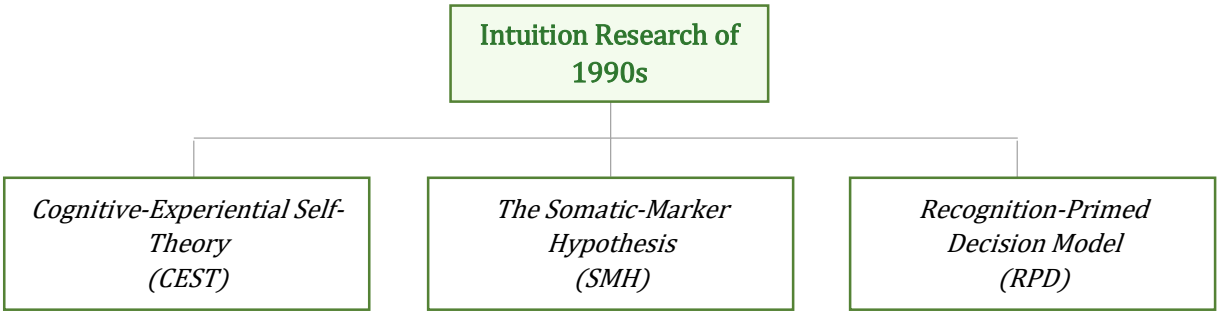
- lack of explicit requirements;
- lack of data to make decisions or extreme information overload.

However, it has been also revealed by Burke and Miller (1999), that mostly managers, when making decisions, tend to *mix intuition and analysis*, combining intuitive and analytical skills. Further, the ratio of skills used to solve the problem is distributed depending on the problem.

It is also important to make an overview, what achievements in the study of intuition have been made outside the field of management in 1990s. In many ways, these achievements have affected the further research on intuition in management, also correcting and complementing the existing theories.

Intuition research of this period are mainly based on three concepts, which are presented below in Figure 1.

Figure 1 Intuition Research of 1990s



Based on: Akinci and Sadler-Smith., 2012, pp.16-20

Among the dual-process theories, Akinci and Sadler-Smith (2012) in their study highlight the Epstein's *Cognitive-Experiential Self-Theory (CEST)*. Epstein in his study divides the information processing into two systems: unconscious (intuitive) Systems 1 and conscious (analytic) Systems 2 (Epstein, 1985, 1994, 2008). The special interest to this dual-process theory in relation to the study of intuition has been caused by the emphasized role of *affect* or 'gut feelling' in intuitive judgments. According to this theory "when a person responds to an emotionally significant event, the experiential (intuitive) system automatically searches its memory banks for related events, including their emotional accompaniments" (Akinci and Sadler-Smith, 2012, p.17).

The Somatic-Marker Hypothesis (SMH) has been formulated by neurologist Antoine Bechara and his co-researchers as a result of their experiment based on a high-risk gambling task (Bechara et al., 1997). The experiment has involved patients with damage to the ventro-medial pre-frontal cortex (VMPC, patients with "impairments in judgment and decision making in real-life settings, in spite of maintaining normal intellect" (Akinci and Sadler-Smith, 2012, p.18)) and patients with no such medical history. The result of the experiment has been evidence that, when the VMPC is not damaged, "autonomic responses associated with intuition based upon previous experience and emotional states guide decision making and outcomes in advance of awareness and influence higher-order thinking processes both consciously and unconsciously" (Akinci and Sadler-Smith, 2012, p.19). Thus, Bechara et al. (1997) have concluded, that the decision-making process is based not only on logic but also on *emotions*.

Recognition-Primed Decision Model (RPD) is the result of research conducted by NDM researcher (Naturalistic decision making researcher) Gary Klein and his co-researchers. The object of research has been the professions that include *complex* barely structured tasks, characterized by a high level of *risk* and responsibility, usually performed in dynamic *uncertain* conditions under the *pressure of time* (Klein and Zsambok, 1997). In particular, the decision-making strategies of professionals like firefighters, police, doctors, military, etc. in such circumstances have been explored. However, it can be noticed, that described conditions of work are also close by characteristics to the managerial once. As a result of research, it has been revealed that for making the right decisions in such conditions professionals mostly rely on the intuition. Decisions are mainly made on the basis of the *problem recognition* through existing *experience* as there is no time for a thorough analysis. Thus, according to Klein, "intuition depends on the use of experience to recognise key patterns that indicate the dynamics of the situation" (Akinci and Sadler-Smith, 2012, p.20).

Klein also notes that judgments based on intuition may have errors. This is due to the fact that each new situation may include some new factors that distinguish it from experienced ones, and then experience can be misleading. Nevertheless, each new situation replenishes the experience, based on which new intuitive decisions are made with increasing accuracy. However, Klein also argues that

sometimes something, which is often impossible to describe, makes us distinguish between a typical situation and an atypical one. "Sometimes […] we just 'feel' the problem, an emotional sense that something is not right" (Klein, 2003, p.96).

2.2.6 2000s.

According to Akinci and Sadler-Smith (2012) one of the main limitations of past decades theories as Simon's pattern-recognition theory, heuristics and biases research by Kahneman and Tversky and others has been rejection of the role of affect in intuitive judgments. However, during 2000s, CEST is becoming quite popular among studies of intuition in management. Thereby the BDT comes to the *recognition of the affect* presence in intuitive judgments and tries to explain its role by combining recently emerging concepts of CEST and SMH. With connection to the CEST appears the concept of 'affect heuristic', denoting a reliance on feelings in judgment and being considered as "the centerpiece of the experiential [intuitive] mode of thinking" (Slovic et al., 2004, p.319; Slovic et al., 2002). At the same time, SMH is being considered as "the most comprehensive theoretical account of the role of affect in decision making" (Akinci and Sadler-Smith, 2012, p.23).

Thereby, the 2000s are characterized by the development of a significant number of studies based on integration of concepts as BDT, NDM, SMH and the dual-process theories, as well as by the questioning of some previous studies. Thus, for example, during this decade, the 'Split-brain' theory has been challenged based on the dual-process theory (Hodgkinson and Sadler-Smith 2003; Hodgkinson et al., 2009).

In this period the importance of intuition in management is no longer in doubt, and research is aimed at finding solutions for its more *efficient* use. Akinci and Sadler-Smith (2012) in their study give a particular attention to the next studies: Khatri and Ng (2000) and Elbanna and Child (2007), examining intuitive processes as a decisive factor for effective strategic decision making; Woiceshyn (2009), examining the complex situation management from the perspective of the intuitive and analytic processes interaction; Sadler-Smith (2004), examining the intuition in perspective of its influence on performance in business and Ritchie et al. (2007) of its influence on performance in non-profit organizations.

At the same time, another study by Sadler-Smith and Shefy (2004) appears, where, in an attempt to combine NDM and SMH, researchers divide intuition into *intuition-as-expertise and intuition-as-feeling*. Based on the study, first type of intuition is influenced by practical, conscious experience, analysis, feedback, and second one by feelings and emotions. Moreover, Sadler-Smith and Shefy (2004) do not oppose each other intuition and rational analysis, but argue that they are rather two *parallel systems of cognition.*

Almost at the same time appears the study by Sinclair and Ashkanasy (2005), in which researchers have developed a model of integrated analytical-intuitive decision making as well as the ways to measure the intuition use. In their study Sinclair and Ashkanasy (2005) have defined intuition as "non-sequential information processing mode, which comprises both cognitive and affective elements and results in direct knowing without any use of conscious reasoning" (p.1).

By the end of the decade, despite a huge amount of new research, the relationship between the affective and cognitive components of intuition and their interaction with analysis, as well as their impact on organizational decision making, remain not fully explored (Akinci and Sadler-Smith, 2012).

2.2.7 2010s.

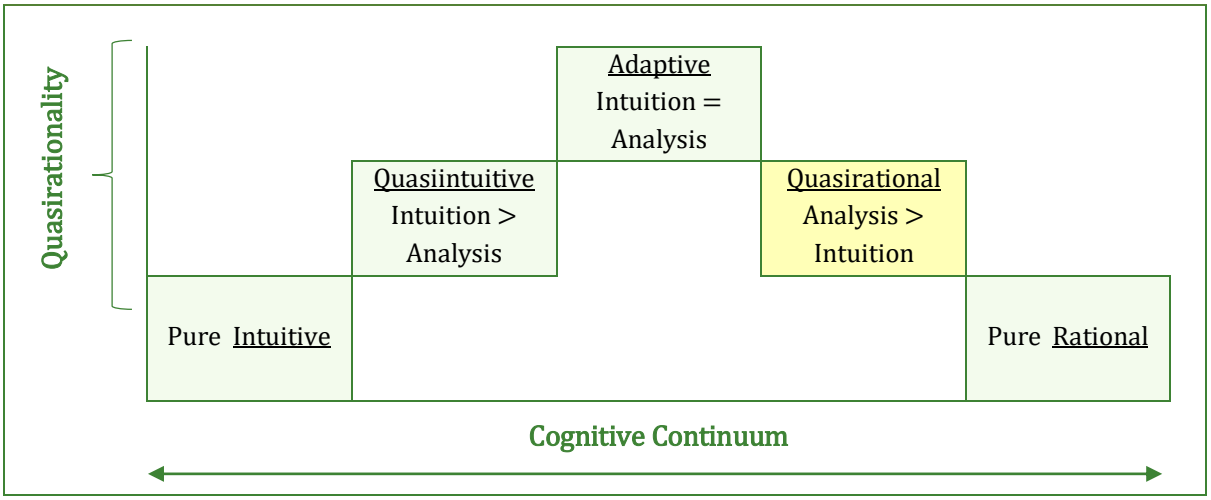
Intuition and reasoning have been studied as two main components of thinking already during some time. Kahneman (2002) in his study describes them as two generic modes of cognitive function. He characterizes intuition as a mode of automatic and rapid judgments and decisions, and reasoning as a controlled deliberate mode, which process slower than the intuitive one. Likewise, researchers in management during long period of time are mostly concentrated in their studies separately on intuitive or on analytical thinking to find out, which type of thinking is more effective in decision-making process.

However, in 2000s. the idea of possible efficiency of integration of intuition and analysis in decision making starts to develop and already in 2010s. the *interaction of intuitive and analytical thinking modes* gets particular attention from management researchers. This tendency finds support in Cognitive Continuum Theory (CCT), which involves the concept of *quasi-rationality* as a combination of intuitive and analytical thinking (Hammond, 1996, 2000). According to CCT, quasi-rationality is the

predominant mode of cognition among variety of other modes that lie on the continuum between intuition and analysis (see Figure 2; Dhami and Thomson, 2012).

It should be also noted that back in the 1980s, Simon (1987) as well has stated, that "it is a fallacy to contrast analytic and intuitive styles of management" (p.63). He has explained this by the fact that in order to get an effective result, the manager has to use a systematic analysis as well as intuitive thinking, which, in turn can, positively influence the speed and quality of the response. He also has concluded, that "behaving like a manager means having command of the whole range of management skills and applying them as they become appropriate" (Simon, 1987, p.63).

Figure 2 Modes of Cognition Along the Cognitive Continuum



Based on: Dhami and Thomson, 2012, p.320; Malewska, 2015, p.101

Dhami and Thomson (2012) in their study present quasi-rationality along with intuition and analysis as one of the suitable cognitive modes for solving managerial problems. They argue that different managerial tasks require a different way of thinking. In connection with this, the importance of studying various types of tasks and determining the most effective cognitive mode for solving them is emphasized.

Matzler et al. (2014) in their research provide the results of the study they conducted in 2011 among 600 entrepreneurs and executive managers from Austria. One of these results, the effectiveness of different types of thinking in organizational decision making, is presented in Table 5 below. This table shows how the decision-making style affects the key performance factors of organizations.

Table 5 Performance of Different Types of Decision Makers

+	The intuitive type		The intuitive-analytic type	
Intuitive decision makers	Growth	-3.9 %	Growth	+7.5 %
	Profitability	+0.4 %	Profitability	+11.9 %
	Innovation	+14.9 %	Innovation	+7.9 %
	Product development	+13.2 %	Product development	+9.8 %
	Process improvement	-15.4 %	Process improvement	+9.2 %
	The passive type		**The analytic type**	
	Growth	-9.1 %	Growth	+2.5 %
	Profitability	-8.1 %	Profitability	+3.5 %
	Innovation	-8.7 %	Innovation	+2.0 %
	Product development	-11.9 %	Product development	+1.7 %
	Process improvement	-8.7 %	Process improvement	+3.6 %
–	Analytic decision makers			+

* The numbers indicate how much above or below average of performance factors organizations are

Adapted from: Matzler et al., 2014, p.35

As it can be seen from Table 5, the intuitive type of decision making has the greatest impact on innovation and product development factors. However, the best overall performance is observed with a *combination of intuitive and analytical types* of decision making.

One more study supporting the effectiveness of *interaction of analytical and intuitive thinking* is the study by Malewska (2015). In her study, Malewska has made an attempt to connect various existing concepts of intuition and, as a result, she has proposed the following definition of intuition as the 'universal' one: "Intuition is a non-sequential process of obtaining and processing information, which takes into account both rational and emotional elements, and the result is direct knowledge without the participation of rational inference" (Malewska, 2015, p.98). Malewska (2015) also has summarized the main characteristics of intuition, which are the following:

- fast, automatic process of thinking, associated with the overall cognition of reality;
- not illogic or irrational, but based on 'deeper' knowledge collected over a lifetime;
- potentially available to every person;
- can be trained and developed;
- participates in any decision-making process;
- uses induction (the conclusion precedes the premises) (p.99).

It has been also conducted an empirical study by Malewska (2015), aimed to assess the extent of intuition use in decision making. As a result, it has been found out, that the quasi-rational approach has prevailed in the sample, however quasi-intuitive approach has been dominating among the top-managers. Based on Malewska (2015), "intuition should be an important component of any decision-making process, complementary to rational analysis" (p.100).

The following Table 6 summarizes the historical overview of intuition research in management of this section.

Table 6 Timeline of Intuition Research

Intuition research in unrelated disciplines		Intuition research in management
	1930	'Non-logical' and 'logical' mental processes; knowledge and experience as a basis for intuition *(Barnard)*
Concept of "bounded rationality" as a foundation for the Behavioral Decision Theory (BDT) *(Simon)*	1940	
BDT development: "Heuristics and biases" research; heuristics as a basis for intuitive judgments *(Kahneman, Tversky)*	1970	
Cerebral hemispheres specialization *(Sperry)*		'Split-brain' concept in management *(Mintzberg)*
	1980	Intuition as a pattern-recognition; knowledge and experience as a basis for intuition *(Simon)* Combination of intuitive and rational thinking as a basis for decision making in management; knowledge and experience as a basis for intuition *(Isenberg)* Growth of research on the role of intuition in management; intuition as a powerful tool guiding executive decision making *(Agor)*

Table 6 (continued)

Cognitive-Experiential Self-Theory (CEST) *(Epstein)* The Somatic-Marker Hypothesis (SMH) *(Bechara)* Recognition-Primed Decision Model (RPD) *(Klein)* Cognitive Continuum Theory (CCT) *(Hammond)*	1990	Ongoing research on the role and applicability of intuition in management; experiences and emotional inputs as a basis for intuition *(Burke and Miller)*
	2000	Growing role of affect in intuitive judgments in management *(Slovic)* The role of intuition in management is no longer in doubt; research on its efficient use *(Khatri and Ng; Elbanna and Child; Woiceshyn)* Intuition-as-expertise and intuition-as-feeling; intuition and rational analysis as two parallel systems of cognition. *(Sadler-Smith and Shefy)* Integrated analytical-intuitive decision making *(Sinclair and Ashkanasy)*
	2010	Growing research on the interaction of intuitive and analytical decision making; different managerial tasks require a different way of thinking (*Dhami and Thomson; Malewska; Matzler)*

Based on: Akinci and Sadler-Smith, 2012

2.3 Overconfidence

"To know that we know what we know, and to know that we do not know what we do not know, that is true knowledge"

– Nicolaus Copernicus

In his study, Plous (1993) has argued that "no problem in judgment and decision making is more prevalent and more potentially catastrophic than overconfidence" (p.217). This can be explained by the fact that overconfidence leads people to believe that their view of things is the only reasonable one, thereby they do not take into account alternative views and can miss better perspectives. Moreover, overconfidence can make people believe that they know exactly what is going to happen, underestimating the likelihood of risks and, as a result, not being prepared to protect themselves (Moore et al. 2015).

Based on Pallier et al. (2002), today, one of the main approaches that explain the phenomenon of overconfidence is the *Heuristics and biases approach* (Kahneman et al., 1982). Based on this approach, intuitive judgments, which, in turn, are mediated by general cognitive biases and heuristics, are considered as error prone and leads to the error in confidence judgments (Kahneman and Tversky, 1996). Klayman et al. (1999) in their study explain overconfidence with two main categories: "biases in information processing and effects of unbiased judgmental error" (pp.218-219).

Based on the study by Russo and Schoemaker (1992), the overconfidence can be caused by such cognitive biases as availability bias, anchoring bias, confirmation bias and hindsight bias.

Availability bias. One of the first reasons for people's overconfidence in predictions, based on Russo and Schoemaker (1992) study, is that the human mind is basically unable to imagine all the possible paths of an event development. This leads to the fact, that when decisions are making, only a limited part of the factors is taken into account, although people believe that they have considered everything and a confident decision can be made.

Anchoring bias. In the literature there is a term, which is used to characterize such situation, when confidence intervals are narrowly set around the 'best guess' – *anchoring*. In that case the 'best

guess' of participant (anchor) represent "the starting point from which one fails to adjust sufficiently when estimating more extreme points in the probability distribution" (Moore et al., 2015, p.17).

Russo and Schoemaker (1992) see this bias as a second reason for the overconfidence. In their study, they have given an example of an experiment conducted for two groups of managers. The experiment has been based on confidence intervals. First group first have had to give the answer for their 'best guess' and only after a 90% confidence interval. The second group has been asked to avoid any commitment to their 'best guess' and provide a confidence interval right away. As a result, the first group in comparison to the second has completed the experiment with 61% of missed answers against 48%. That is, concentration on the range and not on the best estimate when making decision leads to the reduction of overconfidence.

Confirmation bias. In addition to concentrating on their best guess, people are also prone to concentrating on one specific idea when making a decision. Then they begin to try to find support and confirmation for this idea, instead of also trying to refute it. This is the third cognitive reason of overconfidence. Russo and Schoemaker (1992) also describe interesting patterns in this regard, arguing that the more difficult the decision to be made, the easier people find such one-sided confirmation; and the lower its source credibility is and the weaker its evidence, the more it is likely that the overconfidence will appear.

Hindsight bias. One more cognitive reason of overconfidence is that people tend to exaggerate the initially expected by them probability of an event occurrence after it has passed. So, people begin to exaggerate their prediction capabilities, which leads to overconfidence (Russo and Schoemaker, 1992).

Based on Klayman et al. (1999), bias can be exacerbated by such factors as, for example, the desire for a particular answer, choice, decision to be correct or, in other words, by the involvement of own ego in the decision-making process. As it has been considered before, based on Agor (1986), such involvement of own ego can also cause distortion of intuitive thinking when making decisions and entail erroneous decisions.

Effects of unbiased judgmental error is another explanation for overconfidence. They arise, for example, in the erroneous assessment of the validity of information sources or in errors in the evaluation

of available information. Thus, “people’s judgments about the quality of their information include some unsystematic error” (Klayman et al.,1999, p.219)

Moore and Healy (2008) in their study have defined overconfidence with three different effects: overestimation, overplacement, overprecision.

The first effect means the “*overestimation* of one’s actual ability, performance, level of control, or chance of success” (Moore and Healy, 2008, p.502). An example of this type of overconfidence is a situation, where someone is sure to have answered 7 out of 10 questions correctly, although in reality the result is only 4 out of 10.

The second effect is called as *overplacement*, and can be also found in literature as *better-than-average*. This type of overconfidence occurs when someone rates himself higher than the average of people. The example that Moore and Healy (2008) presents in their study tells about the situation, when some student assumes that his result is one of the best in the group. However, it appears to be, that half of this group have got even better results than this student has.

The last effect is the *overprecision*. This term is interesting, first of all, because of its direct relations to this paper, which will be further disclosed. Secondly, this is the most rarely studied type of overconfidence. As an example, Moore and Healy (2008) in their study give the following numbers: 31% of empirical studies have examined overprecision against 72% and 64%, which have examined overestimation and overplacement, respectively. Moore et al. (2015) define overprecision in judgment as “both the most durable and the least understood form of overconfidence” (p.1).

Overprecision – one of the type of overconfidence, which implies “an excessive faith in the quality of own judgmen” or “the excessive faith that you know the truth” (Moore et al., 2015, pp.4-5). To examine this type of overconfidence researchers usually use confidence-range questions, on which this study is also based and which is going to be considered more precisely in the next section. For example, participants are asked to answer the question with numerical range of given 90% probability that the correct answer will fall somewhere within this range. This type of overconfidence can result in setting too narrow intervals, which, in turn, reduces too much the chances of the true value to fall into the interval. This means that instead of 90% hit rate (the percentage of true values that fall into the interval (Zoé, 2016)) can be only 30%.

When summarizing all three effects, it can be noticed that the main reason for overconfidence is the exaggeration by people the accuracy and the correctness of their own knowledge. Russo and Schoemaker (1992) have written in their paper, "good decision making requires more than knowledge of facts, concepts, and relationships. It also requires metaknowledge" (p.7). The difference between knowledge and metaknowledge by Russo and Schoemaker (1992) is the next: if knowledge is a totality of "all the facts, concepts, relationships, theories and so on that we have accumulated over time", metaknowledge is a much deeper concept, which implies "understanding the nature, scope, and limits of our basic, or primary knowledge" (Russo and Schoemaker, 1992, p.8). For example, when making decisions, we may have a certain amount of information and knowledge, but metaknowledge is exactly what tells us, whether this amount of information is sufficient to make a decision right now.

2.4 Confidence Judgments

In this study, the confidence-range type of judgments, which is based on a subjective estimation and involve "the setting of a confidence range of fixed probability for a single estimate" (Klayman et al., 1999, p.238) has been selected to examine. This type of task has been selected as inherently related to managerial tasks, which, based on the literature review, are often associated with estimates and forecasts under uncertainty. Based on Klayman et al. (1999) confidence-range type of judgment is characterized by the high level of overconfidence due to the biased information processing. Thus, the absence of obvious alternatives in range estimates in confidence judgments, according to the Klayman et al. (1999), can provoke confirmation bias: "rather, one can form an initial impression of a single answer and attempt to recruit information that supports or refutes that estimate" (Klayman et al., 1999, p.242), which, in turn, causes the overconfidence (Russo and Schoemaker, 1992).

In previous section, the concept of metaknowledge has been mentioned, which, based on Russo and Schoemaker (1992), is the main requirement for a good decision making. The confidence intervals can be used to study the metaknowledge. The higher the level of metaknowledge is, the more realistic and accurate the level of non-acquaintance can be evaluated. In other words, metaknowledge brings some uncertainty in judgments, which by Russo and Schoemaker (1992) is a crucial factor for successful

decision making. Thereby high level of metaknowledge, or, in other words, high level of accuracy in predicting degree of own uncertainty leads to the greater flexibility in managing the width of the intervals when going through this type of task. This, in turn, brings to the higher precision and higher hit rate. From the other side, the low level of metaknowledge or its absence interrelates with an overconfidence, which, in turn, brings to the opposite effect (Russo and Schoemaker, 1992).

To develop metaknowledge in case of the overconfidence the experience of constant facing own mistakes is required. It can be organized also using tasks based on confidence judgments. Thus, each time seeing the percentage of misses, and realizing the imperfection of their knowledge, people may undergo the task with greater caution. As a result of the accumulation of certain experience on the basis of constant feedback on the accuracy of estimates, a person can develop own metaknowledge. Russo and Schoemaker (1992) in their study confirm it with some examples, when the systematic feedback about judgments has predetermined the development of high level metaknowledge. They also believe, that "timely feedback and accountability can gradually reduce the bias toward overconfidence in almost all professions" (Russo and Schoemaker, 1992, p.11).

3 Research Design

This chapter introduces the research design. Its purpose is to outline the author's goals and objectives when writing this paper and to illuminate the research process on this topic based on the scientific literature studied in the previous chapter. The chapter consists of 2 sections. Section 3.1 identifies the research gap based on the literature review and presents the experiment model. Section 3.2 defines the goals and the objectives of the thesis and outlines the research process.

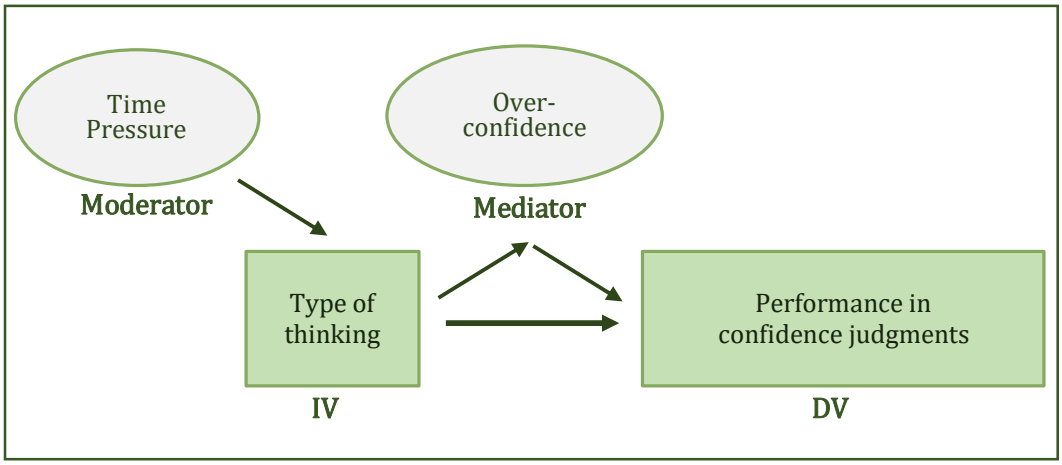
3.1 Research Gap & Experiment Model

The literature review has shown that there are still gaps in understanding of intuitive processes. New concepts still do not give an exhaustive full-fledged answer to the question of what intuition is after all. Despite many different theoretical assumptions concerning the nature of intuition and its effectiveness when making decisions, there is still a lack of empirical research and evidence on this issue. Moreover, the question about effectiveness of analytical type of thinking in decision making is still open.

The importance of a deeper study of these types of thinking is emphasized by the argument of researchers that both mental modes, intuitive and analytical, are needed for solving managerial tasks. However, different managerial tasks require a different way of thinking (Dhami and Thomson, 2012). Therefore, it is important to consider and to study particular problem situations and tasks from the perspective of effectiveness of different types of thinking in solving them.

These facts create an extensive area for new research aimed at deeper understanding of the essence of intuition and analysis in decision making. In this regard, the *main goal* of this study is to examine the effectiveness of intuitive and analytical types of thinking when making decisions in confidence judgments. Moreover, this study *is aimed* to analyze the influence of the phenomenon of overconfidence, which is inherent in a given type of task, on the intuitive and analytical decision-making processes. Based on these research goals a simple model of an experiment has been created. It consists of dependent and independent variables, moderator and mediator. The experiment model is presented in Figure 3.

Figure 3 Experiment Model



Source: own representation

An *independent variable* in the model presents the types of thinking used by the participants during the experiment, namely the intuitive and analytical types. It is expected that these types of thinking will have different efficiency when participants undergo an experiment.

A *dependent variable* is the performance in confidence judgments. It demonstrates how efficient the participants are in completing this type of task. Efficiency is measured by the correctness of answers to the given questions, taking into account its accuracy, and the time spent. Participants have been asked to answer the questions with a numerical range conforming with a given level of confidence 90%. The answer is considered correct if the provided interval includes the true value. The accuracy is measured by two factors: the interval width and the distance from the interval median to the true value.

To study both types of thinking, participants have been divided into 2 groups: intuitive and analytic decision-making groups. To activate one or another type of thinking, the time pressure factor has been chosen, which in this model is presented as a *moderator*. The time pressure is taken as a distinguishing factor between the two groups based on studies that have found that the degree of the reliance on the intuition when making decisions grows with the degree of time pressure on the individual (Dane, 2012). In other words, the greater the time pressure is, the more intuitively decisions are made. Taking this into consideration, the first group has been undergoing the experiment under time constraints, and the second without.

Overconfidence is the *mediator* in the experiment model. The importance of this mediator lies in its serious influence on the decision-making process, as identified in the literature review in the

previous chapter. The interest in this component for this study is that the effect of overconfidence has not yet been studied in the context of various types of thinking (intuitive and analytical) when making decision.

3.2 Research Question and Hypotheses

Based on the literature review presented in the previous chapter, as well as based on the goals, which have been set out of the existing research gap, the following research question and hypotheses have been formulated to describe the relationship between the variables of the experiment model.

Research question:

Is there any difference in the efficiency between the intuitive and the analytical types of thinking in confidence judgments?

Null hypothesis (H0): there is no difference in the efficiency between intuitive and analytical groups.

Alternative hypothesis (H1): there is a difference in the efficiency between intuitive and analytical groups.

Besides the main hypotheses, the following additional hypotheses have been tested in this study:

H1a: there is a difference in overconfidence between intuitive and analytical groups.

H1b: there is a difference in overconfidence between the participants of different gender (Moore et al., 2015).

H1c: there is a difference in average scores between intuitive and analytical groups.

H1d: there is a difference in average scores between the participants of different gender.

H1e: there is a difference in the size of intervals indicated by participants between intuitive and analytical groups.

H1f: there is a difference in the distance from interval medians to the true values of the questions between the intuitive and analytical groups.

H1g: there is a difference in the time taken to complete the experiment between intuitive and analytical groups.

H1h: there is a difference in the time taken to complete the experiment between the participants of different gender.

The expected outcome of this experiment has been the confirmation of H1, in particular, that there is a difference in efficiency between intuitive and analytical types of thinking in confidence judgments.

4 Methodology

This chapter describes method selection for this study, as well as the study design. This research is designed to assess the efficiency of intuitive decision making in comparison to analytical in confidence judgments. The main research method is experiment, which is based on the single numerical estimate tasks, in appliance with a certain requested level of confidence. The experiment questionnaire consists of a random sample of questions from various domains to ensure generalizability. It consists of 3 sections. Section 4.1 reveals the reason behind the selected method of the study. Section 4.2 describes the selection process of the platform for conducting experiment. Section 4.3 presents the study design, including the information about participant and the experiment procedure.

4.1 Method Selection

One of the most commonly used type of confidence judgments in studies is the 2-alternative forced choice type. This kind of method implies the two-choice questions, where participant has to choose one of two alternatives, guessing the likelihood of it being the correct answer. There are two main reasons why this type of confidence judgments has been not selected for this research.

The first reason is that there are already many qualitative studies based on this type of confidence judgments (Moore et al., 2015). Secondly, Klayman et al. (1999) showed in their study that this type of judgments is characterized by a modest amount of overall bias. This was manifested in the low average level of overconfidence - less than 5%. Simultaneously, in the same study Klayman et al. (1999) the level of overconfidence in confidence-range questions has been demonstrated as a large one and represented 45%. Moore et al. (2015) in their study provide the statement: “The confidence people have in confidence intervals tends to be significantly lower than the confidence they have in probability estimates” (p.14). Moore et al. (2015) explain, that when you give to people a task to estimate the likelihood that the true value lies somewhere inside the given interval, they are less confident than if the task is to set by themselves a confidence interval based on the already specified confidence level.

Since this research is also aimed to study the overconfidence as a factor affecting decision making in relation to management, the study focuses on the confidence intervals, as a more bias-susceptible and inherently related to managerial tasks type of confidence judgments.

4.2 Platform Selection

The selection process of the online platform to conduct the experiment has been based on *the lexicographic rule (LEX),* aimed at solving multiobjective optimization problems. The principle of the method is in comparing alternatives based on the most important selection criteria, without considering all the information. So, firstly, each chosen selection criteria has to be ordered based on its importance by the experimenter: from the most significant to the least significant one. Further, the elimination of alternatives begins with the first and the most important selection criterion. In case of inconsistency of the alternative with the first selection criterion, the remaining possible advantages are not considered and the alternative is eliminated. Further, the same procedure is performed with each selection criterion until there is a leading alternative(s) – the platform(s) that meets the most key criteria (Talebian and Kareem, 2010; Betsch and Glöckner, 2010).

Further, for the better visualization, the lexicographic ordering procedure is presented in mathematical form (see Table 7). The goal of the lexicographic ordering procedure is to find the optimal platform(s) x^* so that $f(x^*) \leq f(x)$ (Talebian and Kareem, 2010).

Table 7 Lexicographic Ordering Procedure

$f(x^*) \leq f(x)$

Step 1	$Min\ f_1(x), x > 0$
Step 2	$Min\ f_2(x), x > 0, x \in S_1$
.	
.	
Step k	$Min\ f_k(x), x > 0, x \in S_{k-1}$

where $f_1(x)$ – the most significant criterion; $f_k(x)$ – the least significant criterion; x – set of platforms; x^* – optimal set of platforms; k – criteria number, S_i – the solution set of the step i

Based on: Talebian and Kareem, 2010, p.113; Adam et al., 2011, pp.2-3

The selection process of the online platform to conduct an experiment has been started by choosing the selection criteria. In total, 10 key selection criteria have been chosen by the experimenter (see Table 8).

Table 8 Platform Selection

Qualtrics	–	+	+	10($)	–	1	– ($)	+	100	Free (!)
SurveySparrow	–	+	+	∞	+	1	+	+	100	14
SurveyLegend	–	–	+	∞	+	∞	+	– ($)	∞	Free (!)
SurveyGizmo	–	–	+	∞	–	1	+	+	100	Free (!)
QuestionPro	+	–	+	∞	+	∞	+	+	∞	10
SurveyCrest	+	–	–	10($)	– ($)	∞	– ($)	+	50($)	Free (!)
SoGoSurvey	–	–	+	∞	+	1	– ($)	– ($)	∞	Free (!)
SurveyMonkey	–	+	+	10($)	+	∞	– ($)	+	100	Free (!)
GoogleSurvey	–	+	+	∞	+	1	+	+	∞	Free
ProProfs	+	+	+	∞	+	1	+	+	∞	15

	-	countdown timer		-	number of answer boxes
	-	separated question appearance		-	data export possibility
	-	welcome page (Instructions page)		-	thank you page (Answers page)
1	-	maximum amount of question		-	maximum amount of participants
	-	image in the question	$	-	platform cost
(!)	-	not everything is included	($)	-	can be improved under paid subscription
14	-	days of 'all-included' free trial	∞	-	unlimited amount is available

Source: own representation

The most important criterion for choosing a platform is the countdown timer. According to the experiment model presented in Section 2.2, the time pressure is the moderator, which, as a consequence of its influence or non-influence, activates intuitive or analytic thinking of participants, respectively. During the research it has been found that this function is pretty rare among the platforms offered in the Internet. Only 3 out of 10 considered platforms have the countdown timer: QuestionPro, SurveyCrest

and ProProfs. Therefore, based on the lexicographic ordering procedure, already after the first qualifying round 7 platforms have been eliminated. It is also important to add that originally it has been planned to set a countdown timer for each question. However, as a result of exploring the capabilities of the platforms, such an option has been not identified, and a countdown timer function that operates throughout the experiment has been selected.

The second important criterion is the *separated question appearances*. This refers to the fact that on many platforms the only possible option to display questions on screen is to display them simultaneously on the same page. However, such an option is not suitable for this experiment, due to the fact that it gives participants the opportunity to return to already answered questions. In this case, participants' use of intuitive thinking may be affected. 2 out of 3 remaining platforms do not meet this selection criterion. Therefore, already after the second qualifying round the leading platform has been identified. ProProfs has come out at the top in this process of platform selection and has been chosen to conduct the experiment.

Other presented in Table 8 criteria are further considered for general understanding of the platforms capabilities and of the reasons why these criteria have been chosen.

Welcome page is a necessary option to provide participants with instructions. Based on Table 8, only one platform totally does not have this option – SurveyCrest. However, it is important to notice, that this option differs from platform to platform in the convenience of its use. Some platforms directly offer the welcome page tool, but on the others it is necessary to find some additional solutions. For example, to create a *welcome page* as a separate block of questions, which after would cause inconvenience with data analysis. Same situation has been noticed concerning the previous option – *separated question appearance*. On some platforms, it is possible to separate the questions only by means of creating a separate block for each individual question.

Amount of question, same as *amount of participants*, *data export possibilities* and *'thank you' page* with answers for the questions have appeared to be pretty common tools. If these options have not been insufficient or have not been offered from the very beginning, the issue could always be resolved with an additional fee.

Less optimistic about the *image option in the question* and *number of answer boxes*. First of all, why these options are among the key selection criteria? The purpose of these options is to improve participants' understanding of the experiment tasks. The *image* is supposed to provide additional help for the participants to understand what is the question about, even despite possible imperfections in formulation. *Two answer boxes*, in turn, should have drawn the attention of the participant to the fact that the answer to each question should be an interval, not a number. However, unfortunately, the last option had to be neglected, due to its absence in the selected platform ProProfs. This has been compensated with the additional answer input instructions present in each question.

The final selection criterion is *the platform cost*. Part of the platforms has made it possible to test a full set of tools and opportunities for free during some limited amount of time, which, in turn, seemed to be sufficient. Another part has offered a basic free package with the ability to purchase the necessary options. Therefore, this criterion appears to be the least decisive and it takes the last place in the list of significance.

4.3 Study Design

4.3.1 Participants

This experiment involves people aged between 19 and 32 years (SD = 2.698 years), engaged in different activities. Participants are gathered through the author's personal connections. The percentage of men and women is 44% and 56% of participants, respectively. Each participant is randomly assigned to one of the two groups. The ratio of the first group by gender is 55% of men and 45% of women, the second - 32% of men and 68% of women. The first group has to undergo an experiment based on intuitive decision making, and the second one using analytical thinking.

The experiment took place without participant presenting in the same experimental room. Responses have been collected using the ProProfs Quiz Maker software (ProProfs Quiz Maker, 2019) between 25.11.2019 and 29.11.2019.

A total of 103 responses have been received. However, after the detailed analysis, obviously falsified responses, responses repeatedly obtained from the same IP addresses, as well as responses that

do not meet the requirements of the task or incomplete ones, have been excluded from analysis (see Table 9).

Table 9 Data Collection

	# responses
Collected data	**103**
Obviously falsified responses	1
Responses repeatedly obtained from the same IP addresses	2
Responses that do not meet the requirements of the task (incorrect data entry)	29
Incomplete responses	9
Studied data	**62**

Source: own representation

Ultimately, a total of 62 responses are studied in this paper. Each of two groups includes 31 participants, and each of the participants has taken part in the experiment only once.

It has been decided to conduct an experiment without monetary reward based on participants' performance. This decision has been made due to the next reasons. The first reason is motivation distortion. Based on the study of Moore et al. (2015) in case of being rewarded for taking part in an experiment, such motivations, as intension to help the experimenter, most probably would not totally disappear, however, the degree of such motivation could be significantly reduced. Consequently, this could increase the number of cheating participants and participants who would go through the same experiment several times, as the experiment is taking place through the online platform, without participant presenting in the same experimental place. If the second problem could be solved with the help of specific access restrictions, for example, individual one-time links to the experiment (here it is the issue of the platform capabilities), the first problem would be much more difficult to solve.

Another problem, which Moore et al. (2015) present in their study and which is very applicable for the confidence intervals is the influence of a monetary reward on the size of the setting intervals. A monetary reward based on participants' performance in this case can cause the setting by participants very wide intervals to significantly rise their chances to get true values within their intervals.

4.3.2 Procedure

At the very beginning of the experiment the participants have been given instructions. These instructions include general information about the number and nature of questions in the survey, certain requirements to answer these questions, examples, as well as descriptions of the conditions, in which the experiment has been going to take place.

Participants have been asked to give a numerical estimation on general questions, such as "How many times larger is the diameter of the Sun compared to the Earth?". They have had to provide a numerical range conforming with a given level of confidence 90%. In other words, they have been asked to set the lower and upper values, so that there is a 90% chance that the correct answer lies somewhere between these values, or that there is a 10% probability that the true value is beyond it (Klayman et al., 1999).

In the following Table 10 the text of instructions for each of the two groups is presented.

Table 10 Instructions for the Experiments

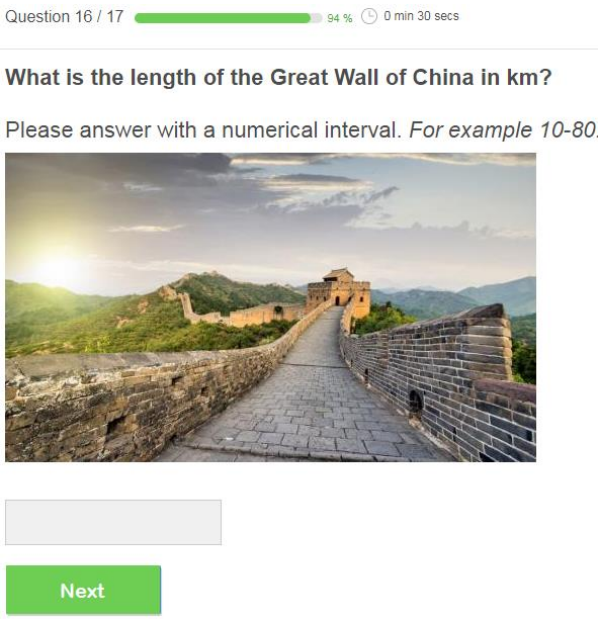
<table>
<tr><td colspan="2">Hello!
I would like to invite you to participate in my Master's thesis Survey.
The survey consists of 2 demographic and 15 general questions. To answer general questions you will have to enter the numerical range, which, in your opinion, with 90% probability includes the correct answer for the question.
For example:
How many countries are there in the world?
You are 90% certain that the correct answer lies somewhere between 180 and 210, then you enter 180-210.</td></tr>
<tr><td>Group 1</td><td>Group 2</td></tr>
<tr><td><u>The survey will go under time constraints.</u> You will have just 5 minutes to complete the questionnaire, on average 17 seconds for each question. Please answer the questions intuitively, avoiding thorough analysis.</td><td><u>The survey does not have any time constraints.</u> You will have unlimited amount of time to think carefully and to complete the questionnaire. Please do not use any additional sources to answer the questions.</td></tr>
<tr><td colspan="2">Thank you very much for your time and support. Please start with the survey now by clicking on the Start button below.</td></tr>
</table>

Source: own representation

In Table 10 it can be seen that the first intuitive group has been informed that the experiment is going to be under time constraints and that participants have 5 minutes to complete the questionnaire, on average 17 seconds for each question. 5 minutes of time for the experiment has been chosen during the pilot-test. This amount of time allows the participants to answer all questions by being mindful of all the prescribed instructions, while maintaining a sense of constant lack of time. The first group has been additionally asked to answer the questions intuitively, avoiding thorough analysis. At the same time, the second analytical group has been instructed to think carefully while completing the questionnaire, and has been informed that participants have unlimited amount of time, as their version of the experiment does not have any time constraints. The second group has also been asked not to use any additional sources to answer the questions.

These instructions are directly followed by questions. In total, the experiment questionnaire includes 17 questions: 2 demographic and 15 general-knowledge questions randomly selected from 7 different domains (history, culture, mythology, astronomy, geography, biology, chemistry). Each of the questions included additional instructions, reminding on how to enter data correctly, as well as an example for answer. On the following Figure 4 an example of how the participants (in this case, the first group) have been seeing the questions on their screens during the experiment is presented.

Figure 4 Question Example



Source: ProProfs Quiz Maker. Retrieved on 30.11.2019

Each of the questions appears on the screen separately in a specific experiment design sequence. The possibility of a return to the previous questions and a change of the submitted answers is not included.

The instructions and question forms have been generated as presented as a result of a series of pilot-tests. In total, in the pilot-tests of the experiment 10 people have taken a part. The following changes have been made during this process:

- the wording of instructions and questions have been modified for better understanding by participants;
- one question has been replaced as a result of the additional inconvenience that it has been creating when entering data (the need to enter the abbreviation BC for the Era Before Christ and AD for the Era After Christ in questions of temporal type);
- time constraint has been edited in accordance with the participants timing capabilities.

5 Evaluation of Results and Data Analysis

This chapter presents the evaluation and analysis of results of the experiment conducted as a part of this thesis. It consists of 2 sections. Section 5.1 presents the primary experiment results and the process of their evaluation. Section 5.2 provides a statistical analysis of the data obtained, including the assessment of quality of confidence judgments; average score analysis; range size analysis; analysis of the distance from the interval median to the true value; and time taken analysis.

5.1 Evaluation of Results

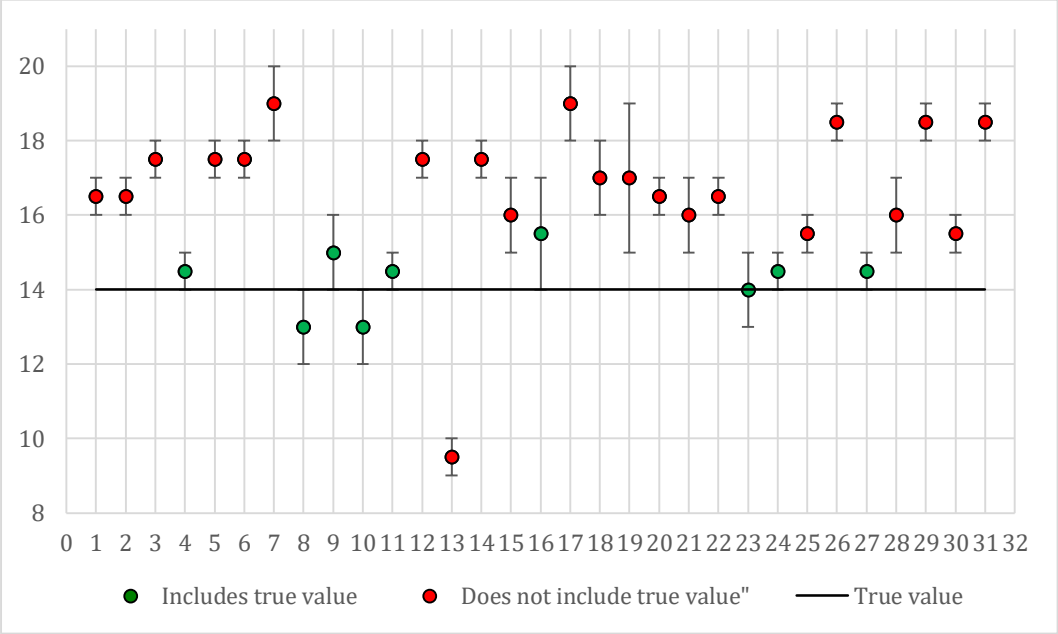
As it was already mentioned in section 3.1, the confidence judgments based on 90% confidence intervals have been selected to examine in this study. A 90% confidence interval implies that in 90% of cases the true value should lie within this interval. In other words, in this experiment, ideally, the true value would have to fall somewhere within the entered by participants intervals 90% of the time and, accordingly, to form a hit rate of 90% (Klayman et al. 1999).

However, in our case the hit rates of the first, intuitive group (N=31), undergoing an experiment under the time pressure, lies between 17% and 67%, with the average of 32.90%, and the hit rates of the second, analytical group (N=31), passing the same experiment without any time constraints – between 8% and 67%, with the average result of 32.69%. On this account, Moore et al. (2015) have been written in their study, “ask your students for 90% confidence intervals around any ten numerical estimates, and you will get hit rates between 30% and 60%, suggesting they have drawn their confidence intervals too narrowly” (p.9). Another example, in the study of Klayman et al. (1999) the correct answer fell within the provided by participants confidence intervals 47% of the time.

Evaluation of the responses has been as following. The answer to the question is considered correct and rated at 1 point if the provided confidence interval includes the true value. Otherwise, the participant’s response is rated at 0 points.

As an example, the evaluation of the responses provided by the first group of participants on the one of the experiment questions “What century did the Italian renaissance began?” is presented in Figure 5.

Figure 5 Example of Responses Evaluation



Source: own representation

It is visible on Figure 5, that the rate of the intervals which include the true value is far from the ideally expected 90%. In this experiment confidence intervals provided by participants, on average, include the true value approximately 33% of times.

One of the main effects, which influences the quality of the confidence judgments and causes such a low hit rate, based on the scientific literature review, is the overconfidence (Klayman et al. 1999; Moore et al., 2015). This effect is going to be also considered in the next section.

5.2 Data Analysis

To test the hypotheses of this study mainly a two-sample *t*-test assuming unequal variances has been performed in Microsoft Excel. This test computes the *t*-value between means of two independent samples when the variances for each group are unknown or unequal. Here 'independent' means that each participant has only been observed once. In this case we have data on two independent groups of participants. The 90% confidence intervals (CI) is chosen for the experiment. This means that the participants should aim for a 90% probability that the true value falls somewhere within the provided by

them interval, and 10% probability of being wrong can be accepted (Nakagawa and Cuthill, 2007; Statsdirect.co.uk., 2016). The standard of 0.05 significance level has been chosen to test the hypotheses.

5.2.1 Assessing Quality of Confidence Judgments

Based on the study by Michailova and Katter (2014), overconfidence level is measured as a Bias score. It is calculated as the difference between the given confidence level (CI = 90%) and the hit rate (see Equation 1). If the result is positive, the overconfidence is taking place, if negative, it is the case of underconfidence.

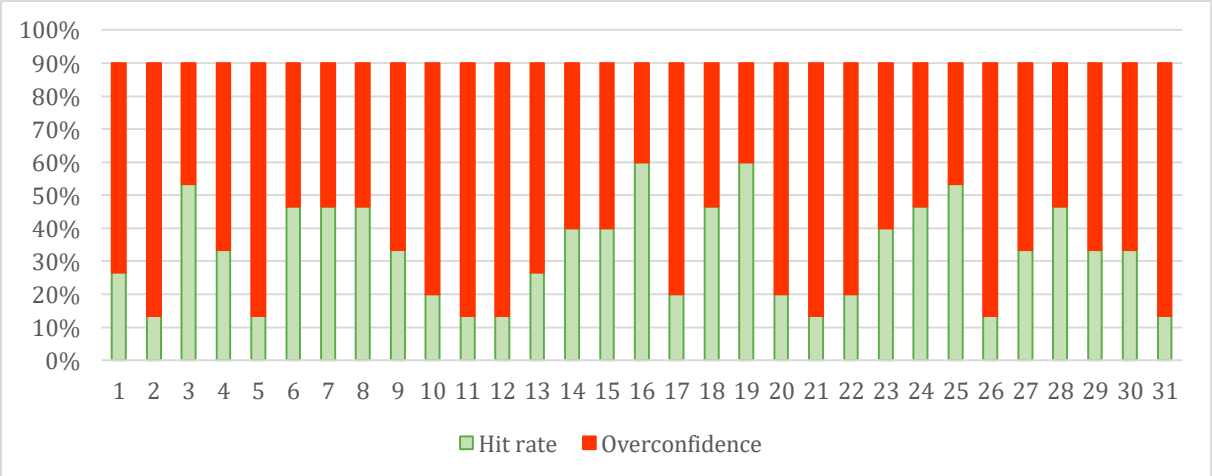
$$BS_g = \frac{1}{N}\sum_{i=1}^{N}(CI - h_i) \quad (1)$$

where BS_g – average Bias score per group g; CI – Confidence level; h_i –average hit rate of participant i; N – number of participants in group.

As the result, the degree of overconfidence for the first group is BS_1 = 57,10% and for the second BS_2 = 57,31%.

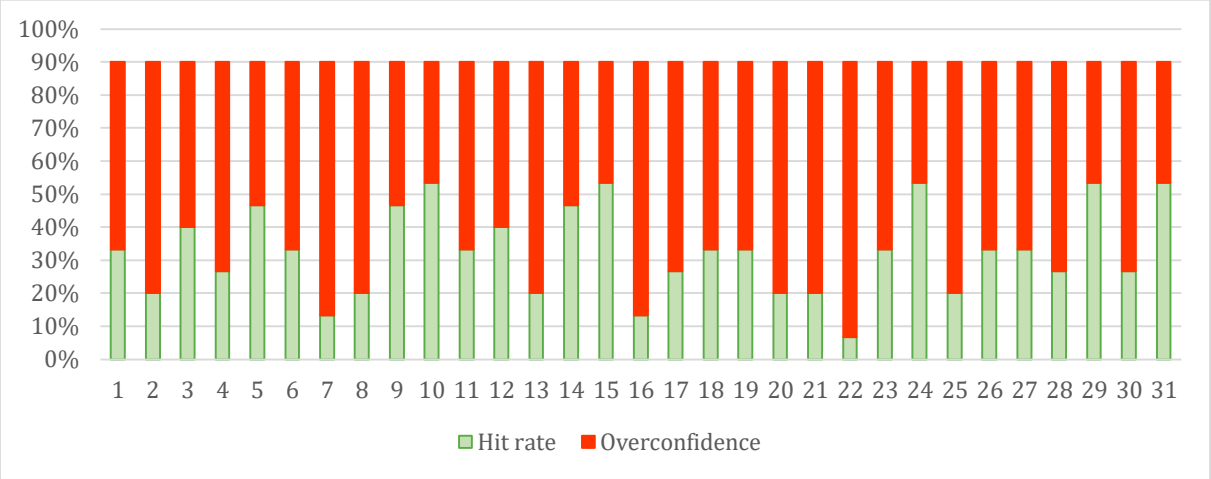
The following Figures 6 and 7 show for both groups the overconfidence degree of each participant. In the first intuitive group, the overconfidence degree ranges from 30% to 77%, and in the second analytical one from 37% to 83%.

Figure 6 Degree of Overconfidence for Group 1



Source: own representation

Figure 7 Degree of Overconfidence for Group 2



Source: own representation

As the following step, the hypothesis H1a has been tested. It states that there is a difference in overconfidence between the intuitive and analytical groups. To do so, a two-sample *t*-test assuming unequal variances has been performed. The results of this test is possible to see in Table 11.

Table 11 t-Test: Overconfidence Analysis

	Group 1	Group 2
Mean	0.5710	0.5731
Variance	0.0234	0.0179
Observations	31	31
Hypothesized Mean Difference	0	
df	59	
t Stat	-0.0589	
P(T<=t) two-tail	**0.9532**	
t Critical two-tail	1.6711	

Source: own representation

Based on the results present in Table 11 it is possible to conclude that the performed t-test is non-significant, the *p*-value (p = 0.9532) is greater than the significance level (α = 0.05). That means that no statistically significant difference has been found in overconfidence degree between the intuitive and analytical groups and the hypothesis H1a has to be rejected.

The next analysis is based on the study by Moore et al. (2015). This study states that there is some evidence that there is a difference in overconfidence degree depended on individual differences.

For example, they state that men are more overconfident than women. It has been decided to check this statement in this study as the hypothesis H1b. For that reason, a two-sample *t*-test assuming unequal variances has been performed. The results are presented in the following Table 12.

Table 12 t-Test: Overconfidence Analysis by Gender

	Men	Women
Mean	0.5617	0.5800
Variance	0.0232	0.0185
Observations	27	35
Hypothesized Mean Difference	0	
df	53	
t Stat	-0.4903	
P(T<=t) two-tail	**0.6260**	
t Critical two-tail	1.6741	

Source: own representation

Table 12 shows non-significant results, as the *p*-value (p = 0.6260) is greater than the significance level (α = 0.05). That means that the hypothesis H1b, which states that there is a difference in overconfidence between the participants of different gender, has to be rejected.

5.2.2 Average Score Analysis

Based on the overconfidence analysis it can be concluded that there is no statistically significant difference in the average scores of tested groups. However, to make it more visible, the results of a two-sample *t*-test assuming unequal variances are presented in Table 13.

Table 13 t-Test: Average Score Analysis

	Group 1	Group 2
Mean	0.3290	0.3269
Variance	0.0234	0.0179
Observations	31	31
Hypothesized Mean Difference	0	
df	59	
t Stat	0.0589	
P(T<=t) two-tail	**0.9532**	
t Critical two-tail	1.6711	

Source: own representation

As the *p*-value ($p = 0.9532$) is greater than the significance level ($\alpha = 0.05$), the H1c has to be rejected.

The Gender analysis of performance has been made to test the hypothesis H1d that there is a difference in average scores between participants of different gender. This has been assessed using a two-sample *t*-test assuming unequal variances (see Table 14).

Table 14 t-Test: Performance Difference Analysis by Gender

	Men	Women
Mean	0.3383	0.3200
Variance	0.0232	0.0185
Observations	27	35
Hypothesized Mean Difference	0	
df	53	
t Stat	0.4903	
P(T<=t) two-tail	**0.6260**	
t Critical two-tail	1.6741	

Source: own representation

The results in Table 14 show that the t-test is non-significant, *p*-value ($p = 0.6260$) is greater than the significance level ($\alpha = 0.05$). That means that the H1d has to be rejected.

No significant difference between the average results of the groups has been revealed. As the next step, the following statistical analyzes have been conducted:

1. *Range size analysis* to compare the average sizes of the ranges provided by the participants of both groups,
2. *Median-TrueValue distance analysis* to compare the average distances from the interval medians to the true values.

5.2.3 Range Size Analysis

The Range size analysis has been conducted to test the hypothesis H1e, which states that there is a difference in the size of the intervals indicated by participants between the intuitive group and the analytical. It has been performed using a two-sample *t*-test assuming unequal variances.

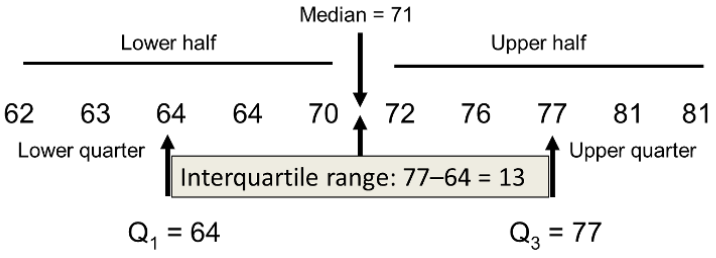
First of all, to prepare data for the analysis the size of every range provided by participants has been calculated as the difference between the maximum and the minimum range values (r_{aimax} and r_{aimin}, respectively, where a –group number and i –participant number (see Equation 2)).

$$Range\ size = r_{aimax} - r_{aimin} \tag{2}$$

Secondly, it is necessary to detect the data set outliers for every question. It has been done using statistics called the *interquartile range (IQR).* These statistics imply the determination of the first quartile (Q_1) and the third quartile (Q_3), which are the values of the data set that cuts off the 25% of values below it and 25% of values above it, respectively (see Figures 8-9). The distance between the first and the third quartiles is called the *interquartile range* and includes the middle 50% of the data set. IQR is calculated as the difference between the third and the first quartiles (see Equation 3 (Sullivan, 2016)).

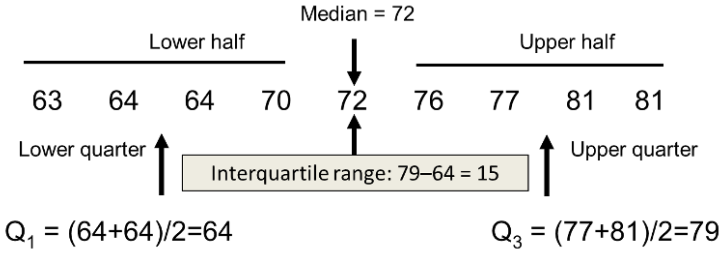
$$IQR = Q_3 - Q_1 \tag{3}$$

Figure 8 Example of Interquartile Range with Even Sample Size



Source: Sullivan, 2016, retrieved on 15.02.2020

Figure 9 Example of Interquartile Range with Odd Sample Size



Source: Sullivan, 2016, retrieved on 15.02.2020

After the quartiles and the interquartile range have been found, it is necessary to determine the value of the upper and lower outlier bounds (UB and LB, respectively). The formulas to calculate UB and LB are presented below (see Equations 4 and 5, respectively (Sullivan, 2016)).

$$UB = Q_3 + (1{,}5 \times IQR) \tag{4}$$

$$LB = Q_1 - (1{,}5 \times IQR) \tag{5}$$

Further, all outliers that fall beyond the lower and upper bounds are excluded from the data sets of each group.

As the third step, in order to make this analysis possible, it has been needed to translate all the range sizes provided by participants into one measurement value. In this case, the percentage has been selected as the ratio of the interval size to the true value, which is presented in the next formula (see Equation 6).

$$Range\ size\ (\%) = \frac{Range\ size}{True\ value} \tag{6}$$

After all the range sizes have been translated into the same measurement value, the average value by question in each of the groups has been calculated.

Finally, based on the obtained data, a two-sample *t*-test assuming unequal variances has been performed. The results of this *t*-test are provided below in Table 15.

Table 15 t-Test: Range Size Analysis

	Group 1	Group 2
Mean	0.4581	1.6761
Variance	0.5679	27.6455
Observations	15	15
Hypothesized Mean Difference	0	
df	15	
t Stat	-0.8881	
P(T<=t) two-tail	**0.3885**	
t Critical two-tail	1.7531	

Source: own representation

Based on the results presented in Table 15, the *p*-value (p = 0.3885) is greater than the significance level (α = 0.05). That means that there is no statistically significant difference in the size of intervals indicated by participants between intuitive and analytical groups and the H1e, has to be rejected.

The same *t*-test has been also conducted for each individual question. Out of 15 *t*-tests, a statistically significant result can be observed in 4 of them. However, a constant prevalence of interval sizes of one group over another has not been identified among these questions.

5.2.4 Median-TrueValue Distance Analysis

The Median-TrueValue distance analysis has been made to test the hypothesis H1f, which states that there is a difference in the distances from interval medians to the true values of the questions between intuitive and analytical groups. This has been performed using a two-sample *t*-test assuming unequal variances.

First of all, the distances from the medians of every interval provided by participants to the true values ($D_{M\text{-}TV}$) have been calculated as the differences between the absolute value of the true value (TV_b) and the interval median (M_{ai}) (where a – the group number, b – the question number and i – the participant number (see Equation 7)).

$$D_{M\text{-}TV} = |TV_b - M_{ai}| \tag{7}$$

Same as in the previous analysis, all the distances from the medians to the true values have been translated into the same measurement value – percentage. It is calculated as the actual distance from the median to the true value divided by the true value (see Equation 8).

$$Distance\ (\%) = \frac{D_{M-TV}}{True\ value} \tag{8}$$

After all the distances from the medians to the true values have been translated into the same measurement value, the average value by question in each of the groups has been calculated.

Finally, based on this data, a two-sample *t*-test assuming unequal variances has been performed. The results of this *t*-test are provided below in Table 16.

Table 16 t-Test: Median-TrueValue Distance Analysis

	Group 1	Group 2
Mean	0.8021	1.1766
Variance	2.4979	7.6863
Observations	15	15
Hypothesized Mean Difference	0	
df	22	
t Stat	-0.4545	
P(T<=t) two-tail	**0.6539**	
t Critical two-tail	1.7171	

Source: own representation

Table 16 shows that the *p*-value (p = 0.6539) is greater than the significance level (α = 0.05). That means that the hypothesis H1f, which states that there is a difference in the distances from interval medians to the true values of the questions between intuitive and analytical groups, has to be rejected.

As in the previous analysis, a separate *t*-test has been carried out on each question. Statistically significant are 2 out of 15 results.

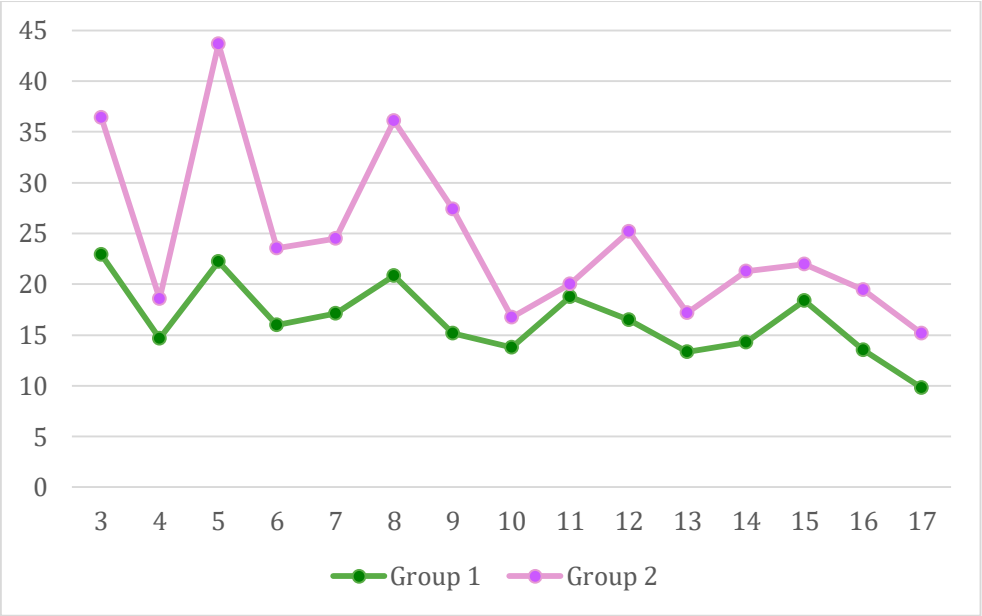
The analyses show that both the average size of the intervals indicated by the participants and the average distance from the median to the true value in the first intuitive group are relatively smaller than in the second one. However, the *t*-test does not reveal the statistical significance of the results.

5.2.5 Time Taken Analysis

As already mentioned before, the first group has had to undergo the experiment under time constraints. The participants of this group have been given 5 minutes to complete the questionnaire. At the same time, the participants of the second group have been given unlimited amount of time to complete the same questionnaire. As a result, the average completion time for the first and second groups are 4 minutes 22 seconds and 7 minutes 31 seconds, respectively. This means that the first intuitive group has completed the questionnaire 1.7 times faster than the second analytical one.

On the following Figure 10 it can be seen how much time participants have spent on each of 15 questions (questions are numbered from 3 to 17, as only general questions are taken into account, without considering two first demographic questions).

Figure 10 Average Time Taken per Question



Source: own representation

It is possible to see on the Figure 10 that the first group has answered all the questions faster than the second one. However, to test these findings, a two-sample *t*-test assuming unequal variances has been performed. The results of this *t*-test are provided below in Table 17.

Table 17 t-Test: Time Taken Analysis

	Group 1	Group 2
Mean	16.481	24.477
Variance	13.126	68.133
Observations	15	15
Hypothesized Mean Difference	0	
df	19	
t Stat	-3.4354	
P(T<=t) two-tail	**0.0028**	
t Critical two-tail	1.7291	

Source: own representation

These results presented in Table 17 are significant as the *p*-value ($p = 0.0028$) is smaller than the significance level ($\alpha = 0.05$). That means that the hypothesis H1g, which states that there is a difference in the time taken to complete the experiment between intuitive and analytical groups, has to be accepted.

The Gender analysis of time taken has been made to test the hypothesis H1h, that there is a difference in the time taken to complete the experiment between the participants of different gender. This has been performed using a two-sample *t*-test assuming unequal variances. The results are presented in the following Table 18.

Table 18 t-Test: Time Taken Difference by Gender

	Men	Women
Mean	381.67	337.43
Variance	117739.85	22203.78
Observations	27	35
Hypothesized Mean Difference	0	
df	34	
t Stat	0.6259	
P(T<=t) two-tail	**0.5355**	
t Critical two-tail	1.6909	

Source: own representation

In these results the *p*-value ($p = 0.5355$) is greater than the significance level ($\alpha = 0.05$). That means that there is no statistically significant difference in the time taken to complete the experiment between the participants of different gender and the hypothesis H1h has to be rejected.

6 Conclusions and Future Research

This chapter is conclusive in this thesis. It consists of 3 sections. Section 6.1 summarizes the work done when writing this thesis as well as presents the results of the analysis of the data obtained as a result of the experiment. Section 6.2 includes the limitations of the study. Section 6.3 provides with ideas for the future related research.

6.1 Summary and Conclusion

This thesis is aimed at investigating the efficiency of different types of thinking, namely, analytical and intuitive types, when making decisions in confidence intervals. In order to understand how these two types of thinking can influence the decision making in confidence judgments, and how important is this topic in business environment, a number of scientific literature has been studied. As a result, a certain research gap in understanding of cognitive processes has been identified and based on it the research question has been formulated.

Based on the literature review and the research question, experiment has been chosen as the research method. It has been followed by the additional literature review, namely the practical experience in researches of relevant issue, and based on it an experiment model was compiled. As the next step, the experiment has been designed, and an online platform to conduct it has been selected based on the determined selection criteria. The participants of different occupational specializations have been gathered through the author's personal connections. They have been divided into two groups. After all the data has been obtained a number of statistical significance tests have been made to identify whether differences between groups are random or actual.

Based on the data analysis the only discovered statistically significant difference in efficiency between analytical and intuitive types of thinking in confidence judgments is the difference in the time taken to conduct the experiment by participants of different groups. The first intuitive group, which has been set up under time constrains conditions, on average has completed the experiment in 4 minutes 22 seconds and the second unlimited in time analytical group in 7 minutes 31 seconds, $p = 0.0028$.

The average score analysis shows that the first group comparing to the second has performed an experiment with a score of 32.90% against 32.69%. However, the *t*-test was associated with a statistically insignificant effect, $p = 0.95$. Same analysis has been performed based on the gender differences. The men average score has been slightly better than women, 33,83% against 32,00%, however no statistically significant difference has been identified, $p = 0.63$.

Same, the analysis of quality of confidence judgement did not show any statistically significant difference between two groups of participants. However, based on this analysis a high level of participants' overconfidence has been revealed during the experiment in both groups, for the first group BS_1 = 57,10% and for the second BS_2 = 57,31%. Based on Klayman et al. (1999) the high level of overconfidence in confidence intervals can be explained by the biased information processing. The study by Klayman et al. (1999) also resulted in a high level of overconfidence in the confidence-range judgments, which has amounted to 47% on average.

Additionally, analysis of quality of confidence judgement has been made between the participants of different gender to verify the Moore et al. (2015) statement that there is a difference in overconfidence degree depending on individual differences, namely, that men are more overconfident than women. As a result, for men the overconfidence degree appeared to be slightly smaller than for women, 56,17% and 58%, respectively. However, the difference has not been confirmed statistically, $p = 0.63$.

Range size analysis shows that the average range sizes for the first and second group are 45,81% and 167,61%. However, the *t*-test does not confirm the statistical significance of this difference, $p = 0.3885$. Same for the Median-TrueValue distance analysis, which compares the average distances from the interval medians to the true values. Despite the difference in average results between the first and second groups, 80,21% and 117,66%, respectively, the *t*-test is non-significant, $p = 0.6539$.

Therefore, it can be concluded that this thesis does not give a clear answer to the research question, but rather is the starting point for further research on the topic, in which this thesis limitations has to be overcome.

6.2 Limitations

6.2.1 Participants Sample Limitations

The first limit of this study is the sample size of the participants. 103 initially received responses have been reduced to 62 appropriate for the analysis responses (31 participants per group). The greatest influence on the sample size reduction has been caused by such factors as incomplete passage of the experiment (9 incomplete responses) and incorrect data entry (29 responses that do not meet the requirements of the task). Assumed reason is the platform limitations, however, this assumption should be verified in future studies.

Firstly, ProProfs Quiz Maker platform same as other considered in this study online platforms does not give a possibility to set the time constraints for each individual question. This possibly have caused time management problems for participants, which has led to the incomplete responses. In this case, incomplete answers could no longer be considered as answers provided based on the intuitive thinking, and have been eliminated. Secondly, the inability to conduct a questionnaire with two boxes for answers instead of one on the ProProfs Quiz Maker platform possibly has led to the incorrect data entry. As it turns out from the participants' feedback, some of them have realized that it has been required to enter answers by intervals only by the middle of the experiment (despite that every question includes the instructions with an example). In some cases, this could be observed by the results themselves, since the answers by number could have been replaced by intervals after, for example, the seventh question.

One more possible limitation in this experiment is the participants' *motivation*. How it is already described in Chapter 3, it has been decided to conduct an experiment without monetary reward. From one side, most probably, if participants would be offered a monetary reward based on their performance, they would follow the instructions more carefully and set the intervals more accurate, thereby increasing the chances of hitting the true value. However, from another side, that could cause the motivation distortion and the interval expansion. In this regard, the decision concerning a monetary reward has not been made.

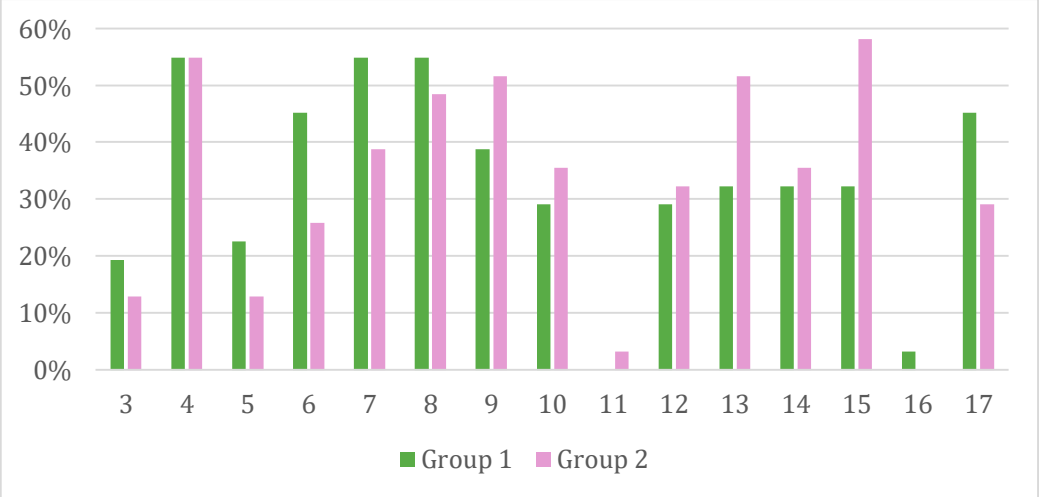
As participants could not lose or win anything during the experiment, except for the opportunity to test their own common knowledge, that probably has influenced their motivation to hit the true value.

Instead of it participants could be interested just to check how close they are to the true value by setting any interval around their 'best guess', without further thinking about the 90% level of confidence. Such situation also reminds the anchoring bias – concentration on some value, without adjusting from it enough, which is considered in Section 2.1.1. It can be also taken into consideration that some participants could not fully understand, what confidence interval means. Some of researchers have conducted experiments with only difference in given confidence level – 90% and 50%. In both cases the hit rates are approximately 23% (Moore et al., 2015).

6.2.2 Questions Sample Limitations

Second limitation is the question sample. This has been revealed after the analysis of the difference in results between the questions has been made. The average proportion of correct answers per group for each of the 15 questions is presented in the following Figure 11. The average results in the first and second groups ranges from 0% to 54.84% and from 0% to 58.06%, respectively. Such low average results in some of the questions may indicate the relation of these questions to the misleading ones. Klayman et al. (1999) in their study name this type of questions as contrary questions and describe them as questions, which participants understand wrong. In other words, they state that these questions are simply inconsistent with one's predictions. At the same time, the questions that are contrary for many participants are distinguished by Klayman et al. (1999) as hard questions.

Figure 11 Average Scores per Question

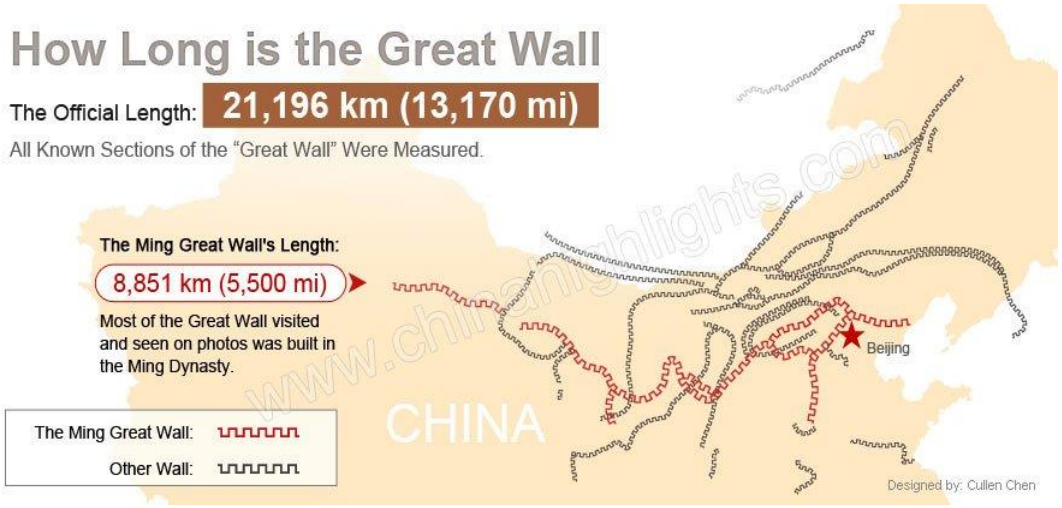


Source: own representation

The first reason that can cause the contrary question by Klayman et al. (1999) is the situation, when answer is beyond the information sources the most used by participants. The examples from this experiment is the next question: "How many years did the longest war in human history last?" Based on the participants' feedback, it has been revealed that some of the participants have understood by 'war' the conflict, which manifests itself in the form of real hostilities. Approximately the same meaning is embedded in the definition of the term 'war' in most information resources. Consequently, most probably some participants have indicated ranges between 100 and 300 years, including Arauco War (1536-1818; 282 years) and Hundred Years' War (1337-1453; 116 years) – wars with the following one after another battles throughout their duration. However, the question implies the so-called bloodless conflict – the Dutch-Scilly War (1651-1986; 335 years), which has been recognized as the longest war in human history. Despite the fact that the hostilities themselves in this war have been ended 3 months after the start, the official signing of the peace treaty has been forgotten. This omission has been discovered and corrected only after 335 years (Johnson, 2015).

The second reason provided by Klayman et al. (1999) is the lack of information in the question wording necessary for the correct interpretation by the participants. They state "the better the available information, the smaller the chance of a contrary question" (Klayman et al., 1999, p.222) An example from this experiment is the question about the Great Wall of China: "What is the length of the Great Wall of China in km?"

Figure 12 "What is the length of the Great Wall of China in km?"



Source: China Highlights, 2019, retrieved on 12.02.2020

The question implies the entire official length of the Great Wall, including all its sections. However, based on the following the experiment participants' feedback, for some of participants the question has been misinterpreted. They have thought that the question is about the Ming Great Wall - the section of the Wall that can be seen today in numerous photos and which is nowadays the most visited by tourists. The difference between the entire Great Wall and the Ming Great Wall can be seen on Figure 12.

However, even assuming that all participants proceeded from this perspective, they still largely underestimate the size of the Wall. The biggest part of answers mostly ranges up to 5000 km. If the question would imply the Ming Great Wall, the hit rate of the first intuitive group would increase from 3% to 10%, and in the second analytical group from 0% to 3%.

6.3 Future Research

The literature studied in this thesis confirms that today's business environment is characterized by rapid variability, uncertainty, and the limited availability of information and time when making decisions. Existing rational decision-making models are rapidly becoming obsolete in light of the emergence of ever new trends, as rational rigid models built on the analysis of past experience can hardly create anything radically new, unlike an intuitive frameless thinking. People, with the development of intuitive thinking, acquire a 'sense of the future', which for a manager is a critical skill that makes it possible to see new opportunities. Thus, nowadays, intuition gets an increasingly significant role as the engine of innovation. This fact underlines the importance and the necessity of further empirical studies of intuition and methods for its development.

Based on the considered limitations of current study, in a future related study, first of all, the participants sample should be expanded in order to increase the reliability of the results.

The research method can be chosen analogous – an experiment based on the single numerical estimate tasks, in appliance with a certain requested level of confidence. However, the form of carrying out the experiment can be reviewed.

The current experiment has taken its place on the online platform, without participant presenting in the same experimental place. In my opinion, it would be more efficient to program own offline experiment to take it 'on place'. However, before to do so, it would be effective to conduct a similar to the current pilot experiment on different online platforms and to test the influence of tools mentioned in Section 5.2 on the results of the experiment.

The size of the sample of questions can be also expanded with questions of the same type in order to get a possibility to analyze the influence of intuitive and analytical types of thinking on the decision making in different domains. The bigger sample could also help to reduce the impact of potential contrary questions on the study results.

It might be also useful to study the influence of intuitive and analytical types of thinking not only in confidence interval type of confidence judgments.

Appendix

Experiment questionnaire with answers

3	What is the age of Notre Dame de Paris Cathedral in years?	856 years old
4	How many years did Merlin Monroe live?	36
5	How many times larger is the diameter of the Sun compared to the Earth?	109 times
6	How tall was the world's tallest giraffe in meters?	6,1 m
7	What is the height of Everest (the highest point on Earth) in meters?	8,848 m
8	What year was the first light bulb created?	1878
9	How many ruling Gods (Olympians) were in Greek Pantheon?	12
10	What is the top speed of a guepard in km/h?	120 km/h
11	How many years did the longest war in human history last?	335 years
12	What century did the Italian renaissance began?	14th
13	How many bones are in the human skeleton of an adult?	206
14	How many elements are there in the Periodic Table 2019?	118
15	What year did Christopher Columbus discover America?	1492
16	What is the length of the Great Wall of China in km?	21,196.18 km
17	What percentage of people are left-handed?	10%

Abstract – English

Over the last century, research on intuition in decision making has been significantly developed. The main reason is the changing environmental conditions. The modern information society has questioned the effectiveness of a rational decision-making model under the prevailing conditions of growing complexity, uncertainty, dynamics, as well as limited or overloaded information. On the other hand, intuition has revealed itself in such human abilities as non-stereotypical creative thinking, vision of a broad integrated picture, fast reaction in changing and non-standard conditions. These abilities, as a rule, significantly increase the efficiency of decision making, which is of particular interest in business.

This study aims to reach a deeper understanding of the meaning of intuition in management and to identify what can affect the decision making process and whether there are differences in effectiveness between analytical and intuitive decision making in confidence judgments. This type of task has been selected as inherently related to managerial tasks, which are often associated with estimates and forecasts. An experiment has been chosen as the main research method.

As a result of the experiment, statistically significant differences between analytical and intuitive decision making in confidence judgments have been not identified. To increase the reliability of the results in further research the limitations of this study have been taken into account.

Keywords: intuitive thinking, analytical thinking, decision making, management, confidence judgments, overconfidence.

Abstract – German

Im letzten Jahrhundert wurde die Erforschung der Intuition bei der Entscheidungsfindung erheblich weiterentwickelt. Ein Hauptgrund dafür ist die Änderung der Umweltbedingungen. Die moderne Informationsgesellschaft hat die Wirksamkeit eines rationalen Entscheidungsmodells unter den vorherrschenden Bedingungen wachsender Komplexität, Unsicherheit, Dynamik sowie begrenzter oder überladener Informationen in Frage gestellt. Auf der anderen Seite hat sich die Intuition in menschlichen Fähigkeiten wie nicht stereotypem kreativem Denken, Vision eines breiten integrierten Bildes, schneller Reaktion auf sich ändernde und nicht standardisierte Bedingungen gezeigt. Diese Fähigkeiten erhöhen in der Regel die Effizienz der Entscheidungsfindung erheblich, was für Unternehmen von besserem Interesse ist.

Diese Studie zielt darauf ab, ein tieferes Verständnis der Bedeutung von Intuition im Management zu erreichen und herauszufinden, was den Entscheidungsprozess beeinflussen kann und ob es Unterschiede in der Wirksamkeit zwischen analytischer und intuitiver Entscheidungsfindung bei Wahrscheinlichkeitsurteile gibt. Diese Art von Aufgabe wurde als inhärent mit Verwaltungsaufgaben verbunden ausgewählt, die häufig mit Schätzungen und Prognosen verbunden sind. Das Experiment wurde als Hauptforschungsmethode gewählt.

Als Ergebnis des Experiments wurden statistisch signifikante Unterschiede zwischen analytischer und intuitiver Entscheidungsfindung bei Wahrscheinlichkeitsurteile nicht festgestellt. Um die Zuverlässigkeit der Ergebnisse in der weiteren Forschung zu erhöhen, wurden die Einschränkungen dieser Studie berücksichtigt.

Schlagwörter: intuitives Denken, analytisches Denken, Entscheidungsfindung, Management, Wahrscheinlichkeitsurteile, Selbstüberschätzung.

References

Adam, S., Bonnans, J.F., Paraisy, R. and Veyrat, S., 2011. Application of convex lexicographical optimization to the balance of GRTgaz gas grid. *Journal of Global Optimization*, *49*(3), pp.415-423.

Agor, W.H., 1986. The logic of intuition: How top executives make important decisions. *Organizational Dynamics*, *14*(3), pp.5-18.

Akinci, C. and Sadler-Smith, E., 2012. Intuition in management research: A historical review. *International Journal of Management Reviews*, *14*(1), pp.104-122.

Barnard, C.I., 1938. The functions of the executive. *Cambridge, MA: Harvard University*.

Bechara, A., Damasio, H., Tranel, D. and Damasio, A.R., 1997. Deciding advantageously before knowing the advantageous strategy. *Science*, *275*(5304), pp.1293-1295.

Betsch, T. and Glöckner, A., 2010. Intuition in judgment and decision making: Extensive thinking without effort. *Psychological Inquiry*, *21*(4), pp.279-294.

Burke, L.A. and Miller, M.K., 1999. Taking the mystery out of intuitive decision making. *Academy of Management Perspectives*, *13*(4), pp.91-99.

China Highlights, 2019. *How Long Is the Great Wall of China? - 21,196 kilometers?* [Online]. Available from: https://www.chinahighlights.com/greatwall/fact/great-wall-length.htm [Accessed 12 Feb. 2020].

Dane, E., Rockmann, K.W. and Pratt, M.G., 2012. When should I trust my gut? Linking domain expertise to intuitive decision-making effectiveness. *Organizational behavior and human decision processes*, *119*(2), pp.187-194.

Dhami, M.K. and Thomson, M.E., 2012. On the relevance of Cognitive Continuum Theory and quasirationality for understanding management judgment and decision making. *European Management Journal*, *30*(4), pp.316-326.

Elbanna, S. and Child, J., 2007. The influence of decision, environmental and firm characteristics on the rationality of strategic decision-making. *Journal of Management Studies*, *44*(4), pp.561-591.

Encyclopedia Britannica, n.d. *Chester Irving Barnard | American sociologist.* [Online] Available from: https://www.britannica.com/biography/Chester-Irving-Barnard [Accessed 5 Mar. 2020].

Epstein, S., 1985. The implications of cognitive-experiential self-theory for research in social psychology and personality. *Journal for the Theory of Social Behaviour*, *15*(3), pp.283-310.

Epstein, S., 1994. Integration of the cognitive and the psychodynamic unconscious. *American psychologist*, *49*(8), pp.709-724.

Epstein, S., 2008. Intuition from the perspective of cognitive-experiential self-theory. In Plessner, H., Betsch, C. and Betsch, T. (Eds.) *Intuition in Judgement and Decision Making*, pp. 23-37. New York: Taylor & Francis Group, LLC.

Gilovich, T. and Griffin, D., 2002. Introduction-heuristics and biases: Then and now. *Heuristics and biases: The psychology of intuitive judgment*, pp.1-18.

Hammond, K.R. and Kenneth, R., 2000. *Judgments under stress.* New York: Oxford University Press.

Hammond, K.R., 1996. *Human judgment and social policy: Irreducible uncertainty, inevitable error, unavoidable injustice*. Oxford, England: Oxford University Press.

Hodgkinson, G.P. and Sadler-Smith, E., 2003. Complex or unitary? A critique and empirical re-assessment of the Allinson-Hayes Cognitive Style Index. *Journal of Occupational and Organizational Psychology*, *76*(2), pp.243-268.

Hodgkinson, G.P., Langan-Fox, J. and Sadler-Smith, E., 2008. Intuition: A fundamental bridging construct in the behavioural sciences. *British Journal of Psychology*, *99*(1), pp.1-27.

Hodgkinson, G.P., Sadler-Smith, E., Burke, L.A., Claxton, G. and Sparrow, P.R., 2009. Intuition in organizations: Implications for strategic management. *Long range planning*, *42*(3), pp.277-297.

Isenberg, D.J., 1984. *How Senior Managers Think.* [Online] Harvard Business Review. Available from: https://hbr.org/1984/11/how-senior-managers-think [Accessed 8 March 2020].

Johnson, B., 2015. *The 335 Year War - The Isles of Scilly vs the Netherlands.* [Online] Historic UK. Available at: https://www.historic-uk.com/HistoryUK/HistoryofEngland/The-335-Year-War-the-Longest-War-in-History/ [Accessed 15 Feb. 2020].

Kahneman, D. and Tversky, A., 1973. On the psychology of prediction. *Psychological review*, *80*(4), p.237.

Kahneman, D. and Tversky, A., 1996. On the reality of cognitive illusions. *Psychological review, 103*(3), pp.582-591.

Kahneman, D., 2002. Maps of bounded rationality: A perspective on intuitive judgment and choice. *Nobel prize lecture*, *8*, pp.351-401.

Kahneman, D., Slovic, S.P., Slovic, P. and Tversky, A. eds., 1982. *Judgment under uncertainty: Heuristics and biases*. Cambridge university press, p.20.

Khatri, N. and Ng, H.A., 2000. The role of intuition in strategic decision making. *Human relations*, *53*(1), pp.57-86.

Klayman, J., Soll, J.B., Gonzalez-Vallejo, C. and Barlas, S., 1999. Overconfidence: It depends on how, what, and whom you ask. *Organizational behavior and human decision processes*, *79*(3), pp.216-247.

Klein, G.A. and Zsambok, C.E., 1997. Naturalistic decision making: Expertise-research and applications. *Lawrence Erlbaum Associates, Inc*.

Klein, G.A., 2003. *Intuition at work: Why developing your gut instincts will make you better at what you do*. New York ua: Currency/Doubleday.

Malewska, K., 2015. Intuition in Decision Making –Theoretical and Empirical Aspects 3, 10.

Malewska, K., 2015. Intuition in Decision Making-Theoretical and Empirical Aspects. *International Journal of Business and Economic Development (IJBED)*, *3*(3), pp.97-105.

Matzler, K., Uzelac, B. and Bauer, F., 2014. Intuition: the missing ingredient for good managerial decision-making. *Journal of Business Strategy*, *35*(6), pp.31-40.

Michailova, J. and Katter, J.K., 2014. Quantifying overconfidence in experimental finance. *International Journal of Behavioural Accounting and Finance*, *4*(4), pp.351-367.

Mintzberg, H., 1976. Planning on the left side and managing on the right. *Harvard Business Review*, *54*(4), pp.49-58.

Moore, D.A. and Healy, P.J., 2008. The trouble with overconfidence. *Psychological review*, *115*(2), pp.502-517.

Moore, D.A., Tenney, E.R. and Haran, U., 2015. Overprecision in judgment. *The Wiley Blackwell handbook of judgment and decision making*, pp.182-209.

Nakagawa, S. and Cuthill, I.C., 2007. Effect size, confidence interval and statistical significance: a practical guide for biologists. *Biological reviews*, *82*(4), pp.591-605.

Pallier, G., Wilkinson, R., Danthiir, V., Kleitman, S., Knezevic, G., Stankov, L. and Roberts, R.D., 2002. The role of individual differences in the accuracy of confidence judgments. *The Journal of general psychology*, *129*(3), pp.257-299.

Piętka, D., 2015. The concept of intuition and its role in Plato and Aristotle. *Organon*, *47*, pp.23-40.

Plous, S., 1993. *The psychology of judgment and decision making*. Mcgraw-Hill Book Company.

ProProfs Quiz Maker., 2019. *Quiz Software by ProProfs*. [Online] Available from: https://www.proprofs.com/quiz-school/ [Accessed 29 Nov. 2019].

Russo, J.E. and Schoemaker, P.J., 1992. Managing overconfidence. *Sloan management review*, *33*(2), pp.7-17.

Sadler-Smith, E. and Shefy, E., 2004. The intuitive executive: Understanding and applying 'gut feel'in decision-making. *Academy of Management Perspectives*, *18*(4), pp.76-91.

Sadler-Smith, E., 2004. Cognitive style and the management of small and medium-sized enterprises. *Organization Studies*, *25*(2), pp.155-181.

Simon, H.A., 1947. *Administrative Behavior: a Study of Decision-Making Processes in Administrative Organization* (1st ed.). New York: Macmillan, p,16.

Simon, H.A., 1955. A behavioral model of rational choice. *The quarterly journal of economics*, *69*(1), pp.99-118.

Simon, H.A., 1957. A behavioral model of rational choice. *Models of man, social and rational: Mathematical essays on rational human behavior in a social setting*, pp.241-260.

Simon, H.A., 1967. Motivational and emotional controls of cognition. *Psychological review*, *74*(1), p.29.

Simon, H.A., 1987. Making management decisions: The role of intuition and emotion. *Academy of Management Executive*, *1*(1), pp.57-64.

Sinclair, M. and Ashkanasy, N.M., 2005. Intuition: myth or a decision-making tool?. *Management learning*, *36*(3), pp.353-370.

Slovic, P., Finucane, M., Peters, E. and MacGregor, D.G., 2002. Heuristics and biases: The psychology of intuitive judgment. *'The affect heuristic'*. New York: Cambridge University Press, pp.397-420.

Slovic, P., Finucane, M.L., Peters, E. and MacGregor, D.G., 2004. Risk as analysis and risk as feelings: Some thoughts about affect, reason, risk, and rationality. *Risk Analysis: An International Journal*, *24*(2), pp.311-322.

Statsdirect.co.uk., 2016. *Unpaired (Two Sample) t Test*. [Online] Available from: https://www.statsdirect.co.uk/help/parametric_methods/utt.htm [Accessed 1 Mar. 2020].

Sullivan, L., 2016. *InterQuartile Range (IQR)*. [Online] Available from: http://sphweb.bumc.bu.edu/otlt/mph-modules/bs/bs704_summarizingdata/bs704_summarizingdata7.html [Accessed 15 Feb. 2020].

Talebian, S.H. and Kareem, S.A., 2010. A lexicographic ordering genetic algorithm for solving multi-objective view selection problem. In *2010 Second International Conference on Computer Research and Development*. IEEE, pp.110-115.

Woiceshyn, J., 2009. Lessons from "good minds": How CEOs use intuition, analysis and guiding principles to make strategic decisions. *Long range planning*, *42*(3), pp.298-319.

Zoé, L., 2016. The impact of the overconfidence bias on financial markets. Strasbourg: Sciences Po Strasbourg, p.112.