

Fabiana Mendes

INSIGHTS FROM
PERSONALITY AND
DECISION-MAKING IN
SOFTWARE ENGINEERING
CONTEXT

UNIVERSITY OF OULU GRADUATE SCHOOL;
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DECISION-MAKING IN SOFTWARE
ENGINEERING CONTEXT**

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Abstract

Context: Software development involves many activities, among which decision-making is an essential one. Various factors can impact a decision-making process, and it is essential to understand them to improve the process. Since people make decisions, some human aspects are amongst such impacting factors. One such aspect is the decision maker's personality.

Objective: This Ph.D. research aims to investigate the relationship between decision-making and personality within the context of software project development.

Method: We conducted a systematic literature review (SLR) and a survey. The SLR searched and analyzed published studies on the relationship between personality and decision-making in the context of companies developing any kind of product or service. In other words, the SLR does not focus solely upon software development companies, but also upon companies in other segments that also provide services and/or products. The survey gathered data about the personalities, decision-making styles, and decision-making self-efficacies of 102 Brazilian software engineers.

Results: The SLR identified 28 distinct personality aspects, 30 decision-making aspects, 75 relationships between the personality and decision-making aspects, two moderators, and two mediator variables of the abovementioned relationship. The survey identified 51 statistically significant correlations between the decision-making and personality variables. It also estimated four regression models to explain from 4.4% to 30.6% in which the independent variables were only the personality ones. Furthermore, one moderator was identified.

Conclusion: The SLR reveals that the relationship between personality and decision-making has been investigated in other fields, especially in the field of management, but not in software engineering. The survey results showed a relationship between personality and decision-making, and the possibility to build models to forecast decision-making using as predictors personality factors. However, the coefficients of determination of prediction models ranged from 4.4% to 30.6%, thus suggesting that other additional factors should also be investigated.

Keywords: decision-making, personality, software engineering, survey, systematic literature review

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Tiivistelmä

Konteksti: Ohjelmistokehitykseen kuuluu monia toimintoja, joista päätöksenteko on aivan olennainen. Monet seikat voivat vaikuttaa päätöksentekoprosessiin, ja on tärkeä ymmärtää niitä, jotta prosessia voidaan parantaa. Koska ihmiset tekevät päätöksiä, jotkut inhimilliset tekijät ovat näitä vaikuttavia tekijöitä. Yksi tärkeä näkökulma on päättäjän persoonallisuus.

Tavoite: Tämän tohtorinväitöskirjatutkimuksen tavoitteena on tutkia päätöksenteon ja persoonallisuuden suhdetta ohjelmistokehityshankkeiden kontekstissa.

Metodi: Suoritimme systemaattisen kirjallisuuskatsauksen ja kartoituksen. Kirjallisuuskatsauksessa haettiin ja analysoitiin julkaistuja tutkimuksia persoonallisuuden ja päätöksenteon suhteesta siinä yhteydessä, kun yhtiöt kehittävät tuotetta tai palvelua. Toisin sanoen systemaattinen kirjallisuuskatsaus ei keskity vain ohjelmistokehitysyrityksiin mutta myös yhtiöihin muissa segmenteissä, jotka myös tarjoavat palveluja ja/tai tuotteita. Kartoitus keräsi dataa 102 brasilialaisen ohjelmoijan persoonallisuudesta, päätöksentekotyylistä ja luottamuksesta omaan päätöksentekoon.

Tulokset: Systemaattinen kirjallisuuskatsaus tunnisti 28 selkeää persoonallisuuspiirrettä, 30 päätöksentekonäkökohtaa, 75 suhdetta persoonallisuuden ja päätöksentekonäkökohtien välillä, kaksi moderaattoria ja kaksi välittäjämuuttujaa yllämainitussa suhteessa. Kartoitus tunnisti 51 tilastollisesti merkittävää korrelaatiota päätöksenteko- ja persoonallisuusmuuttujien välillä. Se arvioi myös neljää regressiomallia, jotka selittivät 4,4–30,6 % itsenäisten muuttujien ollessa vain persoonallisuuteen liittyviä. Lisäksi löydettiin yksi moderaattori.

Päätelmä: Systemaattinen kirjallisuuskatsaus paljastaa, että persoonallisuuden ja päätöksenteon välistä suhdetta on tarkasteltu muilla aloilla, erityisesti johtajuuden alalla, mutta ei ohjelmistokehityksessä. Kartoitus paljasti suhteen persoonallisuuden ja päätöksenteon välillä, sekä mahdollisuuden rakentaa päätöksentekoa ennustavia malleja käyttäen persoonallisuustekijöitä ennustavina muuttujina. Kuitenkin ennustemallien korrelaatiokertoimen arvo vaihteli 4,4–30,6 % välillä, mistä voi päätellä, että muitakin tekijöitä tulee tutkia.

Asiasanat: kartoitus, ohjelmistokehitys, persoonallisuus, päätöksenteko, systemaattinen kirjallisuuskatsaus

Aos meus pais Antônio e Eunice

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Once upon a time, a baby girl was born in a small town in Brazil's countryside. The most important characteristic of this baby's parents: they never limited their kids' dreams.

I am this lucky baby-girl, and I have always dreamed too much! When I was five years old, I dreamed about buying a pickup truck for my father, a nice car for my mother, and a beautiful house for my family. When I was 11 years old, for the first time, I visited a university campus. In my heart, I decided that I would study there one day. Eight years after I was there, in that same place, to start my four years long bachelor course. During this time, I decided that I wanted to work in a University, and when I was 25 years old, I got my first job at a University. I have never stopped dreaming, and later I decided that I wanted my Ph.D. abroad. Here I am, the old-grown-dreaming baby-girl, making true one more dream!

I thank my parents for never limiting my dreams. Antonio and Eunice, you are my strength! And despite the pain related to having a kid living so distant, you have never cut my wings. Instead, you gave me tools to make my wings stronger! You phone called me every single day while I was in Finland just to say that you love me, and you support me. I love you too! As much as my heart can love!

Thank you, my sister, Patrícia, because you promised, and you visited me. You and your (*our*) son, Mateus, gave me the strength I needed to go ahead! And I knew you would go wherever I am just to make me keep going! I love you!

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Thank you, Rameez, for making my days colourful and easier to embrace. Even when everything outside was dark and cold, everything around me was bright and warm because you were near me. Thank you for holding my hand every single day.

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Oulu, April 2021

Fabiana Freitas Mendes

Abbreviations

| | |
|-------|--------------------------------------|
| A | Agreeableness |
| A1 | Trust |
| A2 | Morality |
| A3 | Altruism |
| A4 | Cooperation |
| A5 | Modesty |
| A6 | Sympathy |
| ACE | Affect Control Efficacy |
| AIE | Analytical and Inferential Efficacy |
| B | Coefficient on regressions equations |
| C | Conscientiousness |
| C1 | Self-Efficacy |
| C2 | Orderliness |
| C3 | Dutifulness |
| C4 | Achievement-Striving |
| C5 | Self-Discipline |
| C6 | Cautiousness |
| DMS | Decision-Making Style |
| DMSE | Decision-Making Self-Efficacy |
| E | Extraversion |
| E1 | Friendliness |
| E2 | Gregariousness |
| E3 | Assertiveness |
| E4 | Activity Level |
| E5 | Excitement-Seeking |
| E6 | Cheerfulness |
| EC | Exclusion Criterion |
| EdL | Educational Level |
| Exp | Experience |
| IC | Inclusion Criterion |
| MAR | Mean Absolute Residual |
| MLR | Multiple Linear Regression |
| MdMRE | Median Magnitude of Relative Error |
| MMRE | Mean Magnitude of Relative Error |
| Mod | Moderator |

| | |
|----------|--|
| N | Neuroticism |
| N1 | Anxiety |
| N2 | Anger |
| N3 | Depression |
| N4 | Self-Conscientiousness |
| N5 | Immoderation |
| N6 | Vulnerability |
| O | Openness |
| O1 | Imagination |
| O2 | Artistic Interests |
| O3 | Emotionality |
| O4 | Adventurousness |
| O5 | Intellect |
| O6 | Liberalism |
| Pred(25) | Percentages of the estimate under 25% of the error |
| RQ | Research Question |
| SE | Standard Error |
| SLR | Systematic Literature Review |
| SIE | Social Influence Efficacy |
| TCE | Thought Control Efficacy |
| VIF | Variance Inflation Factor |

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1 Introduction

Software development can be conceived of as a set of decisions (Burge, Carroll, McCall, & Mistrík, 2008), because many decisions are made during its planning and implementation stages – for example, which requirement to develop first, which programming language to write the software in, and what level of documentation to incorporate into the source code.

According to Charette (2005), poor decisions can be the most significant reason for an unsuccessful software project. For example, a requirements engineer's wrong decision about the inclusion of a requirement can lead to an incomplete software requirements list and, consequently, deliver the wrong software to the client (Albayrak, Kurtoglu, & Biçakçı, 2009). A suboptimal decision on software architecture can impact the software quality (Power & Wirfs-Brock, 2019). The choice of old technology can lead to software with a short life span (Coelho & Valente, 2017). Therefore, understanding which factors relate to decision-making in software development is an important step towards mitigating project failure.

According to Fitzgerald (2002, pp. 3–5), there are many reasons for making a poor decision, including time pressure, poor communication, and an incorrect approach. Another important issue related to decision-making success is the amount of stakeholder participation in the process (Vroom & Jago, 1974). As people make decisions, many individual factors can influence the decision — such as the stakeholders' personalities (Abatecola, Mandarelli, & Poggesi, 2013).

However, despite the clear relevance that decision-makers' personalities have upon the decisions they make and the process used, we could not identify any software engineering study investigating such a relationship (F. Mendes, Mendes, & Salleh, 2019); therefore, this Ph.D. thesis contributes towards such a gap. We investigate the relationship between personality and decision-making in the software engineering context.

The **main research question** of this investigation is: **What is the relationship between personality and decision-making?** We answered this question by considering two perspectives, each linked to one of the two research phases employed herein – discovery and investigation, detailed below.

During the *discovery phase*, a systematic literature review was conducted to understand and synthesize the state-of-the-art information on the relationship between decision-making and personality, without restriction to any particular field of science.

On the other hand, the investigation phase employed survey research to collect data on the above-mentioned relationship, considering the software engineering context and two aspects of decision-making: style and efficacy. Table 1 summarizes the research questions for each phase. The details are presented in Chapter 2.

Table 1. Research phases, methods, questions, and objectives (detailed in Chapter 2).

| Research Phase and Method | Research Questions | Objectives |
|---|---|---|
| Discovery – <i>Systematic literature review</i> | RQ-SLR1 What is the relationship between decision-making and personality? | Identify the personality and decision-making aspects that have been investigated, including possible associations between them, in addition to other possible influencing variables. |
| Investigation – <i>Survey research</i> | RQ-SRV1 What is the relationship between decision-making style and personality? | Investigate whether decision-making and personality variables (factors and facets) are related. If so, quantify the strength of their relationships. See if personality factors can explain the variation in decision-making variables. If so, quantify the percentage of explained variation and the accuracy of the prediction. Finally, check whether any demographic variable moderates the relationship between decision-making and personality. |
| | RQ-SRV2 What is the relationship between decision-making self-efficacy and personality? | |

The work presented in this thesis is multidisciplinary, spanning fields such as psychology, management, and software engineering. Therefore, the next sections aim to provide readers with an overview of important concepts used throughout the thesis.

1.1 Decision-making

A decision represents a choice made out of some alternatives, and it implies – in many cases – a commitment of resources (Boddy, 2007, p. 208; Williams, 2016, p. 99). Another way to define a decision is to characterize it as the product of a decision-making process (Fulop & Linstead, 1999, pp. 299–300). Like any other process, it has an input, an output, and procedures, as illustrated in Fig. 1.

As shown in Fig. 1, the **input** to a decision-making process is the problem or situation for which a decision is needed. It has some characteristics that help to define the procedures to be executed. Some examples of input characteristics are the organizational level (e.g., strategic or operational), the nature of the problem (structured or unstructured), and the nature of the decision (programmed or non-

programmed; (Koontz & Wehrich, 2012, pp. 143–144). The **output** of a decision-making process is the decision itself.

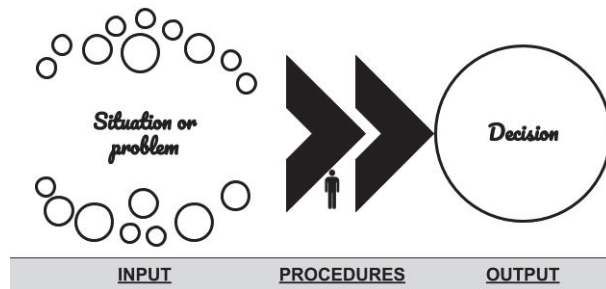


Fig. 1. Decision-making process elements.

The decision-making **procedures** are the necessary steps in making a decision, usually executed by people. An example of procedures is defined by the rational model, which states that the decision is made following five main steps: (1) identify the problem, (2) generate potential solutions, (3) choose a solution among the available alternatives, (4) implement the solution, and (5) evaluate the effectiveness of the implemented solution (Fitzgerald, 2002, pp. 12–16). It is important to measure the process and its elements to ensure the decision-making process' quality.

Decision quality is an important issue in software engineering. A poor decision can lead to many problems; for example, a manager's poor decision can lead to a software project's failure (Charette, 2005). A suboptimal decision on software architecture can impact the software quality (Power & Wirfs-Brock, 2019). The choice of old technology can lead to software with a short life span (Coelho & Valente, 2017).

Myburgh et al. (2015) developed an instrument to measure decision-making self-efficacy. According to the authors, self-efficacy is associated with the decision-maker's ability to control a decision process and their thoughts during the process, infer and analyze decision-making-related data, evaluate alternatives, gather information from many sources, and persuade people about the decision.

The instrument developed by Myburgh et al. (2015) defines four decision-making self-efficacy domains. For each domain, a score from 0 to 100 is computed. The higher the number, the higher an individual's performance in the domain. Table 2 presents the four domains and a brief description of each one.

Table 2. Decision-making self-efficacy and its four domains (Myburgh et al., 2015).

| Domain | Description |
|---|--|
| Affect control efficacy (ACE) | This involves the self-regulation of affective states, for example, by influencing the decisions or by controlling the attention level even under time pressure. |
| Analytical and inferential efficacy (AIE) | This refers to the decision-maker's ability to search for relevant information and use it to find and evaluate the best alternative to the problem. |
| Social influence efficacy (SIE) | This relates to using social skills to gather relevant information or solve a political problem encompassing various interests related to the decision. |
| Thought control efficacy (TCE) | This involves the ability to control intrusive or negative thoughts that can interfere with or divert attention away from the decision-making process. |

The instrument created by Myburgh et al. (2015) focuses on the **decision-makers' abilities**, the ones responsible for executing the process.

Concerning the decision-making process, Malavolta et al. (2014) investigate software architecture-related decisions and state that group decision-making is the best choice, i.e., the more people participating in the process, the better it is. Many other authors highlight the importance of collaborative decision-making in producing accurate and complete architecture-related decisions (Capilla, Zimmermann, Carrillo, & Astudillo, 2020; Gaubatz, Lytra, & Zdun, 2015).

However, Vroom and Yetton (1973) have another perspective; according to them, the amount of stakeholders' participation in decision-making depends on the problem's attributes. In this context, a problem is a situation that needs a decision, and a problem attribute is a characteristic that influences the decision's effectiveness.

These same authors proposed a model that focuses on measuring the **decision-making process** (Vroom & Yetton, 1973). The model has two perspectives: normative and descriptive. The **normative model** helps an organization improve its decision-making process using a questionnaire that assesses the problem's attributes and suggests an optimal process. The problem attributes are presented following (Vroom & Yetton, 1973, p. 31):

1. If the decision were accepted, would it make a difference which course of action was adopted?
2. Do I have sufficient information to make high-quality decisions?
3. Do subordinates have sufficient additional information to result in a high-quality decision?
4. Do I know exactly the information is needed, who possesses it, and how to collect it?

5. Is the acceptance of the decision by subordinates critical to effective implementation?
6. If I decide myself, is it certain that my subordinates would accepted it?
7. Can subordinates be trusted to base solutions on organizational considerations?
8. Is conflict among subordinates likely in preferred solutions?

The **descriptive model** characterizes the decision-making process, taking into consideration the level of participation of others in the process (in other words, the **decision-making style**). It is composed of 30 problems, with a scale to compute the participation level that the respondent would adopt for each problem (Vroom & Jago, 1988). Fig. 2 illustrates the decision-making process defined by the authors.

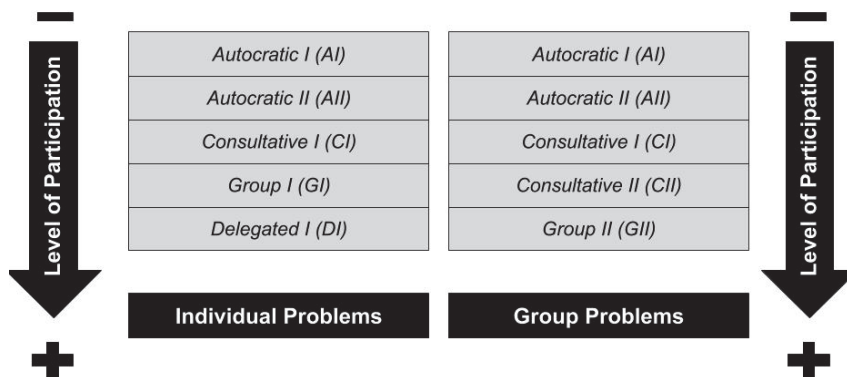


Fig. 2. Decision-making process (Vroom & Yetton, 1973).

Fig. 2 shows that the problems are classified according to their applicability. If a problem affects only one person, it is an individual problem, but if it affects more than one person, it is a group problem. The investigation presented herein focuses on **group problems** because we understand that decisions made in the context of software development projects usually affect more than one person.

The authors also define five distinct processes in each category (individual or group). Their characteristics vary according to how much the decision-maker allows others to participate in the decision-making process, referred to in this investigation as **decision-making style**. Table 3 presents a description of each decision-making process shown in Fig. 2.

Table 3. Description of the decision-making processes (Vroom & Jago, 1988, p. 29).

| ID | DM Process | Decision Process Description |
|-----|-----------------|--|
| AI | Autocratic I | The decision-maker solves the problem using the information available at the present time. |
| AII | Autocratic II | The decision-maker obtains any necessary information from the subordinates and then decide on the solution. The decision-maker may or may not tell the subordinates the purpose of the questions or give information about the problem or decision under analysis. The input provided by them is clearly in response to a request for specific information. They do not play a role in the definition of the problem or in generating or evaluating alternative solutions. |
| CI | Consultative I | The decision-maker shares the problem individually with the relevant subordinates, getting their ideas and suggestions without bringing them together as a group. The decision is then made, and it may or may not reflect the subordinates' influence. |
| CII | Consultative II | The decision-maker shares the problem with the subordinates in a group meeting. The meeting is used to obtain their ideas and suggestions. The decision may or may not reflect the subordinates' influence. |
| GI | Group I | The decision-maker shares the problem with the subordinates. They analyze the problem together and arrive at an agreeable solution. |
| GII | Group II | The decision-maker shares the problem with the subordinates as a group. Together, they generate and evaluate alternatives and attempt to reach an agreement (consensus) on a solution. The decision-maker's role is much like that of a chairman: coordinating the discussion, keeping it focused on the problem, and making sure that critical issues are discussed. The decision-maker provides the group members with information or ideas but does not try to press them to adopt any specific solution. The decision made is support by the entire group. |
| DI | Delegated I | The decision-maker delegates the problem to a subordinate, providing any important information, and giving him/her the responsibility to solve the problem. The decision-maker may or may not request the subordinate to reveal how the solution that was reached. |

The output of the assessment presented in the descriptive model is a score that can vary from 0 to 300. Higher scores imply a more participative decision-making style, and lower scores a more autocratic style (Vroom & Jago, 1974).

Many studies in software engineering studies investigate different aspects of decision-making. The systematic literature review by Cunha et al. (2016) aimed to investigate how software project managers make their decisions. The review identified 27 studies comprising eight main topics, as shown in Table 4.

The topic with the highest number of studies is *agile development practices*. The studies under this topic discuss the challenges of shared decision-making on agile teams (Moe, Aurum, & Dybå, 2012), map agile practices to the decision-

making process (Drury-Grogan & O’duyer, 2013), discuss empowerment and group consensus in agile teams, and explore the negative impact of agile practices on decision-making (Coyle, Conboy, & Acton, 2013; McAvoy & Butler, 2009).

Table 4. Topics discussed in the selected studies of Cunha et al. (2016) ‘s systematic review.

| Topic | Number of Studies |
|---|-------------------|
| Agile development practices | 9 |
| Participatory decision-making | 4 |
| Escalation and de-escalation commitment factors | 4 |
| Stakeholders’ involvement | 3 |
| Cognitive bias | 3 |
| Use of rational methods | 2 |
| Communication | 1 |
| Emotions | 1 |

Involvement, communication, and participatory decision-making are related to others’ level of involvement in the decision-making process; a similar concept is discussed in Vroom and Jago (1988). Medina and Francis (2015) highlight that a good project manager should involve people in the decision, and Rose et al. (2007) state the importance of having the entire team engaged in the decision-making.

Colomo-Palacios et al. (2013) is one of the studies included in Cunha et al.’s (2016) literature review, and it discusses the impact of emotions in IT organizations’ hard decisions. Emotions are related to neuroticism’s personality factor, but the paper does not discuss them from this perspective.

Another literature review conducted in the software engineering context is the one by Jia et al. (2016), aimed at identifying the environmental factors that impact individual decision-making. The authors identified 40 papers, from which they extracted 237 factors. They aggregated these factors and proposed a taxonomy of environmental factors affecting individual decision-making in software projects, as shown in Table 5.

Some factors and subfactors presented in Table 5 are also found in Cunha et al.’s (2016) literature review – e.g., participation, commitment, and communication (feedback). This confirms the importance of these factors in software project decision-making.

Many studies have been conducted in software engineering that investigates decision-making, as shown in the number of studies included by Cunha et al.’s (2016) and Jia et al.’s (2016) literature reviews. However, it is important to mention

the studies in the software engineering field investigated in this research and explore the relationship between decision-making and personality (F. Mendes et al., 2019).

Table 5. Jia et al.'s (2016) taxonomy of environmental factors affecting individual decision-making behaviors in software projects.

| Category | Subcategories |
|---------------------------------|--|
| Challenging work | Work characteristics, participation, benefits, promotions, work practices |
| Goal | Goal attributes, soft goals, goal conditions, personal relation goals, products |
| Appropriate physical conditions | Physical conditions, soft conditions, challenges, risks |
| Company support | Career support, company success, implicit support factors, company support, customer support |
| Characteristics of the task | Task characteristics, project managers, projects, soft factors related to the tasks |
| Distributed teams | Team staff, team spirit, team resources, team ability |
| Feedback from the job | Direct feedback, feedback factors, job feedback |
| Organization | Organization attributes, rewards, time and stress, organizational practices |
| Technical competence | Competence, factors influencing technical competence, software quality, user relationships |
| Development | Technology development, soft development |
| Peer commitment | Peer support, others' commitment |

The next section presents an overview of the important concepts related to personality used throughout this thesis.

1.2 Personality

The word "personality" originates from the *Latin* word *persona*, which implies the "outward appearance or the face we display to people around us" (Schultz & Schultz, 2016, p. 7).

Personality is commonly used to describe how someone is; for example, you can say that someone has a *good personality*, meaning that you like that person. Conversely, saying that someone has *no personality* means that you think that person is boring (Cervone & Pervin, 2012, pp. 7–8). There is, however, a distinction between how the general population uses the term and how psychologists use it.

Usually, the general population employs the term personality to describe a specific person's behavior; however, psychologists use it to describe *what everyone's personality consists of* (Carver & Scheier, 2012, p. 2).

Bergner (2020) discusses many definitions of personality and proposes one that matches the meaning we employ within this thesis's context very closely. According to Bergner, **individual personality** is regarded as a set of *enduring characteristics* (traits and styles) that someone exhibits, representing his/her **uniqueness**. These characteristics are influenced by one's *disposition*. *Endurance* relates to the recurring nature of the characteristics *across time*; and *disposition* represents a person's tendency to exhibit such characteristics *across different situations*, usually explained by his/her internal process.

As Burger (2010, p. 12) states, the way that theorists study personality begins with a personality theory, which is converted into a model. This study approach is usually used across various types of applications (such as psychotherapy, education, and behavior), and it is generally composed of a way to measure the personality-construct model.

There are six main approaches to the study of personality: biological, cognitive, humanistic, learning, psychodynamic, and trait (Corr & Matthews, 2009, p. 4). Table 6 summarizes the main concepts and contributors (theorists) in each approach.

There are many different ways to measure personality, and all of them have the same goal: to identify similarities and differences between people (Weiner & Greene, 2008, p. 19). However, what motivates such assessment can vary depending upon the context. For example, in healthcare, personality assessment can help choose a patient's treatment; in organizations, it can help select the most suitable candidate for a role (Weiner & Greene, 2008, pp. 19–20).

Levy (2007) categorizes personality tests, which are used to assess one's personality. They consider the following: (1) *how data is obtained* (self-reported and projective methods) and (2) the *type of information* collected (psychopathological and non-pathological personality assessment).

For **self-reported** methods, the assessed person is asked about his/her behaviors, attitudes, and/or beliefs. On the other hand, **projective** techniques consist of presenting ambiguous stimuli (e.g., pictures) and ask the subject to interpret the stimuli (Levy, 2007). In both cases, the answers are used to characterize an individual's personality.

Psychopathological tests are employed in a clinical context and aim to identify psychological symptoms for diagnostic purposes. Finally, **non-pathological** tests

are those that **do not** intend to identify something "*wrong*" or "*abnormal*" (Levy, 2007).

The research detailed herein utilizes the **trait approach** using a **self-reported** technique, with **non-pathological** tests to assess one's personality traits.

Table 6. Personality approaches and their main concepts and contributors (Corr & Matthews, 2009, p. 4).

| Approach | Major concepts | Contributors |
|---------------|---|--|
| Biological | temperament, evolution, adaptation, altruism, sexual jealousy, heredity, neurotransmitter pathways, cerebral hemisphere function | D. Buss, Eysenck, J. A. Gray, C. R. Cloninger, Kagan |
| Cognitive | expectancy, self-efficacy, outcome expectation, schema, cognitive person variable, personal construct, reciprocal determinism, modeling, constructive alternativism, life narrative | Bandura, Kelly, Beck |
| Humanistic | self-actualization, creativity, flow, spirituality, personal responsibility, freedom, choice, openness to experience, unconditional positive regard, acceptance, empathy, the real self, hierarchy of needs, peak experience, positive psychology | Maslow, Rogers, Seligman, Csikszentmihalyi |
| Learning | reinforcement, punishment, stimulus, response, conditioning, extinction, shaping, discrimination learning, generalization, situation, act frequency, basic behavioral repertoire, labeling, gradients of approach, and avoidance | Skinner, Staats, Dollard, and Miller |
| Psychodynamic | libido, conflict, id, ego, superego, defense mechanisms, Oedipal conflict, fixation, repression, attachment, object relations | Freud, Jung, Adler, Erikson, Horney, Klein, Sullivan, Chodorow |
| Trait | trait, type, facet, factors | Allport, Cattell, McCrae, and Costa |

In the trait approach, human personality is represented as a set of characteristics (traits) that explain individual differences. According to Burger (2010, pp. 150–151), such an approach is built upon two assumptions: stability and consistency. Stability means that personality characteristics are the same over a certain period, whereas consistency means that personality characteristics remain unchanged across different situations.

The five-factor model (FFM) integrates all personality traits into five main dimensions (or traits): neuroticism, extraversion, openness, agreeableness, and conscientiousness.

Extraversion and agreeableness are factors related to one's interpersonal abilities (Cervone & Pervin, 2012, p. 264). Extraversion focuses on sociability, while agreeableness focuses on the tendency to be cooperative and compassionate toward others (Calefato, Iaffaldano, Lanubile, & Vasilescu, 2018). Conscientiousness relates to how controlled and disciplined someone is (Burger, 2010, p. 162). Neuroticism is also called emotional stability, and it expresses how someone deals with his/her own emotions (Calefato et al., 2018). Finally, openness is associated with creativity and how someone experiences life (Cervone & Pervin, 2012, p. 264). Table 7 shows the five factors and some adjectives for each one.

There are many scales associated with the five-factor model. Some examples include the California Personality Inventory (CPI), the Personality Assessment Inventory, the 16 personality factors (Butcher, 2009, p. 306), and various versions of the NEO Personality Inventory (Weiner & Greene, 2008, pp. 315–318).

Table 7. The five personality factors (Schultz & Schultz, 2016, p. 229).

| Factor | Adjectives |
|-------------------|---|
| Agreeableness | Good-natured, soft-hearted, trusting, courteous |
| Conscientiousness | Careful, reliable, hardworking, organized |
| Extraversion | Sociable, talkative, fun-loving, affectionate |
| Neuroticism | Worried, insecure, nervous, high-strung |
| Openness | Original, independent, creative, daring |

The IPIP-NEO-120 is a questionnaire created by Johnson (2014) and derived from the NEO Personality Inventory set of items. It focuses on the five factors and defines six facets for each factor, as shown in Fig. 3.

The personality facets aim to detail the characteristics related to each factor, thereby providing much more detailed information about individual differences. The next section presents some studies in the software engineering field that investigate decision-making.

Although the scientific study of personality started in 1852 (Hogan, Johnson, & Briggs, 1997, p. 5), the first publication in the software engineering field about personality only appeared in 1972 (Cruz, da Silva, & Capretz, 2015). The mapping study conducted by Cruz et al. (2015) identified 90 studies from 1972 to 2010. Table 8 shows the topics in which the included studies were classified.

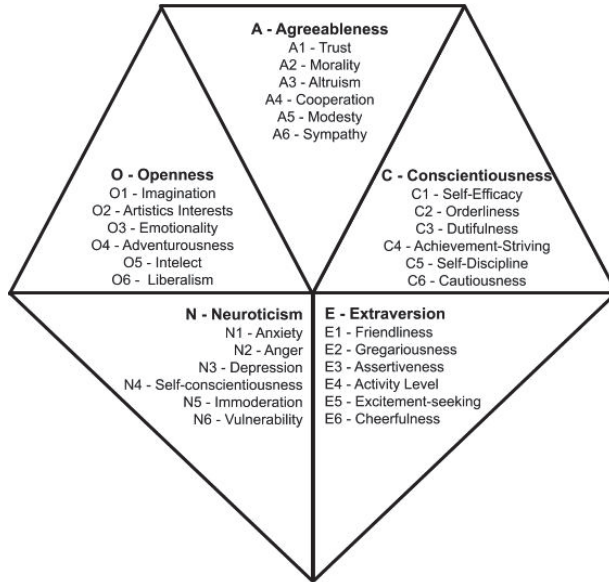


Fig. 3. Personality factors and their facets.

Table 8. Topics discussed in Cruz et al.'s (2015) systematic review.

| Topic | Number of Studies | Main Goal of Included Studies |
|--|-------------------|--|
| Pair programming | 15 | Investigate the influence of personality in the agile practice of "pair programming". |
| Education | 13 | Understand how teaching practices and styles can be adapted to the student's personality. |
| Team effectiveness | 12 | Verify how team effectiveness can be affected by the team's personality composition. |
| Software process allocation | 10 | Investigate if people with a particular personality profile can better perform some tasks. |
| Software-engineering personality characteristics | 10 | Understand the personality profile distribution among software engineers. |
| Individual performance | 9 | Investigate which personality traits or types are ideal for the different software engineering-related tasks. |
| Team process | 6 | Examine the impact of personality on variables such as conflict resolution, communication, and other group behavior variables. |
| Behavior and preferences | 4 | Investigate how personality can influence the attitudes and preferences of software engineers. |
| Leadership performance | 3 | Verify how personality affects leadership in software engineering. |

As Table 8 indicates, software engineering research's main interest is the impact of personality on the software development team (pair programming, team effectiveness, and software process allocation) and on education. Despite the large number of included studies and the diversity of topics, none of them discuss the relationship between personality and decision-making.

Cruz et al. (2015) also include the most used personality models in software engineering. Most of the studies employ the MBTI (Myers-Briggs Type Indicator) to assess personality (48%; 36 studies), followed by FFM (19%; 14 studies) and KTS (Kersey Temperament Sorter, 9%; seven studies). This finding is similar to that presented in Barroso et al.'s (2017) literature review, which notes that MBTI and FFM are the most popular personality assessment instruments used in software-engineering studies.

Barroso et al.'s (2017) literature review investigates the influence of human personality on software engineering professionals and includes 21 studies published from 2003 to 2016. The literature review defines two research questions. The first one was presented in the previous paragraph, and it aims to investigate the personality models employed in software engineering research.

The second research question sought evidence as to whether personality influences the *"activities performed by software engineering professionals"*. The authors found evidence of personality influence in some activities, such as software tests (Shoaib, Nadeem, & Akbar, 2009). Some of the included papers bring a characterization of personality types for software engineers (Feldt, Torkar, Angelis, & Samuelsson, 2008; Hannay, Arisholm, Engvik, & Sjoberg, 2010). However, none of the included studies in this literature review discusses the relationship between personality and decision-making.

1.3 Thesis structure

This thesis is organized into eight chapters. Following this introduction, Chapter 2 details the research design adopted in this investigation, including the SLR and survey research details. Chapter 3 presents the results related to the SLR. The next four chapters discuss aspects related to the survey research. Chapter 4 presents an overview of the collected data; Chapter 5 presents the data-analysis approach employed to produce the results presented in Chapters 6 and 7. Finally, Chapters 8 and 9 present a discussion of the results, the research limitations and contributions, and the future work.

2 Research methodology

As presented in the previous chapter, this research investigates **the relationship between personality and decision-making within a software engineering context**. This chapter presents the research methodology employed in order to answer the main research question.

In this context, a research classification is useful for understanding the decisions related to the methodology. Wohlin and Aurum (2015) discuss eight decision points in research design that help in the choice of research strategy. Table 9 presents the decision points they mention and the choices made in this research, along with some reasons that justify the choices.

Table 9 summarizes some of the main characteristics of this research. The next sections detail some aspects of it: Section 2.1 presents an overview of the research phases, and the following sections (2.2 and 2.3) detail the core phases of the research. Finally, Section 2.4 presents a summary of this chapter.

2.1 Research phases

The research reported in this document was carried out through two core and two supporting phases. The supporting phases consisted of preparation and synthesis, and the core phases were composed of discovery and investigation. Table 9.Fig. 4 illustrates the four phases, along with some of their main characteristics.

The **planning phase** developed a research plan containing a preliminary study of the research subject, goals, main phases, schedule, and outputs. The plan was adapted and then published at the Doctoral Symposium of International Conference on Software Engineering (F. Mendes, 2018).

For the **discovery phase**, an SLR was carried out. It aimed to identify, analyze, and synthesize the published studies on the relationship between decision-making and personality. This phase's result was documented in a journal article (F. Mendes et al., 2019).

The **investigation phase** consisted of survey research, which aimed to collect data about decision-making and personality in the software engineering context. The result of this survey was converted into a paper that focus on the relationship between decision-making style and personality (F. Mendes, Mendes, Salleh, & Oivo, 2021). Another paper will also be written focusing on the relationship between decision-making self-efficacy and personality. Finally, the **synthesis phase** aggregated all the research results into a single document: this Ph.D. thesis.

Table 9. Decision points and the choices in this research (Wohlin & Aurum, 2015).

| Decision Points | The choice for this research | Reasons for the choice |
|--------------------------|---|--|
| Research outcome | Basic research | According to Wohlin and Aurum (2015), basic research tries to understand a problem and <i>not to provide a solution to it</i> . This research aims to understand the relationship between personality and decision-making. Although the results can be used to create a solution to problems, this investigation does not explore any solution to any specific software engineering problem. |
| Research logic | Inductive research | In this research, the theoretical concepts and patterns were inferred from observed data. |
| Research purpose | Exploratory | The literature review conducted in the context of this investigation revealed a lack of information about the relationship between decision-making and personality. Thus, exploratory research was employed to explore the abovementioned relationship in the software engineering context. |
| Research approach | Positivist | Positivism believes that the <i>social world is made of facts that can be studied using a scientific approach</i> . Usually, researchers that employ this approach measure the world using quantifiable measures, analyze the data quantitatively, and infer conclusions based on the quantitative data (Wohlin & Aurum, 2015). The research presented in this document did precisely this: measured a social aspect of the world (decision-making and personality) quantitatively and employed statistical techniques to make inferences. |
| Research process | Quantitative | The data collected aimed to characterize the relationship between personality and decision-making using quantitative data. |
| Research methodology | Systematic literature review (SLR) and survey | An SLR was employed to gather data from published studies on the subject of this research. A survey methodology was used to collect data in the software engineering context. |
| Research data collection | Electronic databases and questionnaire | The SLR used electronic databases with snowballing to collect data, and the survey used an instrument composed of four questionnaires. |
| Data analysis methods | Statistical analysis | The SLR data analysis employed some basic statistical techniques, and the survey analysis some more sophisticated ones (see Chapter 5 for more details). |

Observe that Fig. 4 shows that the phases are sequential. Indeed, the knowledge that the Ph.D. candidate gathered during a phase was somehow important in the next phases. For example, the decision-making style questionnaire employed to collect data during the investigation phase was among the discovery phase' findings.

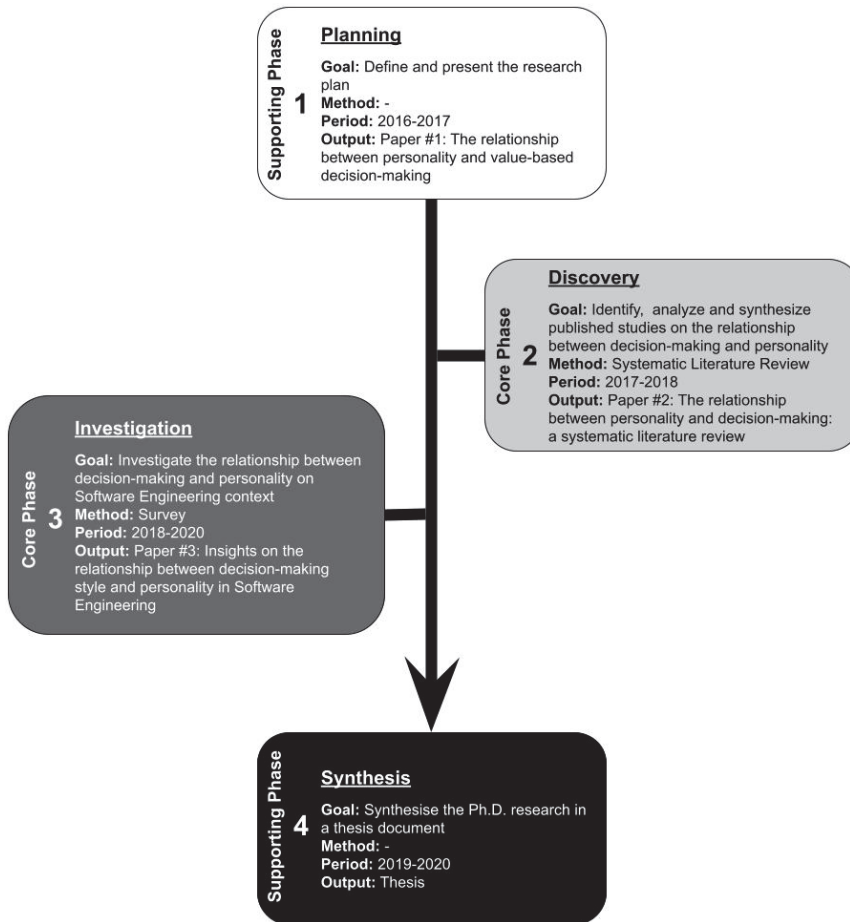


Fig. 4. Research phases with the goal, method, execution period, and output.

The next sections detail how the core phases were conducted – in other words, how the discovery (Section 2.2) and investigation (Section 2.3) phases were executed.

2.2 Discovery phase: The systematic literature review protocol

The main goal of the discovery phase is to understand similar research that has been previously produced. A literature review is a suitable choice for this purpose. However, there are many different ways to conduct a literature review – such as meta-analysis, mapping studies, and systematic reviews (Kitchenham, Budgen, & Brereton, 2015, pp. 31–32).

The choice of a systematic approach was based on its three characteristics: clarity, validity, and auditability (Booth, Sutton, & Papaioannou, 2016). **Clarity** is related to the structure defined that helps in the communication of the results. When developing a protocol, the researcher has some potential bias in mind, and from this concern emerges a literature review potentially **valid**. Finally, **auditability** comes into play, because everything is defined in a protocol; therefore, it is possible to verify what has been done (Booth et al., 2016, p. 19).

This section details the protocol developed to conduct the SLR that is part of this research. Section 2.2.1 shows the overall process, and the subsequent sections describe each essential part of the process. It is important to highlight that a version of the protocol has already been published in a journal (F. Mendes et al., 2019).

2.2.1 Systematic literature review process

The phases and activities executed in the SLR were based on Kitchenham et al. (2015). The process has three phases, as illustrated in in Fig. 5.

In the **planning phase**, the need for a new SLR was established, and the protocol was defined. During the **executing phase**, the activities specified in the protocol were executed. Finally, the **reporting phase** relates to the reporting and evaluation of the SLR process.

Fig. 5 shows, in the executing phase, activities related to the study selection and data extraction. These were carried out by the Ph.D. student and validated by the main and one of the co-supervisors. The validation activities are marked in Fig. 5 in dark grey and detailed in Fig. 6.

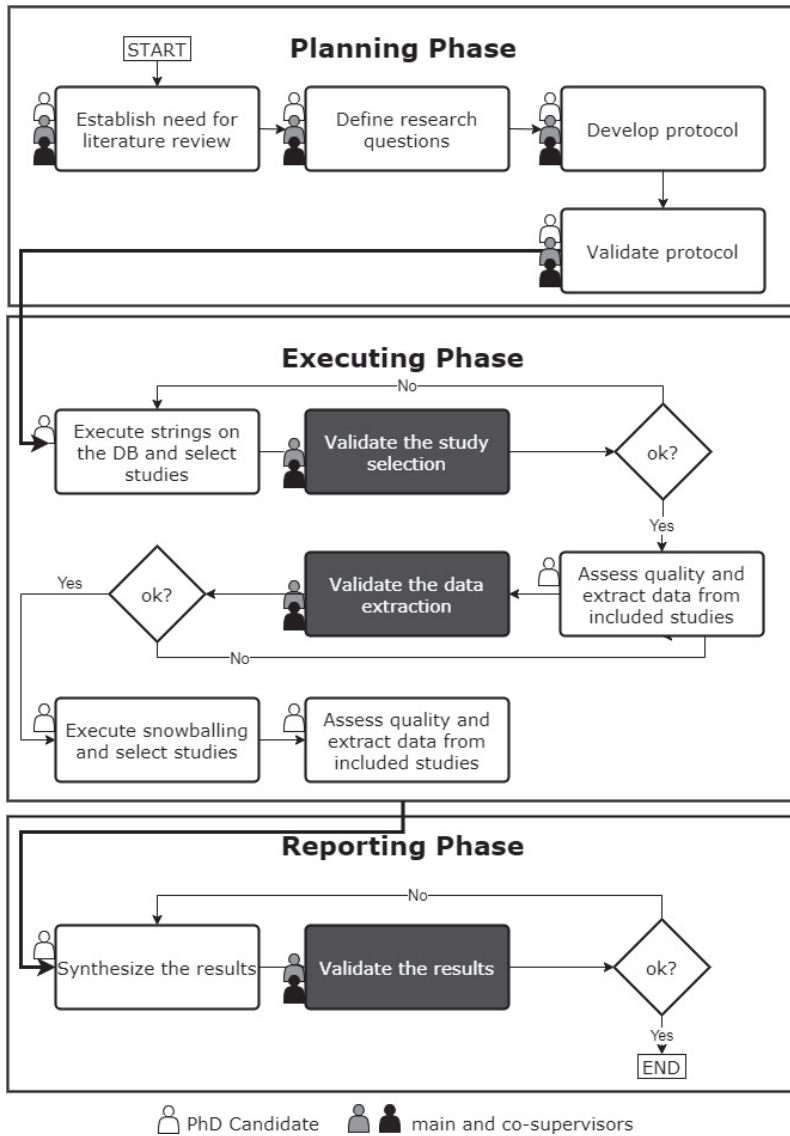


Fig. 5. The SLR process.

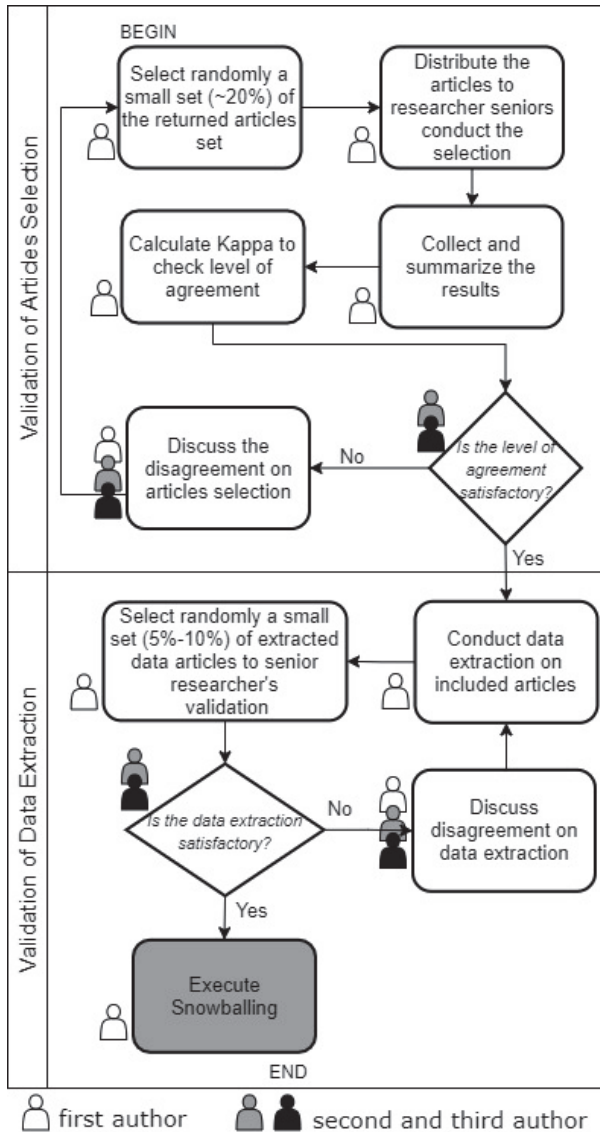


Fig. 6. Detailed validation activities.

As observed in Fig. 6, the validation activities were executed by a team of three: the Ph.D. student, the main supervisor (Dr. Emilia Mendes), and one of the co-supervisors (Dr. Norsaremah Salleh).

The **validation of the study selection** employed Kappa calculation as described by Kitchenham et al. (2015). Two iterations were necessary to reach the final criterium of a Kappa number greater than 0.40. During the first iteration, the team analyzed 76 randomly selected studies. This number represents 20% of the total number of studies retrieved from electronic databases. The Ph.D. candidate analyzed all 76 studies, and each supervisor received 38 studies. They proceeded with the study selection independently, and their results were compared. Table 10 shows the numbers from the first iteration.

Table 10. Studies selection – First iteration.

| | | Main and co-supervisors | | | Total |
|-----------------|----------|-------------------------|-------|----------|-------|
| | | Excluded | Doubt | Included | |
| Ph.D. Candidate | Excluded | 52 | 10 | 4 | 66 |
| | Doubt | 0 | 0 | 0 | 0 |
| | Included | 5 | 4 | 1 | 10 |
| Total | | 57 | 14 | 5 | 76 |

The Kappa number calculated for this first iteration is 0.1099, which indicates a *"poor level of agreement"* (Kitchenham et al., 2015). During a meeting, the disagreements were discussed, and another iteration was planned.

During the second iteration, another 54 studies were randomly selected and distributed to the team. They analyzed the studies independently, and the results were compared. The Ph.D. candidate analyzed all the studies, and each supervisor analyzed 27 studies. Table 11 shows the outcome of the second iteration.

Table 11. Studies selection – Second iteration.

| | | Main and Co-supervisors | | | Total |
|-----------------|----------|-------------------------|-------|----------|-------|
| | | Excluded | Doubt | Included | |
| Ph.D. Candidate | Excluded | 42 | 2 | 2 | 46 |
| | Doubt | 2 | 3 | 0 | 5 |
| | Included | 1 | 0 | 2 | 3 |
| Total | | 45 | 5 | 5 | 54 |

In this second iteration, the Kappa number is 0.5327, which signals a *"moderate level of agreement."* The team considered the number satisfactory, and the next SLR activities were executed.

During **data extraction validation**, the Ph.D. candidate extracted data from the studies included (26% of the total number). The studies and extracted data were

distributed to the supervisors. They judged the extraction as adequate, and the Ph.D. candidate proceeded to execute the next SLR activities.

2.2.2 Study of the viability to update a systematic literature review

Mendes et al. (2019) stressed the high number of SLRs produced by the software-engineering community and the importance of updating existing SLRs instead of producing new ones. The authors conducted a study comparing some methods for updating SLRs and recommended a procedure for the update.

According to Mendes et al. (2019), once the target SLR to be updated is selected, the first step is to use a seed containing the original SLR and its primary studies to execute forward snowballing. Google Scholar can be used to support the snowballing procedure. Furthermore, more than one researcher must perform the initial screening, and only one forward-snowballing iteration is necessary.

In line with recent recommendations by Mendes et al. (2019), before starting to develop the SLR protocol for this thesis, the possibility of updating an existing mapping study was checked. We used the mapping study carried out by Cruz et al. (2015) to search for studies similar to this Ph.D. research.

Although Cruz et al.'s (2015) research questions are different from those investigated in this Ph.D. research, their literature review aims to take an overall picture of software engineering studies that investigate personality. Therefore, any study investigating the relationship between personality and decision in software engineering would be, most probably, among the papers included by Cruz et al.'s (2015) literature review.

Fig. 7 illustrates the strategy employed to verify the studies included in Cruz et al.'s (2015) literature review. The strategy was divided into three phases: selection, inconsistency checking, and decision. During the **selection phase**, the 90 papers included in Cruz et al. (2015) were analyzed by the Ph.D. student and two supervisors (Emilia Mendes and Norsaremah Salleh). The student analyzed all 90 studies, and each supervisor analyzed 45 studies.

During the analysis, each participant read the title and abstract of a study and then decided whether it should be included ("accepted"), excluded ("rejected"), or further examined ("doubt"). Therefore, a particular study could be assigned with two different labels, generating an inconsistency, which was checked in the next phase.

The "accepted" label was used when, according to the researcher, the paper could be included in the planned SLR; "rejected" was applied when the study could not be included; and "doubt" indicated that the researcher was not sure.

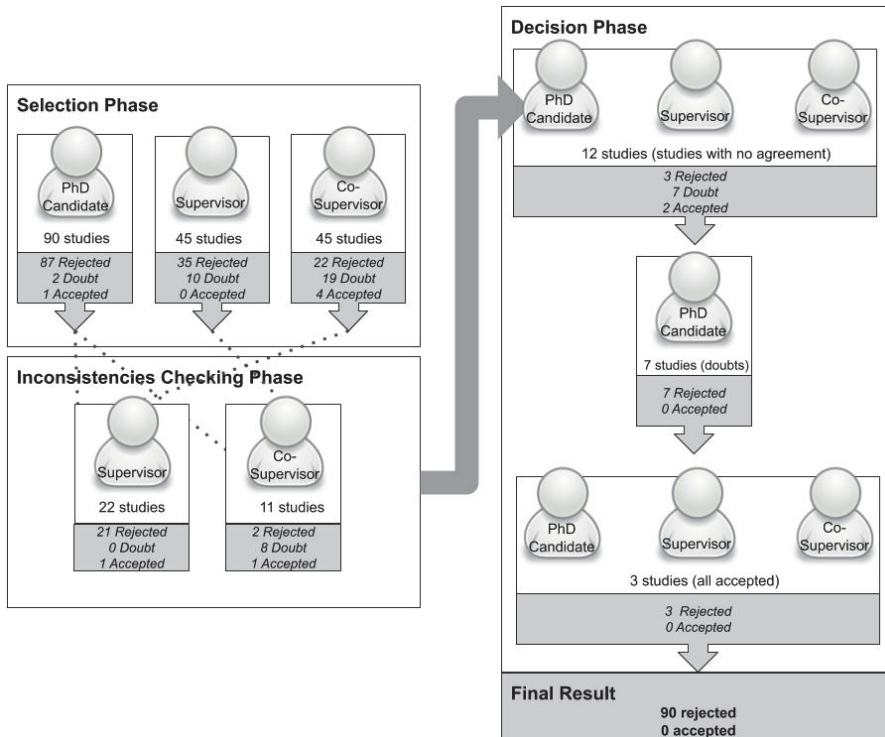


Fig. 7. Strategy for checking the seeds.

During the **inconsistency checking phase**, the main supervisor analyzed the disagreements between the student and the second supervisor (co-supervisor). The co-supervisor analyzed the disagreements between the student and the main supervisor.

After all the disagreements were checked, the researchers *did not* reach an agreement on 12 papers; therefore, the team executed the **decision phase**.

During a meeting, each paper was analyzed and discussed until consensus was reached. At the end of the first meeting, the researchers still have doubts about the inclusion of seven studies. The student then read the full text of all seven studies and scheduled a new meeting. During this meeting, the team decided that none of

the studies included in Cruz et al.'s (2015) 's mapping study could be included in the planned SLR. This decision and the different goals of the mapping study led to the need for a new SLR.

2.2.3 Research questions

The main RQ (research question) of this literature review is ***RQ-SLR1: What is the relationship between decision-making and personality?*** This main research question was divided into four sub-research questions. Table 12 presents the sub-research questions, along with the motivation for each one.

Table 12. Sub-research questions and their motivations.

| ID | Research Question | Motivation |
|------------|--|---|
| RQ-SLR1.1 | What are the personality aspects and respective instruments that have been identified as relating to decision-making? | Identify the personality aspects and assessment instruments employed in the studies. |
| RQ-SLR 1.2 | What are the decision-making aspects that have been identified as relating to personality? | Identify the decision-making aspects that the studies have investigated. |
| RQ-SLR 1.3 | Which personality aspects and decision-making aspects are correlated? How is this relationship characterized? | Identify all the relationships between personality and decision-making aspects investigated by the studies. |
| RQ-SLR1.4 | Is there any moderating or mediating factor that influences the relationship between personality and decision-making? If so, what is this influence? | Identify all the factors that can influence the relationship between personality and decision-making aspects. |

2.2.4 Search strategy

This SLR employed two strategies to search for studies: first, electronic database searches were conducted, followed by backward snowballing using the references of the selected studies. The snowballing was included to increase the extent of the searching process.

0 shows two activities in the executing phase related to the search process: "execute string on the database and select the studies" and "execute snowballing and select the studies." The next sections present the database list and the strategy used to select them, as well as the search string developed to run on these selected databases.

Databases selection

This SLR aimed to search for studies in many fields of science; therefore, it was necessary to include databases that index these fields. First, the potential areas of knowledge (or fields of science) were searched. A potential area is one with greater probability of finding studies that discuss the relationship between decision-making and personality, considering the company context.

Among the services provided by the University of Oulu's library is a list of areas of knowledge, called subject guides.¹ The following areas were selected by analyzing the description provided for each item in the discipline-specific list: economic science and business studies, education and psychology, industrial engineering and management, and information processing science.

With the list of potential areas of knowledge, the relevant databases related to each one were searched. A list of scientific search engines for each discipline was also provided by the University of Oulu library. However, after collecting all the recommended databases for each selected area of knowledge, a long list of databases was identified (see Table 13). Therefore, a reduction strategy was applied with the help of three literature reviews (Abatecola et al., 2013; Cruz et al., 2015; Cunha et al., 2016); they were chosen because of the following reasons.

Abatecola et al. (2013) is a literature review investigating the relationship between personality and decision-making but focuses on top-board management and its outcomes. Furthermore, the authors searched for studies produced in the management field.

Cruz et al. (2015) aimed to review software engineering studies investigating personality without any particular focus. Likewise, Cunha et al. (2016) review studies that investigate decision-making in the context of a software development project.

As discussed before, all these three literature reviews have some similarities to the one conducted in this Ph.D. research, and we decided to use this similarity to build our own.

We compared each database in Table 13 to the database list in Abatecola et al. (2013), Cruz et al. (2015), and Cunha et al. (2016). If the database was in one or more of these three literature reviews, it was selected; if not, it was discarded.

¹ <http://libguides oulu fi/subjectguides>

Table 13. List of databases recovered from the University of Oulu's library¹.

| Area of Knowledge | Databases |
|---------------------------------------|--|
| Economic and business | Ebsco Databases, Business Source Ultimate (EBSCO), Academic Search Ultimate (EBSCO), EconLit (Ebsco), eBook Collection (Ebsco), Scopus, Web of Science, ProQuest Databases, Business databases (ProQuest), ABI/INFORM Collection, Emerald, ScienceDirect, Wiley Online Library, SpringerLink, JSTOR |
| Education and psychology | Ebsco Databases, Academic Search Ultimate (EBSCO), ERIC (EBSCO), APA PsycArticles (EBSCO), Communication & Mass Media Complete (EBSCO), ProQuest Databases, Humanities, Education @ Social Sciences databases (ProQuest), ERIC (ProQuest), ABI/INFORM Collection (ProQuest), Scopus, Web of Science, JSTOR |
| Industrial Engineering and management | Scopus, Web of Science, ProQuest Databases, SciFinder-n, TRID EN, IEEE Xplore, ScienceDirect (Elsevier), Academic Search Ultimate (EBSCO), Emerald Journals, SpringerLink, Wiley Online Library, EJS: Electronic Journals Service (EBSCO), ABI/INFORM Collection (ProQuest) |
| Information Processing science | Scopus, Web of Science, SciFinder-n, Ebsco Databases, ProQuest Databases, IEEE Xplore, ACM Digital Library, ScienceDirect (Elsevier), Wiley Online Library, Academic Search Ultimate (EBSCO), arXiv e-print archive, ABI/INFORM Collection (ProQuest) |

For example, the literature review conducted by Abatecola et al. (2013) uses EBSCOhost; therefore, this database was included in our SLR. Cruz et al. (2015); and Cunha et al. (2016) use Scopus, and this database was also selected. In the end, all the databases used in the three literature reviews were included in this SLR database list, except EI Compedex, which is included in Cruz et al. (2015). This database was excluded because the University of Oulu library does not support it.

The overlap between the databases was also verified. The search string was executed in all the selected databases; Parsifal² then counted the number of overlapping studies between the databases. Table 14 shows the result of the overlap analyses. The first column and first line contain the database name, along with the number of studies returned by the string. The remaining cells contain the number of overlapping studies between each pair of databases. The string used in the databases is presented in Table 17.

By observing the number of overlapped studies, it is possible to visualize a complete overlap between Ovid and Scopus. As a result, Ovid was excluded from the final list of selected databases, which is presented in Table 15.

² <https://parsif.al/>

Table 14. Analysis of overlaps between pre-selected databases.

| ↓ Databases → | EBSCOhost (90) | IEEEExplore (154) | Ovid (6) | ScienceDirect (43) | Scopus (338) | Wiley (137) |
|---------------------|-------------------|----------------------|-------------|-----------------------|-----------------|----------------|
| ACM (74) | 0 | 1 | 0 | 0 | 2 | 0 |
| EBSCOhost (90) | | 0 | 3 | 0 | 21 | 9 |
| IEEEExplore (154) | | | 0 | 0 | 20 | 0 |
| Ovid (6) | | | | 0 | 6 | 0 |
| Science Direct (43) | | | | | 22 | 0 |
| Scopus (338) | | | | | | 5 |

Table 15. List of selected databases.

| # | Database | Link |
|---|----------------------|---|
| 1 | ACM Digital library | http://dl.acm.org/ |
| 2 | EBSCOhost | https://search.ebscohost.com |
| 3 | IEEEExplore | https://ieeexplore.ieee.org/ |
| 5 | Science Direct | http://www.sciencedirect.com/ |
| 6 | Scopus | www.scopus.com/home.uri |
| 7 | Wiley Online Library | http://onlinelibrary.wiley.com/ |

The criteria for database selection are following summarized.

- The database access is provided by the University of Oulu library.
- Each database on the list was used in one or more of the three literature reviews we used to build our SLR protocol (Abatecola et al., 2013; Cruz et al., 2015; Cunha et al., 2016).
- A selected database cannot completely overlap with any other database on the list.

Search string

The search string was built using the terms employed in three literature reviews and their synonyms. From Cruz et al. (2015) and Abatecola et al. (2013), the terms and synonyms related to personality were obtained; and from Cunha et al. (2016), the ones related to decision-making.

The Quasi-Gold Standard proposed by Zhang, Babar, and Tell (2011) presents principles that can improve the string quality. String precision and sensitivity were estimated by counting the number of false negatives in the database that returned a smaller number of articles and verifying if the known set studies were returned using the created string, respectively. The known set was composed by Abatecola

et al. (2013); Erjavec, Khan, and Trkman (2016); and Kauer, Waldeck, and Schäffer (2007).

A study selection was performed on the database with the smallest number of returned papers (Ovid). We found 72 false negatives among the 90 papers retrieved in Ovid. The papers discussed personality in a context that we were not aiming for, such as gender, smoking decision, a medical decision, adolescents, and disaster response. Because of the variety of contexts and the high percentage of false negatives, we decided to focus only on companies or business context, which led to the inclusion of a new term ("company") and its corresponding synonyms. This term's inclusion helped define the SLR focus, which is on companies that develop any product or service. Table 16 shows the number of studies that each tested string returned.

Table 16. Number of studies returned by each string.

| Database | Initial string | Final String |
|----------------------|----------------|--------------|
| ACM Digital library | 453 | 74 |
| EBSCOhost | 2567 | 90 |
| IEEEExplore | 154 | 154 |
| Ovid | 90 | 6 |
| Science Direct | 484 | 43 |
| Scopus | 4300 | 338 |
| Wiley Online Library | 726 | 137 |
| Total | 8772 | 842 |

The final string has a smaller number of false negatives, and it was used to retrieve the studies in the *known set*, leading to the conclusion that it was satisfactory. Table 17 shows the keywords, their related search terms, and the final string.

Table 17. Search terms and the final search string.

| Keyword | Search Term |
|--|--|
| Personality | personality, extraversion, emotional stability, locus of control, agreeableness, conscientiousness, openness, psychological typology, psychological types, temperament types |
| Decision making | decision making, decision-making, decision theory, decision model |
| Company | company, enterprise, team, workgroup, industry, organization, business environment |
| <i>Final string:</i> (personality OR extraversion OR emotional stability OR locus of control OR agreeableness OR conscientiousness OR openness OR "psychological typology" OR "psychological types" OR "temperament types") AND ("decision making" OR "decision-making" OR "decision theory" OR "decision model") AND (company OR enterprise OR team OR "workgroup" OR industry OR organization OR "business environment") | |

2.2.5 Selection

In Fig. 5, the activities related to the study selection are *"execute string on the database and select the studies"* and *"execute snowballing and select the studies;"* all of which can be found in the executing phase.

From the list of studies retrieved, all the titles and abstracts were read, resulting in a set of pre-selected studies. The full texts of all the pre-selected studies were then checked, which resulted in the set of included studies. The inclusion and exclusion criteria are presented in Table 18.

Inclusion criterion (IC) 01 aims to verify if the study under analysis can answer the defined RQ. Inclusion criterion 02 examines the study's credibility by checking if someone else has analyzed and agreed to publish the paper. Inclusion criterion 03 checks the language employed in the study text, and IC 04 verifies if it is possible to recover the full text from the database.

Exclusion criterion (EC) 01 excludes any study with fewer than four pages, because we believe that it is not possible to discuss the subject of this SLR in an adequate level of detail in such a small number of pages. Exclusion criterion 02 and EC 03 are the opposites of IC 03 and IC 04, respectively.

Exclusion criterion 04 excludes any paper that does not report empirical research. The study conducted by Briggs and Little (2007) is an example of this criterion; it reviews some concepts related to personality and decision-making. Considering the literature review and the authors' experience, the study provides insights into the relationship between personality and decision-making. Since no empirical evidence is provided, the paper was excluded from this SLR.

Table 18. Inclusion and exclusion criteria.

| ID | Inclusion Criteria |
|-------|---|
| IC 01 | The paper describes empirical studies about the relationship between personality and decision-making in the context of companies developing any kind of service or product. |
| IC 02 | The paper was peer-reviewed, and it is a full paper. |
| IC 03 | The paper is written in English. |
| IC 04 | The full text of the article is available. |
| ID | Exclusion Criteria |
| EC 01 | The publication was not peer-reviewed, or it is not a full paper (abstract or short paper – i.e., one with fewer than four pages). |
| EC 02 | The paper is not written in English. |
| EC 03 | The full text of the paper is not available. |
| EC 04 | The paper presents lessons learned, or it is an opinion article; in other words, it is not an empirical study. |
| EC 05 | The paper does not study the relationship between personality and decision-making. |
| EC 06 | The paper is not in the context of companies developing any kind of service or product. |
| EC 07 | The paper discusses a variable that can be considered a personality trait, but it does not relate the trait to a personality perspective. For example, the paper discusses emotion but does not consider it as a personality trait. |

Some of the studies retrieved do not discuss the relationship examined in this SLR; therefore, they were excluded using EC 05. Tsiga, Emes, and Smith (2016) is an example of such a study. The authors collected information about decision-making and characterized the subject's personality using the MBTI instrument. However, the authors do not make any conclusion about the relationship between personality and decision-making since they did not study it.

The main goal of EC 06 was to exclude studies that are not conducted in the context of companies. Lepine, Hollenbeck, Ilgen, and Hendlund's (1997) study is an example. It discusses the relationship between personality and decision-making; however, the simulation scenario was related to either a naval command or control task or a hospital task.

Finally, EC 07 aims to detect studies where the personality aspect is arguable. Ürü, Çaliskan, Atan, and Aksu (2011) is the only study excluded due to this EC. The paper discusses the relationship between some strategic decision-making process characteristics and entrepreneurial characteristics. Some of the entrepreneurial characteristics (e.g., the need of achievement) can be argued as personality aspects. However, others – such as competitiveness – are arguably not personality aspects. The authors do not give any discussion to clarify this point, and they use the generic term "psychological and cognitive characteristics of

entrepreneurs" to name all the characteristics. The paper was excluded because the authors do not deal with these characteristics clearly as personality aspects.

2.2.6 Study quality assessment

We compared three methods of conducting a quality assessment. Dieste et al. (2011) conducted a review on quality assessment in software engineering, in which they propose a quality scale with four dimensions: context, design, interpretation, and presentation of results. The scale has 11 questions; it is objective and easy to use. However, a forward snowballing showed that no SLR had employed this scale.

Ivarsson and Gorschek (2011) conducted another review and presented a model to evaluate software-engineering studies' rigor and relevance. Rigor relates to the research method's quality, while relevance is associated with the community's research impact. The model is well-defined and extensively used, but it is too dependent on the researcher's judgment by our analysis.

Dyba and Dingsøyr (2008) conducted an SLR on agile software development and created a set of quality-assessment criteria. These criteria are less subjective than the abovementioned ones; in other words, it is less dependent of the researcher's judgment. They focus on analyzing the strength of the publication's evidence; thus, this method was chosen. However, the control group criterion was excluded because it is too specific for experiments. The criteria for quality assessment are shown in Table 19. Dyba and Dingsøyr (2008) also present sub-questions to guide the answering of the main question. Although we used them, they are not presented in Table 19.

The questions in the "detailed questions" section of Table 19 could be answered with "yes," "partially," or "no." A "yes" answer added 1.0 point to the total score of the evaluated studies, "partially" added 0.5, and "no" did not change the score. Therefore, the maximum possible score was 7.0. If a study scored equal to or less than 3.5 (half of the maximum score), it was excluded from the SLR due to poor quality.

The tool Parsifal² supported the electronic databases searching phase spreadsheets helped during the snowballing.

Table 19. Quality assessment criteria (Dybå & Dingsøy, 2008).

| Screening Questions ¹ | |
|----------------------------------|---|
| SQ1 | 1. Is the paper based on research (or is it merely a "lessons learned" report based on expert opinion)? |
| SQ2 | 2. Is there a clear statement of the aims of the research? |
| SQ3 | 3. Is there an adequate description of the context in which the research was conducted? |

| Detailed Questions ² | |
|---------------------------------|--|
| Type of Research | 4. Was the research design appropriate for addressing the aims of the research? |
| Sampling | 5. Was the population selected for the study appropriate to the aims of the research? |
| Data Collection | 6. Was the data collected in a way that addressed the research issue? |
| Data Analysis | 7. Was the data analysis sufficiently rigorous? |
| Reflexibility | 8. Has the relationship between the researcher and participants been considered to an adequate degree? |
| Findings | 9. Is there a clear statement of findings? |
| Value of Research | 10. Is the study of value to research or practice? |

¹ If question 1, or both questions 2 and 3, receive a "no" response, do not continue with the quality assessment), ² Add one to the total publication score for each "yes" response

2.2.7 Data extraction

Table 20 presents the template for data extraction. Each item is also presented with the related research question (if applicable). The Ph.D. candidate conducted the extraction, and the supervisors checked a sample of the results. The validation activities are presented in Section 2.2.1.

Parsifal2 supported the data extraction of studies retrieved from electronic databases, whereas the spreadsheet helped on the snowballing process. Finally, all the data was converted into a spreadsheet format.

Table 20. Template for the extraction form.

| Data Item | Value | RQ |
|---|--|-----------|
| Study ID | - | - |
| Publication title | - | - |
| Author(s) | - | - |
| Year of publication | - | - |
| Study type | experiment, case study, survey, literature review, or mixed types | - |
| Study Context | market, organization, product, process, practices/tools/techniques, and/or people | - |
| Context facet description (for each item selected) | Some suggestions of what to extract (Petersen & Wohlin, 2009): - market: number of customers, market segments, strategy, constraints; organization: the model of the overall organization, organizational unit, certification, distribution, type of industry; product: maturity, quality, size, system type, customization, programming language; process: activities, workflow, artifacts; practices/tools/techniques: case tools or practice/technique descriptions; people: role, experience | - |
| Subject and sampling | Describe the characteristics of the study subject | - |
| Data collection | Describe how the data was collected | - |
| Data analysis | Describe how the data were analyzed | - |
| Personality traits/sub-aspects and related framework/instrument/model/test | - | RQ-SLR1.1 |
| Decision-making aspects/items/tasks and related theory/model/process | - | RQ-SLR1.2 |
| Personality aspect/item/task related to which decision-making aspect/item/task and type of relationship | - | RQ-SLR1.3 |
| Moderated/Mediated variables that influence the relationship between personality and decision-making and type of relationship | - | RQ-SLR1.4 |

2.2.8 Data synthesis

The data synthesis considered two points of view: general and focused. The indicators used for a general analysis are:

- Number of studies retrieved;
- Number of studies (total and included) per database;
- Number of included studies per year;
- Number of included studies per type (experiment, case study, survey or literature review, and mixed types);
- List of venues where the studies were published; and
- Quality assessment score for each included study.

The second group contains indicators focused on the research questions, as presented in Table 21. Parsifal² supported the data extraction of studies retrieved from electronic databases, whereas the spreadsheet helped on the snowballing process. Finally, all the data was converted into a spreadsheet format.

Table 21. List of Indicators for each research question.

| Description of the Indicator | Research Question |
|---|-------------------|
| Personality traits: A table with the personality traits considered in each article and the related framework. | RQ-SLR1.1 |
| Personality tests/instruments/models: A list of personality tests/instruments/models with the number or percentage of articles for each one. Track the articles that use each personality test/instrument/model. | RQ-SLR1.1 |
| Decision-making aspects: A table with the decision-making aspects considered in each article and the relevant model. | RQ-SLR1.2 |
| Decision-making models/processes/theories: A list of decision-making models/processes/theories with the number or percentage of articles for each one. Track the articles that use each decision-making model/process/theory. | RQ-SLR1.2 |
| Personality traits × Decision-making aspects: A table where the first column is a list of personality traits, and the first row is a list of decision-making aspects. The intersection between each item contains the type of relationship identified between the personality and the decision-making aspects. Track the list of articles related to each intersection point. | RQ-SLR1.3 |
| Other variables that influence the relationship between personality and decision-making: A list of variables that influence the observed relationship with the type of influence. Track the articles that report each variable. | RQ-SLR1.4 |

2.3 Investigation phase: survey preparation

The investigation phase's main goal was to understand the relationship between personality and decision-making in the software-engineering context. The SLR conducted in the discovery phase pointed to a lack of software engineering studies that discuss the relationship mentioned above; therefore, this phase's contribution is the generation of knowledge in this specific field.

This survey has an **exploratory** nature, because it was not possible to find studies that provided some theoretical support for the creation of hypotheses. Therefore, the survey detailed herein was guided by exploratory research questions instead of hypotheses.

Case study and formal experiment were also considered as potential research methods; however, a formal experiment was discarded due to the inability to generate hypotheses and the complexity related to the experiment design – for example, selecting participants with a wide spectrum of personality combinations. A case study could be another option; however, the results would not have the same generalization power as survey research. Therefore, considering all the existing limitations, a survey was judged to be the best method to address the research goal.

This section presents the survey design, which includes the research question, goal, timeline, population, variables, data-collection instrument, pilot, and support tools. The statistical approaches used to analyze the survey data are presented in Chapter 5.

2.3.1 Survey goal and research questions

This survey's main goal was to understand the relationship between personality and two aspects of decision-making: **style** and **self-efficacy**. Table 22 presents the survey goal using the GQM (Goal-Question-Metric) template defined in Basili et al. (2014).

Table 22. Survey goal using the GQM.

| Type | Goal |
|---|---|
| Analyze: (<i>object of study</i>) | Decisions made in the software-engineering context and individuals involved in these decisions. |
| To: (<i>purpose</i>) | Understand the relationship between decision-making and personality. |
| With respect to: (<i>focus</i>) | Decision maker's personality, decision-making style, and decision-making self-efficacy. |
| From the point of view of: (<i>viewpoint</i>) | Anyone who is involved in the decision-making. |
| In the following context: (<i>environment</i>) | Software engineering practice. |

Table 23 presents the research questions, along with their corresponding objectives.

Table 23. Research questions and their objectives.

| ID | Research Question | Objectives |
|---------|--|---|
| RQ-SRV1 | What is the relationship between <i>decision-making style</i> and personality? | (1) Investigate whether decision-making style (DMS) and personality variables (factors and facets) are related. If so, quantify the strength of the relationship. (2) Verify if personality factors can be used to explain the variation in DMS. If so, quantify the percentage of variation explained and the accuracy of the prediction. (3) Verify if any demographic variable moderates the relationship between DMS and personality factors. |
| RQ-SRV2 | What is the relationship between <i>decision-making self-efficacy</i> and personality? | (1) Investigate whether decision-making self-efficacy (DMSE) domains and personality variables (factors and facets) are related. If so, quantify the strength of the relationship. (2) Verify if personality factors can explain the variation in DMSE domains. If so, quantify the percentage of variation explained and the accuracy of the prediction. (3) Verify if any demographic variable moderates the relationship between DMSE domains and personality factors. |

2.3.2 Survey timeline

This survey was executed from March 2018 to June 2020, as shown in the timeline of Table 24.

The survey instrument is composed of questionnaires that have been used many times before (Section 2.3.4); however, because all the survey participants are

Brazilian, the questions were translated into Portuguese. Furthermore, since the instrument is long, the questionnaire distribution strategy was tested using the **survey pilot**. These activities were executed during the **instrument design phase**.

Table 24. Survey execution timeline.

| Time | Survey phase |
|----------------|-------------------------|
| Mar – Jun 2018 | Survey planning |
| Jun – Jul 2018 | Instrument design |
| Jun 2018 | Survey pilot |
| Jun 2018 | Participant recruitment |
| Jul – Sep 2018 | Data collection |

During the **recruitment phase**, a message (see Appendix 1) with the research goal and other details related to the survey was sent to 344 people. The message also asked the individual to suggest other people who could participate in the survey. We sent an email with the questionnaire link only to those who agreed to participate.

The **data-collection phase** started when we sent the questionnaire link to the participants. We also sent three follow-up reminders to increase the dataset size.

In order to provide feedback to the survey participants, we created a report for every person who requested it and who filled all four parts of the survey. The report briefly explained the theory behind the questions and the participant's score for the five personality facets, decision-making style, and decision-making self-efficacy domain.

We received feedback for 15 of the 61 participants we sent a report to, discussing their experience in answering the survey. Some stated that they had never thought about how they make decisions before the survey. Others said that the survey helped them to think about factors that can influence their decisions. Some confirmed that the report describes their decision-making and personality characteristics accurately.

The **data-analysis phase** was the longest, followed by the survey report. Details about the data-analysis approach can be found in Chapter 5.

2.3.3 Population and sample

This survey targeted professionals who are **involved** in the decision-making process in software engineering. We defined three categories of such professionals, which are presented here:

- **Business-related:** people who know about the business and contribute with requirements or any other business knowledge needed to understand the software characteristics.
- **Management-related:** people who perform any task related to software project management.
- **Technical-related:** people who perform any task necessary to develop the software directly (e.g., requirements engineers, software architects, developers, and testers).

From the authors' point of view, these three categories are concise and complete, and they summarize the main roles of software development. They were motivated by the work of Schwaber and Sutherland (2017), who define teams as being composed of team leaders (management-related professionals), team members (technical-related professionals), and product owners (business-related professionals).

The criteria for selecting the survey population are summarized below:

- The participant should be involved in the decision-making process in the software-engineering context.
- The participant should be actively engaged professionally in one or more of the three defined roles (business, management, or technical).

All the participants were Ph.D. candidate's acquaintances; therefore, we used a **non-probabilistic convenience sample**. They were contacted via email or other online-messaging tools (such as Facebook and LinkedIn messengers). Participation in the survey was on a voluntary basis, and only those respondents who agreed to participate received a link to the data-collection instrument (an online questionnaire).

We also executed snowballing in two different ways. We sent a message to the Ph.D. candidate's acquaintances who did not comply with the criteria to select the survey population and we asked them to contact others who might also be willing to participate in the study. We also asked the Ph.D. candidate's acquaintances who complied with the criteria and agreed to participate in the survey to contact others to participate in the survey. Therefore, we performed a **non-probabilistic snowballing**.

In total, 344 people were contacted, out of which 138 agreed to participate (40.12%). The survey was divided into four parts. Among those who agreed to

participate, 102 answered only the first part (73.91%), and 63 participants answered all four parts of the survey (46.38%). Table 25 summarizes the sampling statistics.

Table 25. Sampling numbers.

| Description | Number | Percentage |
|--|--------|--|
| Received invitation | 344 | - |
| Accepted invitation | 138 | 40.12% success rate |
| Number of answers per questionnaire part | | |
| Part I | 102 | 73.91% of the 138 who accepted the invitation |
| Part II | 74 | 53.62 % of the 138 who accepted the invitation |
| Part III | 63 | 46.38 % of the 138 who accepted the invitation |
| Part IV | 63 | 46.38 % of the 138 who accepted the invitation |

The survey response rate was high (73.91%); however, only 63 participants (46.38%) completed all four parts. Another important number is related to the snowballing procedure; 30 out of 102 people who answer Part 1 were contacted through snowballing; and 19 from 63 participants answered all four parts were also from snowballing.

We analyzed the data of questionnaires that were answered entirely. In other words, even though we collected some data related to decision-making style on Part I and II, they were discarded during the data analysis. Therefore, the total amount of data points on the decision-making style variable was only 63.

The distribution of the participants' roles is shown in Table 26. Note that a mixed role characterizes those who perform more than one role during a software-development activity.

Table 26. Distribution of participants by defined roles.

| Role | Number | Percentage |
|----------------------------|--------|------------|
| Business | 6 | 5.9% |
| Management | 18 | 17.6% |
| Technical | 51 | 50.0% |
| Mixed (more than one role) | 27 | 26.5% |
| Total | 102 | 100.0% |

The participant distribution shown in Table 26 supports the usual composition of a software development team in practice: the largest number of people in technical roles, followed by management and business roles, respectively.

2.3.4 Data-collection instrument

The survey data-collection instrument is a questionnaire with four parts. Part I gathers personal information, part II gathers personality data, part III gathers data on DMSE, and finally, part IV gathers data on DMS. The questionnaire was self-administrated through an online tool (see Section 2.3.7). All the questions are closed-ended, which means that the participant should choose one of the listed alternatives.

The **personal information** part aims to characterize the participants' demographics. It includes questions about gender, age, education level, experience, and role in the project. This first part has six questions in total, and the estimated time to complete it ranges from 5 to 10 minutes.

The **personality assessment** part is a questionnaire proposed by Johnson (2014), which has already been used in many studies (Halim, Atif, Rashid, & Edwin, 2017; Kanij, Merkel, & Grundy, 2015; Salleh, Mendes, Grundy, & Burch, 2009). It measures the five factors (agreeableness, conscientiousness, extraversion, neuroticism, and openness) and their corresponding facets (six per factor, resulting in 30 facets in total; see Fig. 3 for the complete list of facets). The questionnaire is in the public domain and available on the Web³. It comes in two versions; one contains 300 items, while the other has 120. We used the latter version; despite the former's superior reliability by comparison, the shorter version can be completed more quickly (between 10 to 20 min). Because of the total time required to answer all four questionnaires, it was important to choose the version that requires less amount of time to be filled.

The **decision-making self-efficacy** part used the questionnaire proposed by Myburgh et al. (2015). This questionnaire is based on the premise that self-efficacy beliefs influence decision-making efficacy. These beliefs relate to some abilities required to execute decision-making activities. The questionnaire contains 30 statements distributed across four domains, and it has been validated in two studies conducted by Myburgh et al. (2015). It was chosen due to its validity, and because it measures the decision-maker's capacity to make decisions objectively.

Finally, the **decision-making style** part assesses how much the lead decision-maker allows other people to participate in the decision process. The model proposed by Vroom and Yetton (1973) defines 10 decision-making styles: five for individual problems and five for group problems (see Section 1.1 for an overview).

³ <http://www.personal.psu.edu/~j5j/IPIP/>

The Vroom-Yetton model contains two perspectives: normative and descriptive. This survey employs the latter model, which consists of 30 problems (Glube, 1978 Appendix B) and a scale to compute others' level of participation in the decision-making process, the decision-making style.

The estimated time for completing the decision-making style part ranged from 1.5 to 3 hours (3 to 6 minutes per case). The total time required to fill out all four parts was between 2 and 4 hours. This duration is rather long, and it motivated us to divide the data-collection procedure into four parts, as presented in Table 27.

We set the answering sequence for the four different parts strategically. During the first part, the respondents completed three questionnaires. In this manner, even if they decided not to continue participating in the survey, we had enough data to analyze the relationship between personality and decision-making self-efficacy (RQ-SRV2).

Table 27. Survey questionnaire distribution.

| Part | Questionnaire |
|------|---|
| 1 | - Personal information (6 questions); - Personality (120 items); - Decision-making self-efficacy (30 items) |
| 2 | - Decision-making style (12 cases) |
| 3 | - Decision-making style (9 cases) |
| 4 | - Decision-making style (9 cases) |

Furthermore, the cases in the decision-making style part were ordered from shortest to longest, based on the number of words in each case description. We employed this strategy to motivate the respondents to continue answering the questions.

The original language of the personality, decision-making self-efficacy, and decision-making style questionnaires is English; however, since the participants' native language is Brazilian Portuguese, it was necessary to translate the questions. The student translated them, and the text was reviewed twice, as described below.

During the survey-pilot sessions, we took notes when the participants had any difficulty understanding the questionnaire, and we later provided alternative translations to these parts.

After the survey pilot, a third-party person (TPP) reviewed the questionnaire. The TPP's mother tongue is Brazilian Portuguese, but she is also proficient in English. She compared the original text to its translated version, noting any parts where the meanings differed. In some cases, she provided an alternative translation,

whereas in others, she explained the problem. She was always available for discussion when we reviewed her comments.

2.3.5 Variables

This survey focuses on the relationship between personality and decision-making in the context of software engineering. Fig. 8 shows the variables for which we collected data. Personality, decision-making self-efficacy, and decision-making style were measured on an interval (or continuous) scale; age, education level, and experience were measured on an ordinal scale, and role on a nominal scale (Wohlin et al., 2012, pp. 39–40).

In this survey, the dependent variables are those related to decision-making (i.e., decision-making self-efficacy domains, and decision-making style). The independent variables are those associated with personality (i.e., personality factors and facets). Finally, the moderation factors are the demographic variables (i.e., age, role, education level, and experience). Fig. 8 shows the abovementioned variables, which are discussed in the following sections.

Personality

The personality variables in this survey are the factors and facets presented in Fig. 8. In total, this survey has 35 personality variables: five factors and 30 facets (six facets per factor).

This research uses the IPIP-NEO-120, a questionnaire created by Johnson (2014) and derived from the set of items in the NEO-PI. The IPIP-NEO is available on the Web⁴, and it is in the public domain. It comes in two versions: one contains 300 items, while the other has 120. Within this thesis's context, we adopted the latter version, because it is reliable for measuring personality, and it can be completed more quickly (between 10 to 20 min). Note that the time required to answer the IPIP-NEO questionnaire had to be considered very carefully, as our population is comprised of very busy industry professionals.

⁴ <http://www.personal.psu.edu/~j5j/IPIP/>

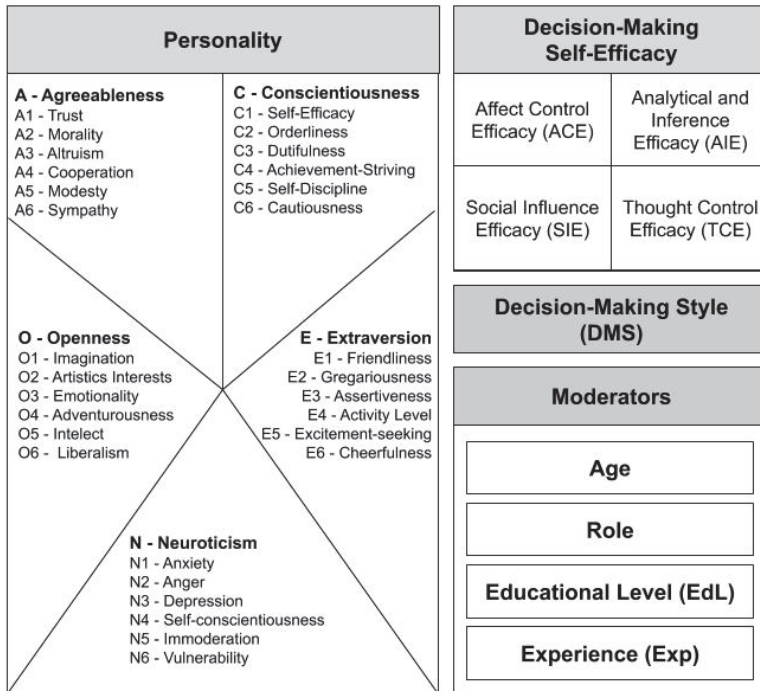


Fig. 8. Survey variables.

Each item in the personality questionnaire is simultaneously related to one factor and one facet; moreover, each item can be + or -keyed. A +keyed item adds a value between 1 (“very inaccurate”) and 5 (“very accurate”) points to the personality score (factor and facet); and for a -keyed item, the score attribution is inverted⁵, as shown in Table 28.

Table 28. Score calculation for personality variables.

| Chosen alternative | +keyed | -keyed |
|---------------------------------|--------|--------|
| Very accurate | 5 | 1 |
| Moderately accurate | 4 | 2 |
| Neither inaccurate nor accurate | 3 | 3 |
| Moderately inaccurate | 2 | 4 |
| Very inaccurate | 1 | 5 |

⁵ <https://ipip.ori.org/newScoringInstructions.htm>

Table 28 shows the rules for score calculation. Since the questionnaire has 24 items per personality factor, the theoretical score varies from 24 to 120: and since the questionnaire has 4 items for each personality facet, the questionnaire produces a score between 4 and 20.

Decision-Making Self-Efficacy

The decision-making self-efficacy theory defines four domains, and each domain represents one variable in this survey. The associated questionnaire contains 30 statements and collects data for the four variables that represent the respective domains. The participants need to select a number from 0 to 100 for each statement. The number expresses how confident they are that they can regularly perform the action described. Fig. 9 shows the scale employed in the questionnaire.

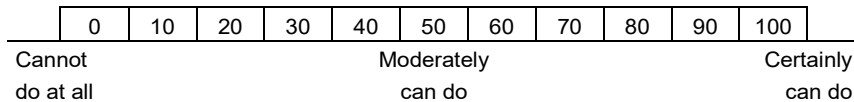


Fig. 9. Decision-making self-efficacy questionnaire scale.

Each domain has its own final score, which is related to the number on the scale that the respondent chose for each item. The score is calculated using the sum of the chosen number for each statement related to the domain:

$$gross.score = \sum_{number.items}^1 chosen.number$$

The gross score is then divided by the total number of items in the domain:

$$final.score = gross.score / number.items$$

Therefore, the final score is a number between 0 and 100. Table 29 shows the number of items in the questionnaire for each decision-making self-efficacy domain and the maximum gross score possible.

Table 29. Domains, number of items in the questionnaire per domain, and gross score.

| Domain | Number of items | Max. gross score |
|---|-----------------|------------------|
| Affect Control Efficacy (ACE) | 9 | 900 |
| Analytical and Inferential Efficacy (AIE) | 11 | 1100 |
| Social Influence Efficacy (SIE) | 5 | 500 |
| Thought Control Efficacy (TCE) | 5 | 500 |

Decision-Making Style

The questionnaire used to collect data on the decision-making style variable contains 30 problems. The participant chooses one of five available alternatives, which are the same for all problems. The alternatives are shown in Table 30, along with the added score if the alternative is chosen.

Table 30. Alternatives and their scores added to the final decision-making style score (Vroom & Jago, 1988 Chap. 7).

| ID | Description | Added score |
|-----|---|-------------|
| AI | You solve the problem or decide yourself using the information available to you at the present time. | 0 |
| All | You obtain any necessary information from subordinates, then decide on the solution to the problem yourself. You may or may not tell them the purpose of your questions or give information about the problem or decision you are working on. Their input is clearly in response to your request for specific information. They do not play a role in the definition of the problem or in generating or evaluating alternative solutions. | 1 |
| CI | You share the problem with the relevant subordinates individually, getting their ideas and suggestions without bringing them together as a group; then you make the decision. This decision may or may not reflect their influence. | 5 |
| CII | You share the problem with your subordinates in a group meeting. In this meeting, you obtain their ideas and suggestions. You then make the decision, which may or may not reflect their influence. | 8 |
| GII | You share the problem with your subordinates as a group. Together, you generate and evaluate alternatives and attempt to reach an agreement (consensus) on a solution. Your role is much like that of a chairman, coordinating the discussion, keeping it focused on the problem, and making sure that the critical issues are discussed. You can provide the group with information or ideas, but you do not try to "press" them to adopt "your" solution; you are willing to accept and implement any solution which has the support of the entire group. | 10 |

The questionnaire has 30 problems (Glube, 1978); therefore, each participant can have a decision-making style score between 0 and 300:

$$DMStyle.score = \sum_{30}^1 chosen.alternative.score$$

Higher scores indicate a more participative decision-making style, and lower scores a less participative style.

Despite the questionnaire proposed by Vroom and Jago (1988) deal with two types of problems (individual and group, Section), the investigation presented herein focuses only on **group problems**.

2.3.6 Pilot survey

According to Kasunic (2005, p. 76), the pilot can expose problems or weaknesses related to the questions, questionnaire layout, process, and technology used. Since the most complex questionnaires had been created and frequently used before this survey (personality, decision-making self-efficacy, and decision-making style questionnaires), the pilot's focus was **not** on the questions' content. The pilot aimed to verify:

- the estimated time reported to complete the survey;
- the clarity and understandability of the questionnaires;
- the arrangement of the questionnaires and the decision-making style cases; and
- any opportunities for improvement of the survey execution process.

Three people participated in the pilot survey using the language that they feel more comfortable with. Table 31 presents their respective profiles.

The participants were observed while they answered the survey, and they were allowed to interact with the researcher. These interactions were counted and classified according to type. The data collected during the pilot were used to assess the questions' understandability, list any difficulties that the respondents might face, and improve the survey execution process.

Table 31. Profiles of pilot participants.

| Participant ID | Language | Population Category | Experience |
|----------------|----------------------|---------------------------------|---|
| 1 | English | Technical-related professional | Six months' experience as a tester in three projects that include software development. Software is one of the project results that need to be tested. |
| 2 | Brazilian Portuguese | Management-related professional | Two years and one month as a software project manager. Planning and controlling the schedule, people management, and quality management are some of the tasks performed. |
| 3 | Brazilian Portuguese | Management-related professional | Seven years of experience in traditional project management and four years in agile projects. Among the usual activities performed are, for example, schedule control and communication management. |

The participants interacted with the researcher 93 times. Fig. 10 shows the percentage breakdown of interactions per participant and by type. The interactions resulted in many changes to the data-collection strategy: for example, the tool for collecting the answers, the format of the questions, the disposition of the cases in the decision-making style questionnaire, and the questionnaire translations were all improved upon.

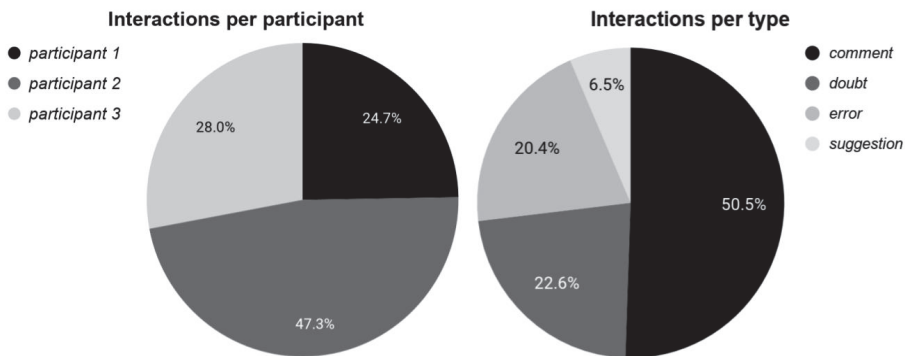


Fig. 10. Pilot statistics.

Furthermore, during the observation, we recorded the time that each participant took to answer each questionnaire. This information was used to verify the estimated time for completion, which was compared with the reported figure in the literature. This time was also used to decide the distribution of the questionnaires across the four parts. Table 32 presents the time that each participant spent on each

questionnaire and the time reported in the literature (Johnson, 2014; Vroom & Yetton, 1973).

Table 32. Time required to complete the questionnaires.

| Questionnaire | Pilot Study Respondents | | | Literature | |
|----------------------------|-------------------------|---------------|--------------|------------|--------|
| | 1 | 2 | 3 | Min | Max |
| Personal information | 1 min 40 sec | 9 min 3 sec | 4 min 6 sec | - | - |
| Personality | 10 min 40 sec | 43 min 12 sec | 23 min 1 sec | 10 min | 20 min |
| Decision-making efficiency | 4 min 35 sec | 10 min 31 sec | 7 min 30 sec | - | - |
| Decision-making style | 1 h 45 min | 2 h 46 min | 1 h 17 min | 1 h 30 min | 3 h |

2.3.7 Support tools

We used Webropol⁶ to support the survey data collection. Although Webropol provides some data-analysis features, we decided to choose another more specific tool for this purpose, the IBM SPSS Statistics Version 25⁷. The IBM SPSS Modeler Version 18.2.1.0 was used to conduct the cross-validation-related procedures.

2.3.8 Strategies to deal with potential survey errors

Regarding the types and sources of survey error, Blair, Czaja, and Blair (2014, pp. 23–25) present three reasons that can interfere with an accurate representation of the survey population: sampling error, sample bias, and non-sampling error.

The **sampling error** or sample variance refers to the fact that the survey sample cannot accurately reflect the population's characteristics accurately, which is controlled by the sample size. A larger survey population is preferable. In this survey, snowballing was used to expand the survey population and, therefore, to deal with this error.

According to the same authors, surveys can also have three general types of **sample bias**: coverage, selection, and nonresponse (Blair et al., 2014, p. 23). In terms of *coverage bias*, the main problem of this survey population is the geographical distribution. The whole survey population is Brazilian, although some of the participants work in other countries. Another coverage problem is that most of the survey population hold technical roles. These characteristics can impact the generalization power of the survey results.

⁶ <http://w3.webropol.com>

⁷ <https://www.ibm.com/products/spss-statistics>

In order to deal with *selection bias*, during the planning phase, we defined the roles and criteria for selecting the survey population. Using this strategy, we reduced the selection bias. Finally, for *nonresponse bias*, we first sent a message asking for a commitment to survey participation. We sent the survey instrument only to those who agreed to participate. Furthermore, we also sent four reminders to increase the response rate (check Table 24).

The last group of reasons mentioned by Blair et al. (2014, pp. 23–25) is the **non-sampling error**. According to the authors, there are three sources of error in this category: interviewer, response, and coding. *Interviewer errors* are related to the survey administration; for example, the researcher may fabricate data. This survey used an automatic tool to collect data; it exports a file with all the responses. This file was made available to the supervisors upon request; in this manner, they could verify any possibility of data fabrication.

It is important to mention that the variable related to education level was changed after data collection; this **does not characterize cheating** but a correction in the data. In Brazil, there are post-bachelor courses, usually one year in duration, with classes during the weekends. Through these courses, students acquire a more profound knowledge of specific subjects, such as agile methodologies and web development. Ten participants marked the “other” option and described the subject in which they have specialized. We decided to merge these 10 responses into the “bachelor’s degree” category, because these are not degree programs.

The *response error* is related to the accuracy of the response given. It relates to respondent comprehension and knowledge of the questions and their alternatives, as well as their sincerity in answering the questionnaire. During the pilot study, one of the goals was to assess the questionnaire's clarity and understandability. Furthermore, the researcher guaranteed the anonymity of the responses; in this way, we protected the survey participants from any repercussions that might result from an honest answer.

2.4 Summary of the chapter

This chapter presented the methodology used to conduct this research. First, the main goal and an overview of the main decision points were presented. The research phases and their main goals, execution periods, and outputs were outlined, followed by the detailing of the two core phases: discovery and investigation.

Section 2.2 detailed the SLR protocol's discovery phase, including the SLR goal, research questions, search strategy, selection criteria, quality assessment strategy, and data-extraction form.

The investigation phase was detailed in Section 2.3, which included the survey goal, research questions, timeline, population, instrument, variables, pilot, and data-analysis techniques.

3 A systematic literature review on the relationship between personality and decision-making

This SLR was planned and executed from February 2017 to April 2018. The planning phase started in February 2017; however, the SLR protocol started to be produced in April 2017. The execution phase started at the end of June 2017; the string was run on the electronic databases between June and July 2017; backward snowballing was executed in September 2017, and forward snowballing at the end of October 2017. Table 33 summarizes the SLR timeline, considering only the most frequently executed activities each month or period.

Table 33. Systematic literature review timeline.

| SLR Phase | Month Year | SLR Activity |
|-----------|-------------------|--|
| Planning | Feb-Jun 2017 | Establish the need for a literature review. |
| | | Define research questions. |
| | | Develop and validate the protocol |
| Execution | Jul-Oct 2017 | Execute strings on the database and select the studies. |
| | | Validate the study selection. |
| | | Assess the quality and extract data from the studies included. |
| | | Validate the data extraction. |
| | | Execute snowballing and select studies. |
| Reporting | Nov 2017-Apr 2018 | Assess the quality and extract data from the studies included. |
| | | Synthesize the results. |
| | | Validate the results. |

The longest phases were planning and reporting. In the SLR timeline, however, the planning phase includes the viability study of updating another SLR. As for the reporting phase, although the first version of the SLR report was ready in November 2017, the reviewed and approved version was released only in April.

Fig. 11 illustrates the search process, with the number of studies analyzed per search phase and the number of studies included per phase. The total number of analyzed studies is 3814, considering all searching phases. Backward snowballing was executed until saturation – in other words, until it was not possible to include more studies in this SLR.

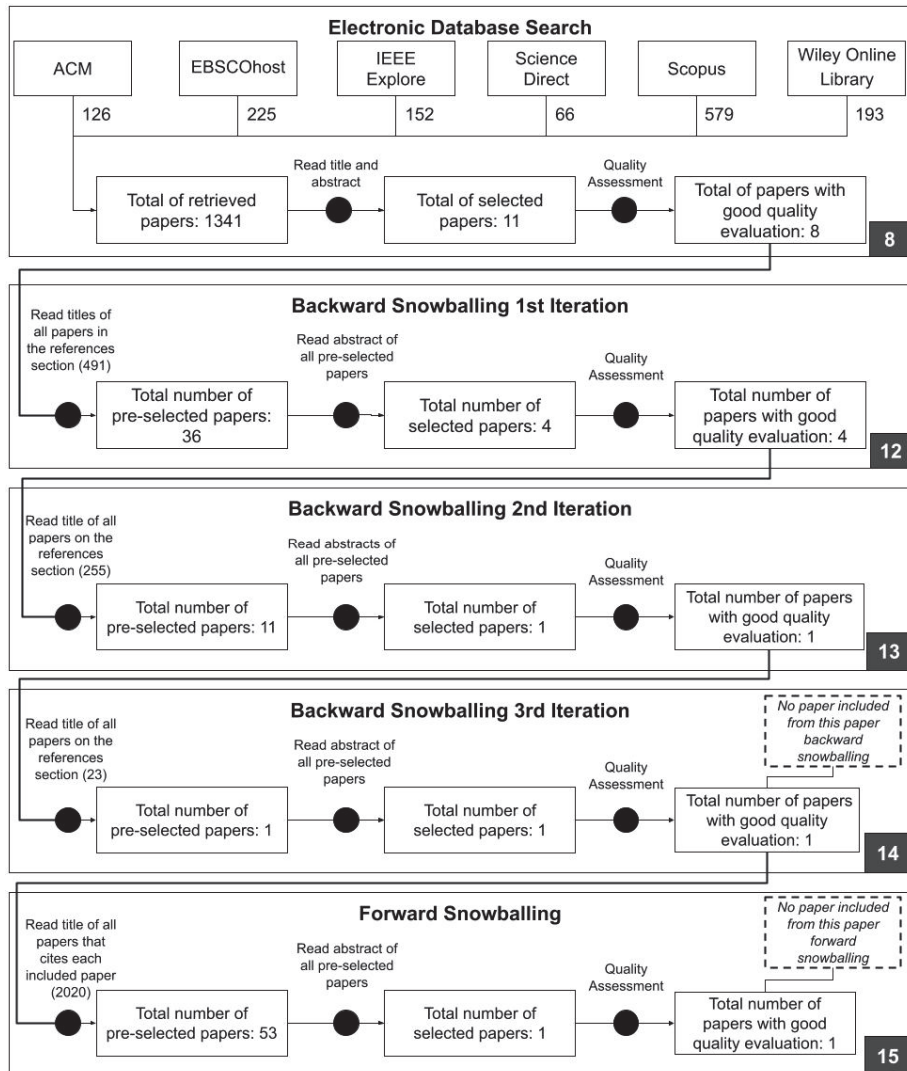


Fig. 11. Search process with numbers.

More than 50% of the studies included (8 out of 15) were retrieved from the electronic databases; therefore, this was the most efficient phase. The phase with the smallest number of included studies was forward snowballing, despite the analysis of the highest number of studies. However, since the snowballing goal was to complement the search, this did not pose a problem.

3.1 Overview of the studies

This section presents an overview of the studies included. First, the list of included studies is presented, followed by some of their characteristics, such as the databases where they can be recovered, year of publication, research methods used, publication venues, and quality-assessment results.

3.1.1 List of included studies

The 15 primary studies included in this SLR are shown in Table 34. The complete reference for each one is presented, along with an ID used to refer to it henceforth.

Table 34. List of included studies.

| ID | Reference |
|----|--|
| S1 | Neuert, J., & Hoeckel, C. A. (2013). The Impact of Personality Traits and Problem Characteristics on Management Decision-Making Outcomes: Some Experimental Findings and Empirical Conclusions. <i>Journal of Business and Management</i> ; Fort Collins, 19(3), 79–96. |
| S2 | Selart, M. (2005). Understanding the role of locus of control in consultative decision-making: A case study. <i>Management Decision</i> , 43(3), 397–412. |
| S3 | Papadakis, Vassilis M. (2006). Do CEOs shape the process of making strategic decisions? Evidence from Greece. <i>Management Decision</i> , 44(3), 367–394. https://doi.org/10.1108/00251740610656269 |
| S4 | Müller, R., Spang, K., & Ozcan, S. (2009). Cultural differences in decision making in project teams. <i>International Journal of Managing Projects in Business</i> , 2(1), 70–93. https://doi.org/10.1108/17538370910930527 |
| S5 | Erjavec, J., Khan, N. Z., & Trkman, P. (2016). The impact of personality traits and domain knowledge on decision-making—A behavioral experiment. <i>Research-in-Progress Papers</i> . Retrieved from https://aisel.aisnet.org/ecis2016_rip/38/ |
| S6 | Torchia, M., Calabrò, A., & Morner, M. (2015). Board of Directors' Diversity, Creativity, and Cognitive Conflict. <i>International Studies of Management & Organization</i> , 45(1), 6–24. https://doi.org/10.1080/00208825.2015.1005992 |
| S7 | Kauer, D., Waldeck, T. C. P. zu, & Schäffer, U. (2007). Effects of top management team characteristics on strategic decision making: Shifting attention to team member personalities and mediating processes. <i>Management Decision</i> , 45(6), 942–967. https://doi.org/10.1108/00251740710762017 |
| S8 | Lin, H.-C., & Rababah, N. (2014). CEO–TMT exchange, TMT personality composition, and decision quality: The mediating role of TMT psychological empowerment. <i>The Leadership Quarterly</i> , 25(5), 943–957. |
| S9 | Hough, J. R., & Ogilvie, D. (2005). An empirical test of cognitive style and strategic decision outcomes. <i>Journal of Management Studies</i> , 42(2), 417–448. |

| ID | Reference |
|-----|---|
| S10 | Miller, D., & Toulouse, J.-M. (1986). Chief Executive Personality and Corporate Strategy and Structure in Small Firms. <i>Management Science</i> , 32(11), 1389–1409. https://doi.org/10.1287/mnsc.32.11.138 |
| S11 | Halley, U. C. V., & Stumpf, S. A. (1989). Cognitive trails in strategic decision making: Linking theories of personality and cognitions- Haley—1989— Wiley Online Library. <i>Journal of Management Studies</i> , 26(5), 477–497. https://doi.org/10.1111/j.1467-6486.1989.tb00740.x |
| S12 | Papadakis, V. M., & Barwise, P. (2002). How much do CEOs and top managers matter in strategic decision-making? <i>British Journal of Management</i> , 13(1), 83–95. |
| S13 | Hunt, R. G., Krzystofiak, F. J., Meindl, J. R., & Yousry, A. M. (1989). Cognitive style and decision making. <i>Organizational Behavior and Human Decision Processes</i> , 44(3), 436–453. https://doi.org/10.1016/0749-5978(89)90018-6 |
| S14 | Maniatis, P. (2016). Investigating influence of practical supply chain constraints on decision-making of SCM agents of different personality types. <i>International Journal of Applied Business and Economic Research</i> , 14(6), 3893–3907. |
| S15 | Francioni, B., Musso, F., & Cioppi, M. (2015). Decision-maker characteristics and international decisions for SMEs. <i>Management Decision</i> , 53(10), 2226–2249. https://doi.org/10.1108/MD-03-2015-0094 |

The studies were retrieved during two different phases: electronic-database search and snowballing. The following section presents the studies' distribution by electronic database, year, venue, and other analyses.

3.1.2 Distribution of studies included by database

Fig. 12 presents a summary of the electronic-database search phase. Note that most of the databases did not return any relevant studies; in fact, only two of the six databases returned useful studies: EBSCOhost (1) and Scopus (7).

The most probable reason behind this is because EBSCOhost is a database with many venues related to the management field. In addition, because this SLR focused on companies, it makes sense that a database specific to the management field returned useful papers. Concerning SCOPUS, it is a database that indexes many other databases, which means that many potential areas and studies are included in it. This could explain the large number of studies drawn from this database.

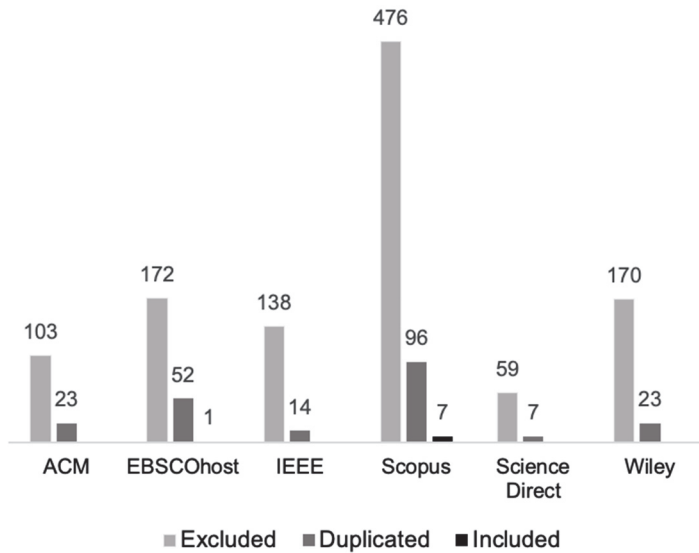


Fig. 12. Number of studies included per database.

The selection process included an initial screening of titles and abstracts, followed by a reading of potential studies' full texts. The initial screening resulted in 44 potential studies; however, the detailed check excluded most of them. Section 2.2.5 shows some examples of studies excluded after the detailed check.

A concern as to whether the search is broad enough is present in any SLR. In order to verify if all the relevant databases were included in this SLR, we consulted Google Scholar to search for each included paper and, using the option “*all versions*”, we checked the databases from which it can be retrieved. Table 35 shows the results of this analysis.

The databases that are not included in this SLR database list are: AIS Electronic Library, APA PsycNet, Connecta, Emerald Insight, Infona, Ingenta JSTOR, Proquest, Taylor&Francis. Most of them are indexed by Scopus and EBSCOhost, including AIS, Emerald Insight, Ingenta, and Proquest. Others are **not** supported by the University of Oulu library, including APA PsycNet and Taylor&Francis. Considering that the listed databases or it is already included or could not be included due to the criteria mentioned in Section 2.2, we believe that the search conducted in this SLR sufficiently covered the amount of work available on the target subject.

Table 35. Studies included by database.

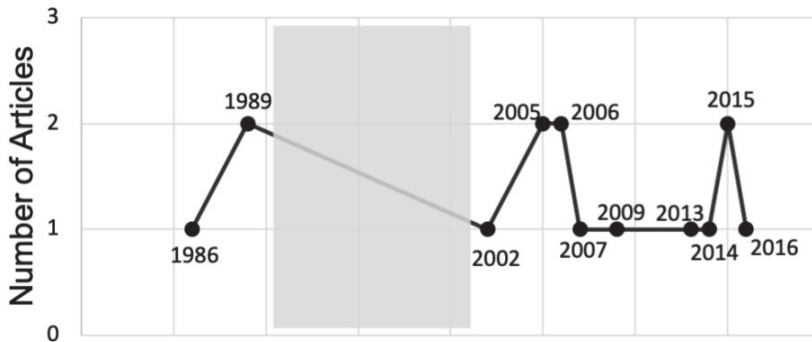
| ID | Databases where the included studies can be found |
|-----|---|
| S1 | EBSCOhost, Proquest |
| S2 | Scopus, Emerald Insight, Ingenta |
| S3 | Emerald Insight, Scopus |
| S4 | Emerald Insight, Scopus |
| S5 | AIS Electronic Library, Scopus |
| S6 | Taylor&Francis, Scopus |
| S7 | APA PsycNet, Emerald Insight, Ingenta Connect, Scopus |
| S8 | Elsevier, Infona, Scopus |
| S9 | Wiley, Ingenta |
| S10 | ACM, EBSCOhost, JSTOR |
| S11 | Wiley |
| S12 | Wiley, Ingenta |
| S13 | Elsevier |
| S14 | Scopus |
| S15 | Emerald Insight, Ingenta |

3.1.3 Temporal view of the included studies

Fig. 13 presents the temporal distribution of the studies included in this SLR. Note that 20% of the included papers (three studies) were published in the 1980s and 80% after 2001. Furthermore, there are no publications from between 1990 and 2001.

The studies published during the 1980s were found through backward snowballing, and all of them are in the management field. Two of these three studies discuss personality as a cognitive style and use the MBTI to assess personality.

The papers published after 2001 employ many different personality instruments and discuss various decision-making aspects. Note that there are no publications from the years 2003, 2004, 2008, 2010, 2011, and 2012. Despite this, it is possible to conclude that interest in this topic grew after 2002. The many years without publications led us to investigate the reasons behind this observation. The next section attempts to provide an explanation.



Note: the shadow area represents the years that this SLR did not recover any publication.

Fig. 13. Temporal distribution of the included articles.

3.1.4 Researchers' motivation

An intriguing fact motivated to another analysis: only one author, Vassilis Papadakis, has more than one study included in this SLR (S3 and S12). All the other authors published only one paper on the relationship between personality and decision-making. Two hypotheses were developed to explain this: (H1) the paper was funded by an institution, and when the funding ended, the research also terminated; (H2) the study was a result of Ph.D. research, and after it ended, the authors did not investigate this subject further.

In order to check whether the proposed hypotheses are valid, the acknowledgments section of all the included papers was checked for any information about financial support (H1). The first author's curriculum vitae (when available) was also verified to draw conclusions about H2. The results of this analysis are shown in Table 36.

Regarding research motivation, only three studies mention any financial support (S9, S10, and S11). Furthermore, the curriculum-vitae analysis revealed that only two studies were part of a Ph.D. thesis (S7 and S11). Therefore, the information collected was not enough to support either hypothesis.

Table 36. Results for the researchers' motivation and research funding.

| ID | Does the study mention any funding in the acknowledgments section? | Was the study published around the year that the first author received a Ph.D. degree? |
|-----|--|--|
| S1 | No | No |
| S2 | No | No |
| S3 | No | No |
| S4 | No | No |
| S5 | No | No |
| S6 | No | No |
| S7 | No | Yes |
| S8 | No | No |
| S9 | Yes | ?? ¹ |
| S10 | Yes | No |
| S11 | Yes | Yes |
| S12 | No | No |
| S13 | No | ?? ¹ |
| S14 | No | No |
| S15 | No | No |

¹ Cells marked with “??” indicate that it was not possible to check the information.

3.1.5 Research methods

The studies included comprise case studies, surveys, experiments, and some mixed types. Most of the studies can be classified as surveys (47%; seven papers) or experiments (33%; five papers). Fig. 14 shows a pie chart with the distribution of studies by research methodology.

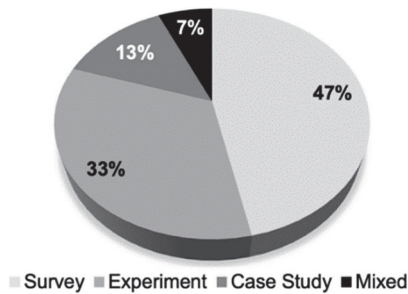


Fig. 14. Research methods employed by the included articles.

The name of the research method registered in this SLR for each study is the exact method that the authors claimed that they employed. However, it is not very easy to defend in some cases – using only the document analyzed – that the authors used the methods they claimed, especially for experiments.

According to Wohlin et al. (2012), a controlled experiment manipulates variables and, based on randomization, sets different treatments for different subjects. It becomes a quasi-experiment when it is not possible to choose the subjects for different treatments based on randomization. Therefore, randomization is a crucial aspect of planning and executing an experiment.

Based on the above-stated definition, we checked six items for each paper that claims to be an experiment:

1. Are the hypotheses stated?
2. Are the variables for which the data were collected defined?
3. Are the independent variables (IVs) and dependent variables (DVs) clearly mentioned in the text?
4. Are the randomization procedures mentioned in the text?
5. Are the measurement procedures for each variable mentioned in the text?
6. Are the statistical techniques used to analyze the data mentioned in the text?

The results of this check are presented in Table 37; the columns represent the six abovementioned items, respectively.

Table 37. Analysis of the studies that claim to employ experiment as a research method.

| Study ID | (1) Hypothesis | (2) Variables Studied | (3) IVs and DVs | (4) Randomization | (5) Measurement Procedures | (6) Statistical Techniques |
|----------|-------------------|--------------------------|--------------------|----------------------|-------------------------------|-------------------------------|
| S1 | yes | yes | yes | no | yes | yes |
| S5 | yes | no | no | no | yes | yes |
| S9 | yes | yes | no | no | yes | yes |
| S11 | yes | yes | no | no | yes | yes |
| S13 | yes | no | no | no | yes | yes |

Note that none of the studies presented in Table 36 mention the randomization aspect, and some of them do not explicitly mention the IV's and DV's (S5, S9, S11, and S13). However, the studies employed some common statistical techniques in experiments, such as the chi-squared test (S1, S9), ANOVA (S13), and *t*-test (S11). According to the information presented in 6 and the definition of an experiment

(Wohlin et al., 2012), we would classify most of these papers as *quasi-experiments* rather than controlled experiments.

3.1.6 Venues

Most of the included studies are published in journals (93%; 14 studies). The complete list of venues, including journal titles and conference names, is presented in Table 38.

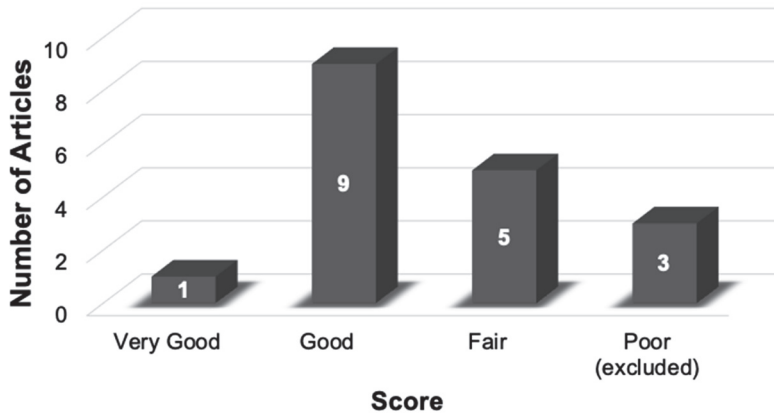
Table 38. List of Journals and Conferences.

| Venue | # Articles | References |
|---|------------|---------------------|
| Journal | | |
| British Journal of Management | 1 | S12 |
| International Journal of Applied Business and Economic Research | 1 | S14 |
| International Journal of Managing Projects in Business | 1 | S4 |
| International Studies of Management and Organization | 1 | S6 |
| Journal of Business and Management | 1 | S1 |
| Journal of Management Studies | 2 | S9, S11 |
| Management Decision | 5 | S2, S3, S7, S8, S15 |
| Management Science | 1 | S10 |
| Organizational Behavior and Human Decision Processes | 1 | S13 |
| Conference | | |
| European Conference on Information Systems (ECIS) | 1 | S5 |

All journals are from the business and management field, and the journal with the largest number of papers focuses on decision-making. We could find only one paper from the conference list, and the venue is within the information systems field.

3.1.7 Quality assessment

The criteria used to assess the quality of the studies are presented in Table 19. Ten criteria were employed; however, only seven of them add to the study's final score. For each question that adds to the final score, there are three possible answers: "yes" (adds 1.0 point to final score), "partially" (adds 0.5 points), and "no" (does not modify the score). Fig. 15 shows the studies assessed and their final scores.



Note: Score ≥ 6.1 : very good; score ≤ 6 and > 5 : good; score ≤ 5 and > 3.5 : fair; score ≤ 3.5 : poor (all articles below a score of 3.5 were excluded, i.e., 50% of the highest score).

Fig. 15. Quality assessment results.

Most of the included studies fail to mention the threats related to the relationship between the researcher and the subjects. It is important to mention these threats, such that the reader can be aware of the bias associated with the researcher-subject interaction – in other words, bias related to the data collection.

Three papers were excluded due to poor quality; one was found during the e-database search, another in the third iteration of backward snowballing, and the last one during forward snowballing. The problem with these studies is the data analysis; they collected data about the relationship examined, but the authors did not succeed in drawing a proper conclusion. These studies also fail to discuss the relationship between the researcher and the subjects, among other problems. Table 39 shows the details of the quality assessment of each paper, including the excluded ones.

The complete references of the rejected articles are presented below. They are referred to in Table 39 as E1, E2, and E3.

- **E1:** Su-li, Z., & Ke-fan, X. (2010). Research on entrepreneurial team members' personality traits influence on group risk decision-making. 2010 International Conference on Management Science Engineering 17th Annual Conference Proceedings, 937–942. <https://doi.org/10.1109/ICMSE.2010.5719911>
- **E2:** Kottemann, J. E., & Remus, W. E. (1988). When and how cognitive style impacts decision-making. [1988] Proceedings of the Twenty-First Annual Hawaii International Conference on System Sciences. Volume III: Decision

Support and Knowledge Based Systems Track, 3, 223–231. <https://doi.org/10.1109/HICSS.1988.11911>

- **E3:** Taylor, R. N., & Dunnette, M. D. (1974). Relative contribution of decision-maker attributes to decision processes. *Organizational Behavior and Human Performance*, 12(2), 286–298. [https://doi.org/10.1016/0030-5073\(74\)90052-X](https://doi.org/10.1016/0030-5073(74)90052-X).

Table 39. Results of quality assessment.

| ID | Quality Criteria ID | | | | | | | Final Score | Classification |
|-----|---------------------|-----------|-----------|-----------|-----------|-----|-----|-------------|----------------|
| | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| S1 | Yes | Partially | Yes | Yes | No | Yes | Yes | 5.5 | Good |
| S2 | Yes | Yes | Yes | Yes | No | Yes | Yes | 6.0 | Good |
| S3 | Yes | Yes | Yes | Yes | No | Yes | Yes | 6.0 | Good |
| S4 | Yes | Yes | Partially | No | No | Yes | Yes | 4.5 | Fair |
| S5 | Yes | Yes | Yes | Yes | No | Yes | Yes | 6.0 | Good |
| S6 | Yes | Yes | Partially | Yes | No | Yes | Yes | 5.5 | Good |
| S7 | Yes | Yes | Partially | Yes | Partially | Yes | Yes | 6.0 | Good |
| S8 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | 7.0 | Very good |
| S9 | Yes | Yes | Yes | Yes | No | Yes | Yes | 6.0 | Good |
| S10 | Yes | Yes | Yes | Yes | No | Yes | Yes | 6.0 | Good |
| S11 | Yes | Partially | Yes | Yes | No | Yes | Yes | 5.5 | Good |
| S12 | Yes | Yes | Partially | Yes | No | Yes | Yes | 5.5 | Good |
| S13 | Yes | Yes | Yes | No | No | Yes | Yes | 5.0 | Fair |
| S14 | Yes | Yes | Yes | Yes | No | Yes | Yes | 6.0 | Good |
| S15 | Yes | Yes | Yes | Yes | No | Yes | Yes | 6.0 | Good |
| E1 | Yes | No | Partially | No | No | No | Yes | 2.5 | Poor |
| E2 | Yes | No | No | Partially | No | Yes | Yes | 3.5 | Poor |
| E3 | Yes | Yes | Partially | No | No | No | Yes | 3.5 | Poor |

Table 39 presents the assessment only for criteria 4 to 10, because the assessment of criteria 1, 2, and 3 aim to decide if it is worth conducting the quality assessment. This means that all the studies presented in the table fulfill the three criteria.

3.1.8 The answers to the research question

The main research question (RQ-SLR1) of this SLR is: ***“What is the relationship between personality and decision-making?”*** and it contains four associated sub-questions. Specifically, RQ-SLR1.1 focuses on the personality aspect, RQ-SLR1.2 on the decision-making aspect, RQ-SLR1.3 on the link between personality and decision-making, and RQ-SLR-1.4 on other factors that can affect the relationship

(i.e., moderating and mediating factors). The answer to the main RQ is given by the answers to its related sub-questions.

Regardless of the detailed answers to the sub-questions, it is possible to briefly conclude that: (1) there is a link between decision-making and personality; (2) the relationship between personality and decision-making has been characterized in different ways, depending on how personality is assessed; (3) there is no standard way to measure decision-making aspects; and (4) few studies have explored mediating and moderating factors. The answer to each SLR sub-RQ detailed in Section 2.2.3 is presented in the following sections.

Personality aspects and respective instruments investigated as they relate to decision-making (RQ-SLR 1.1)

From the 15 included studies, we extracted 28 personality aspects, as measured by eight different instruments. Table 40 lists the instruments, the related personality aspects, and the studies where they were found.

The most commonly employed are the MBTI and Steers and Braunstein Instrument (four studies for each), followed closely by the FFM and Rotter's Locus of Control Instrument (three studies for each).

Although four different studies employed the **MBTI**, each one uses it differently. For example, S9 compares dichotomies of personality type and relates them to a decision-making aspect. On the other hand, S11 chooses to analyze some possibilities of MBTI personality types. Finally, S1 and S13 take the MBTI aspect "*process of perception*" as their focus.

On the other hand, the studies that use the **Steers and Braunstein Instrument** do so homogeneously – i.e., the authors characterize the subjects according to the *need of achievement* and draw conclusions relating it to some decision-making aspect.

In terms of **personality aspects**, the most investigated are: (1) need of achievement, with four studies, and (2) agreeableness, extraversion, neuroticism, and locus of control, with three studies for each. The need of achievement is measured by one of the most refereed instruments: Steers and Braunstein Instrument. Agreeableness, extraversion, and neuroticism are measured using the FFM instrument, and locus of control is measured with Rotter's instrument.

Table 40. Instruments identified and related personality aspects.

| Instrument | Personality aspect | References |
|---|---|----------------------|
| Five-Factor Model | Extraversion | S5, S8, S14 |
| | Agreeableness | S5, S8, S14 |
| | Conscientiousness | S8, S14 |
| | Neuroticism | S5, S8, S14 |
| | Openness | S8, S14 |
| Myers-Briggs Type Instrument | Sensing/Intuition | S9 |
| | Thinking/Feeling | S9 |
| | Extroversion/ Introversion | S9 |
| | Judging/Perceiving | S9 |
| | Sensing-thinking | S11 |
| | Intuition-thinking | S11 |
| | Sensing-feeling | S11 |
| | Intuition-feeling | S11 |
| | Analytic | S1, S13 |
| | Intuitive | S1, S13 |
| | Mixed types (analytic and intuitive) | S13 |
| Steers and Braunstein Instrument | Need of achievement | S3, S10, S12, S15 |
| Business-focused Inventory of Personality | Flexibility | S7 |
| | Achievement motivation | S7 |
| | Networking abilities | S7 |
| | Action orientation | S7 |
| Flexibility scales of the California Psychological Inventory | Flexibility | S10 |
| Rotter's Locus of Control Instrument | Locus of control | S2, S3, S10 |
| Jackson Personality Inventory + Eysenck and Eysenck Instrument | Risk propensity | S3, S13 |
| Hyrsky and Tuunanen Instrument | Risk attitude | S15 |
| No Mention of Personality Instrument | Personality differences | S4 |
| | Diversity in personality | S6 |

Two studies do not mention any specific instrument (S4 and S6) but defined their own way of calculating the personality aspect they are studying. The next section focuses on the decision-making aspects (RQ-SLR1.2).

Decision-making aspects investigated as they relate to personality (RQ-SLR1.2)

In order to better understand the decision-making aspects, we decided to aggregate them in classes, entities, and attributes, using the guidelines presented by Cruzes and Dybå (2011) and the model defined by Fenton and Bieman (2014, p. chap. 1 and 3). The aggregation is presented in Table 41 with a brief description and references in which the decision aspect is discussed. This aggregation was discussed and approved by the supervisors to prevent bias. The term “attribute” is used synonymously in this document with “aspect”.

The **decision-making** class is related to the decision as to the output of a decision-making process. The **decision-maker** class is associated with the person who makes the decision, and it has four entities: characteristics, decision biases, decision style, and orientation. Finally, the **decision-making process** class aggregates the main and mediating processes of strategic decisions.

The class with the largest number of studies is decision-maker (nine studies), followed by decision-making (five studies), and strategic decision-making (four studies).

Most of the decision attributes have only one related study. However, this is not true for decision quality (with two studies), lateral communication (two studies), hierarchical decentralization (two studies), politicization (three studies), and comprehensiveness/rationality (three studies).

Table 41. Decision-making aspects identified.

| DM Aspect | Entity | Attribute | References | Description ¹ |
|-----------------|----------------------------------|----------------------------------|---|---|
| Decision-making | Characteristics | Decision-making efficiency | S1 | The time taken to perform the decision-making tasks. |
| | | Cognitive conflict | S6 | This is a disagreement about the content of the tasks being performed, including differences in viewpoints, ideas, and opinions. |
| | Perceived decision effectiveness | Decision quality | S8, S9 | This is related to how "good" the decision is. |
| | | Perceived decision effectiveness | S9 | How each person sees his/her own ability to implement a decision. |
| Decision-maker | Characteristics | Decision-making time span | S10 | The time impact of a decision (short or long term). |
| | | Confidence | S5 | This is a decision-maker's level of belief about the desired outcome. |
| | | Creativity | S6 | This is related to the number of ideas generated by a decision-maker. |
| | | Decisiveness | S9 | The total number of problems addressed by an individual manager during the simulation was used to indicate a manager's decisiveness. |
| | Decision biases | Analysis style | S10 | The analysis style of a decision-maker (e.g., intuitive, analytical or informal). |
| | | Proactiveness style | S10 | How the decision-maker acts during a decision (e.g., reactive or proactive). |
| | | Risk-taking style | S10 | How the decision-maker faces a known risk: by taking it, avoiding it, or acting in a neutral way. |
| | | Input biases | S11 | The decision biases are related to a cognitive ability that can culminate in inferior decisions. Input, output, and operational biases are related to when (during a decision-making process) the biases can occur. |
| | | Output biases | S11 | |
| | | Operational biases | S11 | |
| Decision styles | General | S4 | Indicates the way decisions are made and implemented. | |
| | Analytic decision | S13 | | |
| | Intuitive decision | S13 | | |
| | Mixed-type Decision | S13 | | |
| | Participative | S2 | | |
| | Group consultative | S2 | | |

| DM Aspect | Entity | Attribute | References | Description ¹ |
|-------------------------|-------------------------|--------------------------------------|--------------|---|
| Decision-making process | Orientation | Profit and environmental Orientation | S14 | The orientation is related to what the decision-maker considers important during decision-making. |
| | | Cultural orientation | S14 | |
| | | Sustainability orientation | S14 | |
| | Process characteristics | Comprehensiveness/Rationality | S3, S12, S15 | This is a measure of how rational a decision-maker is, considering the five steps of the decision-process: (1) situation diagnosis, (2) alternative generation, (3) alternative evaluation, (4) making of the final decision, and (5) decision integration. |
| | | Hierarchical decentralization | S3, S12 | This is related to the total amount of participation from various hierarchical levels and departments in each phase of the decision process. |
| | | Lateral communication | S3, S12 | The degree of balanced participation from all major departments in the adopted five stages of the process. |
| | | Politicization | S3, S12, S15 | This measures the degrees of coalition formation, negotiation taking place among major participants, external resistance encountered, and process interruptions experienced. |
| | Mediating process | Timing of agenda setting | S7 | Related to the time that the team takes to define an agenda (early or late). |
| | | Number of strategic alternatives | S7 | Related to the number of alternatives generated by the team during decision-making (many or few). |
| | | Strategic decision-making speed | S7 | Related to how fast a team makes a decision (fast or slow). |

¹ The descriptions are inspired by or, in some cases, taken directly from the study that investigates the decision-making aspect.

The identified relationships between personality and decision-making aspects (RQ-SLR1.3)

The total number of identified relationships between personality and decision-making aspects is 75. This number was obtained through the following process. A table with all the personality aspects identified in the first row and all the decision-making aspects identified in the first column was created. Subsequently, each cell that connects a personality and a decision-making aspect with a reported study on that relationship was filled with the study ID and a symbol that somehow represents that relationship. Each non-empty cell was counted as a reported relationship. Table 42 presents a summary of the relationships identified.

Table 42. Number and percentage of relationships per personality aspect and per decision-making aspect.

| Group | # Relationships | Percentage |
|--|-----------------|------------|
| Personality Instruments | | |
| Myers-Briggs Type Indicator | 22 | 29.33 % |
| Five-Factor Model | 12 | 16.00 % |
| Business-focused Inventory of Personality | 12 | 16.00 % |
| Rotter's Locus of Control Instrument | 7 | 9.33 % |
| Steers and Braunstein Instrument | 6 | 8.00 % |
| No specific model | 6 | 8.00 % |
| Jackson Personality Inventory + Eysenck and Eysenck Instrument | 4 | 5.33 % |
| Flexibility scales of the California Psychological Inventory | 4 | 5.33 % |
| Hyrsky and Tuunanen Instrument | 2 | 2.67 % |
| Decision-Making Aspects | | |
| Decision-maker | 38 | 50.67 % |
| Decision-making process | 24 | 32.00 % |
| Decision-making | 13 | 17.33 % |

With regard to the personality instruments, the one with the highest number of reported relationships is the MBTI, followed by the FFM and the Business-focused Inventory of Personality. On the decision-making aspects side, the decision-maker class contains the highest number of relationships. The relationships were studied in three quantitative ways, as shown below:

1. **Comparing personality dichotomies:** 13 reported relationships.
Example: Compare how the decision effectiveness differs in extroverted and introverted people.

2. **Calculating the percentage for each personality type:** eight reported relationships.

Example: The use of anchoring during decision-making is observed in 82.5% of the sample with sensing-thinking personality type.

3. **Verifying if the relationship between a personality and decision-making aspect is positive** (an increase in a personality variable impacts in an increase in a decision-making variable), **negative** (an increase in a personality variable impacts in a decrease in a decision-making variable), **or neutral** (no relationship detected): among 51 reported relationships, 32 are positive, 18 negative, and one neutral.

Only one study involves qualitative analyses (S7), representing three relationships (3.94%).

All the abovementioned relationships are shown from Table 43 to Table 47, arranged by personality instrument. Along with the study in which the relationship is reported, there is also a symbol that characterizes the relationship. The meaning of each symbol is explained with the instrument related to it.

Table 43 shows all 22 relationships reported using the **MBTI**, which is used in four different ways:

1. **Comparing personality dichotomies:** This kind of study is indicated in the table with the words “greater than” or “no diff.” “X higher than Y” means that the personality type X has a greater impact than Y on the decision-making aspect in question. The words “no diff” mean no difference in each personality aspect's impact in the decision-making aspect.
2. **Comparing two or more different MBTI personality types in relation to their impact on some decision-making aspect:** This kind of study is represented using the “>” sign. On the same line of the table, it is possible to see some cells with one or more of these signs. The greater the number of “>” signs, the greater the strength of the link between the MBTI type and the decision-making aspect.
3. **Percentage of subjects with a certain MBTI personality type and simultaneously have a certain decision-making style or present a decision-making bias:** In this case, the study calculates the percentage of people with a particular MBTI personality type who has a decision-making style or present a decision bias.

4. **Positive, negative, or non-existent relationship between personality and decision-making aspects:** In this case, the study applied statistical techniques to verify the relationship between personality and decision-making aspects. These cases are marked with the “+” sign (for a positive relationship between the personality and decision-making aspects), “-“ (negative relationship), or “0” (no correlation found).

The personality aspects most commonly studied by the MBTI are the sensing-thinking (4 related relationships) and intuition-thinking (4) types, followed by sensing-feeling (3). In terms of decision-making aspects, the most common ones are decisiveness (6), followed by decision quality (4), and perceived decision effectiveness (3). All the relationships are shown in Table 43.

The combination of the four groups of dichotomies defined by the MBTI results in 16 different personality types; however, none of the studies that use the instrument consider all the dichotomies simultaneously. Perhaps the reason is the complexity that would result from the combination of all the dichotomies.

Three papers adopted an FFM instrument to study 12 different relationships, as shown in Table 44. Unlike the MBTI, the FFM was used in only one way: to determine a positive (+) or a negative (-) relationship between a personality and a decision-making aspect.

From the five personality factors defined by the FFM, agreeableness and openness each have three reported relationships. The other three factors (extraversion, conscientiousness, and neuroticism) have two reported relationships each. Note also that only agreeableness and neuroticism have negative relationships with a decision-making aspect.

Concerning the decision-making classes, the decision-maker has 11 investigated relationships, and decision-making has only one. Among the decision-making aspects, the decision quality is investigated only for the relationship with openness. Therefore, the impact of the other traits on this decision-making aspect is unknown. All the other decision-making aspects have at least three personality traits related to them; however, it would be interesting to check the relationship with all five traits.

Table 43. Reported relationship using MBTI.

| Personality x Decision-Making Aspects | T/F ¹ | E/I ² | J/P ³ | ST ⁴ | IT ⁵ | SF ⁶ | IF ⁷ | A ⁸ | I ⁹ | Mixed ¹⁰ |
|---------------------------------------|-----------------------|-----------------------|------------------|-----------------|-----------------|-----------------|-----------------|----------------|----------------|---------------------|
| Decision-Making | | | | | | | | +/-,11 | | |
| Characteristics | | | | | | | | | | |
| Decision-making efficiency | | | | | | | | | | |
| Decision quality | | | | > | >>> | > | >> | | | |
| | | | (S9) | (S9) | (S9) | (S9) | (S9) | | | |
| Perceived decision Effectiveness | T greater than F (S9) | E greater than I (S9) | No diff (S9) | | | | | | | |
| Characteristics | | | | | | | | | | |
| Decisiveness | | No diff (S9) | No diff (S9) | >> | >>>> | > | >>> | | | |
| | | (S9) | (S9) | (S9) | (S9) | (S9) | (S9) | | | |
| Decision biases | | | | 82% | | | | | | |
| INPUT – Anchoring | | | | (S11) | | | | | | |
| INPUT – Perseverance | | | | | 91% | | | | | |
| INPUT – Availability | | | | | (S11) | | | | | |
| OUTPUT - Functional Fixedness | | | | 36% | | | | 80% | | |
| | | | | (S11) | | | | (S11) | | |
| OUTPUT – Positivity | | | | | 36% | | | | | |
| | | | | | (S11) | | | | | |

| Personality x Decision-Making Aspects | T/F ¹ | E/I ² | J/P ³ | ST ⁴ | IT ⁵ | SF ⁶ | IF ⁷ | A ⁸ | I ⁹ | Mixed ¹⁰ |
|---------------------------------------|------------------|------------------|------------------|-----------------|-----------------|-----------------|-----------------|----------------|----------------|---------------------|
| Decision styles | | | | | | | | 46% | | |
| Analytic | | | | | | | | (S13) | | |
| Intuitive | | | | | | | | | 56% | |
| | | | | | | | | | (S13) | |
| Mixed type | | | | | | | | | | 36% |
| | | | | | | | | | | (S13) |

¹ thinking x feeling, ² extraversion x introversion, ³ judging x perceiving, ⁴ sensing-thinking, ⁵ intuition-thinking, ⁶ sensing-feeling, ⁷ intuition-feeling, ⁸ analytic, ⁹ intuitive, ¹⁰ analytic and intuitive, ¹¹ Depending on the problem structure (if well-structured, the relation is positive; if ill-structured, the relationship is negative)

Table 44. Reported relationship using the FFM instrument.

| Personality Aspects × Decision-Making Aspect | | | E ¹ | A ² | C ³ | N ⁴ | O ⁵ |
|--|-----------------|--------------------------------------|----------------|----------------|----------------|----------------|----------------|
| Decision-making | Characteristics | Decision quality | | | | | + (S8) |
| Decision-maker | Characteristics | Confidence | - (S5) | - (S5) | | - (S5) | |
| | Orientation | Profit and environmental orientation | | - (S14) | - (S14) | | - (S14) |
| | | Cultural orientation | + (S14) | | | + (S14) | |
| | | Sustainability orientation | | + (S14) | + (S14) | | + (S14) |

¹ extraversion, ² agreeableness, ³ conscientiousness, ⁴ neuroticism, ⁵ openness

Business-focused Inventory has 12 relationships examined, all from the same study (S7). Note that some cases are valid only when the team has a similar degree of personality diversity; these cases are marked in Table 45 with an asterisk. Business-focused Inventory was studied with regard to a positive (+) or a negative (−) relationship between a personality and a decision-making aspect.

Table 45. Reported relationship using the Business-focused Inventory of Personality Instrument.

| Personality Aspects × Decision-Making Aspect | | | Flexibility | Achievement Motivation | Networking Abilities | Action Orientation |
|--|-------------------|----------------------------------|---------------------|------------------------|----------------------|---------------------|
| Decision-making process | Mediating process | Timing of agenda setting | + (S7) ¹ | + (S7) ¹ | + (S7) ¹ | − (S7) ¹ |
| | | Number of strategic alternatives | + (S7) ¹ | + (S7) ¹ | + (S7) ¹ | − (S7) ¹ |
| | | Strategic decision-making speed | + (S7) | + (S7) | + (S7) | + (S7) |

¹ The relationship is valid only when the team has a similar degree of personality diversity

While the BIP describes 14 characteristics classified into four different areas, only four of these characteristics have been studied, which means 10 non-studied characteristics. This is a research gap that can be investigated in future studies.

The Steers and Braunstein Instrument has six reported relationships, and all of them are either positive (+), negative (−), or neutral/non-existent (0) relationships. Table 14 presents all the relationships for this instrument.

Table 46. Reported relationship using the Steers and Braunstein Instrument.

| Personality Aspects × Decision-Making Aspect | | | Need of Achievement |
|--|-------------------------|---------------------------|---------------------|
| Decision-making | Characteristics | Decision-making time span | + (S10) |
| Decision-maker | Decision styles | Analysis style | + (S10) |
| | | Proactiveness style | + (S10) |
| | | Risk-taking style | 0 (S10) |
| Decision-making process | Process characteristics | Lateral communication | - (S12) |
| | | Politicization | + (S15) |

All the reported relationships for the Steers and Braunstein Instrument are between the need of achievement and one of the decision-making aspects. However, this instrument also measures three other personality aspects: affiliation, autonomy, and dominance; thus, there is a research gap regarding other personality aspects. Note also that all the decision-making aspects have the same number of reported relationships.

The remaining personality instruments identified in the studies included are presented in Table 47. All the relationships are either positive (+) or negative (-).

Table 47. Reported relationships using various instruments.

| Personality Aspects × Decision-Making Aspect | | | CPI ¹ | Rotter's | Hyrsky and Tuunanen's | JIP ² + Eysenck & Eysenck's |
|--|-------------------------|-------------------------------|------------------|------------------|-----------------------|--|
| | | | Flexibility | LOC ³ | Risk Attitude | Risk Propensity |
| Decision-making | Characteristics | Decision-making time span | + (S10) | - (S10) | | |
| Decision-maker | Decision styles | Analysis style | - (S10) | - (S10) | | |
| | | Proactiveness style | - (S10) | - (S10) | | |
| | | Risk-taking style | + (S10) | - (S10) | | |
| | | Participative | | + (S2) | | |
| Decision-making process | Process characteristics | Group consultive | | + (S2) | | |
| | | Comprehensiveness/Rationality | | | + (S15) | + (S12) |
| | | Hierarchical decentralization | | | | + (S3, S12) |
| | | Lateral communication | | | | + (S12) |
| | | Politicization | | - (S3) | + (S15) | - (S12) |

¹ California Psychological Inventory, ² Jackson Personality Inventory, ³ Locus of Control

The California Psychological Inventory (CPI) has 20 core personality scales; however, only flexibility has been investigated. Rotter’s instrument is specifically for locus of control, and two different studies employ it. The Jackson Personality Inventory (JIP) has 15 different scales, and the Eysenck and Eysenck Instrument involves three different personality dimensions; however, only risk propensity has been explored. Hyrsky and Tuunanen Instrument, it also contains items related to innovativeness; however, only risk attitude has been investigated. In summary, except for Rotter’s instrument, other personality aspects can be further investigated in the future.

Three papers do not mention any specific personality assessment instrument. The six relationships are shown in Table 48. The three aspects investigated are: personality (S7), personality differences (S4), and personality diversity (S6).

First, S7 uses the BIP and adds some general conclusions to the results, considering personality as one variable. In S4, personality differences are calculated using a questionnaire, but the authors did not provide the details. Finally, S6 calculates personality diversity by asking the subjects to evaluate the board members’ personality diversity with respect to three items: degree of creativity, orientation on action, and attitude to listening.

Table 48. Reported relationships with no mention of personality instrument from the field of psychology.

| Personality Aspect × Decision-Making Aspect | | | Personality | Personality Differences | Personality Diversity |
|---|-------------------|----------------------------------|-----------------|-------------------------|-----------------------|
| Decision-making | Characteristics | Cognitive conflict | | | + (S6) |
| Decision-maker | Characteristics | Creativity | | | + (S6) |
| | Decision styles | General | | + (S4) | |
| Decision-making process | Mediating process | Timing of agenda setting | not affect (S7) | | |
| | | Number of strategic alternatives | not affect (S7) | | |
| | | Strategic decision-making speed | affect (S7) | | |

Moderating and mediating aspects of the relationship between personality and decision-making (RQ-SLR1.4)

From all 15 studies included, only four (S1, S6, S7, S8) discuss mediating and moderating variables in the relationship between personality and decision-making. Each study analyzes one variable, which means four variables in total. These are discussed below.

Two studies, S1 and S7, report **moderating variables** on the relationship between personality and decision-making. In other words, these factors affect the direction and/or strength of a relationship (Baron & Kenny, 1986).

Meanwhile, S1 defines the variable **problem structure**, which characterizes a problem that requires a decision, considering four characteristics: statement and goal definition, number of correct answers, unknown elements required to reach the solution, and strategy required to solve the problem. According to the combination of these characteristics, the problem can be **well-, mid- or ill-structured**, as shown in Table 49.

Table 49. Problem structure variable defined in S1 and its possible values.

| Problem Structure | Statement and Goal Definition | Number of correct answers | Unknown Elements | Strategy to solve the problem |
|-------------------|---|--------------------------------------|---|--|
| Well-structured | Well-defined initial state and goals | There is one single correct answer | All elements required for the solution are known | Well-known strategy and rules to solve the problem |
| Mid-structured | The initial state and goals are defined but need some effort to be explicit | - | A limited number of concepts, rules, and principles are required to solve the problem | Metacognition is required |
| Ill-structured | Vague goal definition or no definition at all; unclear problem statement | No single objectively correct answer | Information needed to solve the problem is not in the problem statement; the problem is within a particular context; the problem is in between domain transfer capabilities | There is no algorithm available to solve the problem |

Each person in the experiment received three tasks with three different problems (one well-, one mid-, and one ill-structured). Fig. 16 shows the moderating effects studied in the experiment.

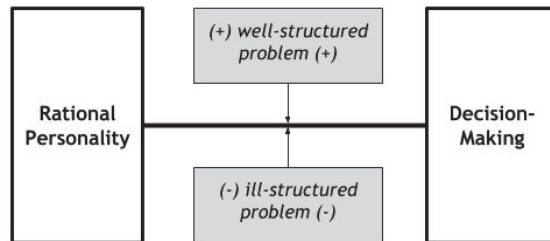


Fig. 16. Problem structure as a moderating factor.

As shown in the above figure, S1 concludes that a well-structured problem positively affects the relationship between a rational personality and decision-making, while an ill-structured problem affects this negatively.

The variable **similar degree of team diversity (SDTD)** is identified in S7 as another moderating factor. Team diversity has two possible values: homogeneous and heterogeneous. The authors did not show precisely how the variable was calculated; however, they indicated that the value was derived from two questions. The first one belongs to a questionnaire distributed at the beginning of the study, which contains a question about background experience.

Another question was posed during an interview. The interviewer asked the interviewee to classify his/her team either homogeneous or heterogeneous. Following data aggregation and analysis, the authors developed two propositions related to the moderating effect of SDTD:

*“P4 - If teams show a **similar degree of diversity**, the team whose members show high flexibility, achievement motivation, and networking abilities will have environmental changes earlier on their agenda and will develop more strategic alternatives.*

(...)

*P6 - If teams show a **similar degree of diversity**, the team whose members show high action orientation will have environmental changes later on their agenda and will discuss fewer strategic alternatives.”*

The other two studies (S6 and S8) discuss the **mediating effect** of some variables in the relationship between personality and decision-making – i.e., variables that explain or cause the relationship under investigation (Baron & Kenny, 1986).

Furthermore, S6 defines the variable **board member’s interaction (BMI)** as a mediating factor. During a decision-making process, the decision-makers need to interact with each other to reach a solution; the BMI aims to measure the degree of such interaction.

The board members were asked: (1) how often the board reopens previously closed issues based on suggestions from individual board members; (2) after consulting each other, how often board members ask the CEO to keep the board better informed; and (3) to what extent they prefer to consult each other rather than external consultants. The BMI value was calculated as a mean of each subject's answers for these three items. Fig. 17 shows the mediating factor of BMI reported in S6.

As shown in Fig. 17, the relationship between diversity in personality and degree of cognitive conflict disappears when there is BMI. On the other hand, the relationship between diversity in personality and the degree of creativity diminishes when there is such interaction.

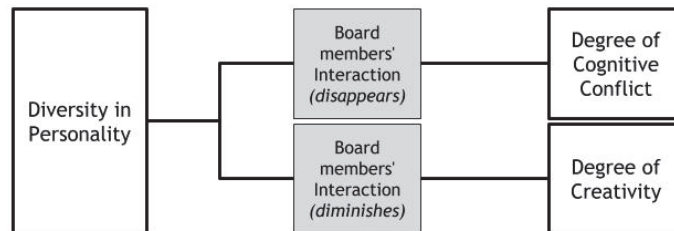


Fig. 17. Board member interaction (BMI) as a mediating factor.

Finally, S8 studies the mediation effect of top management team (TMT) psychological empowerment on the relationship between TMT personality composition variables and decision quality. The authors employed a 12-item questionnaire using a seven-point Likert-type scale to measure TMT psychological empowerment. Following data collection and analysis, the study S8 confirms the proposed hypothesis: *“TMT psychological empowerment partially mediates the relationships between TMT personality composition variables and decision quality.”*

Since only four studies discuss the moderating and mediating factors in the relationship between personality and decision-making, it is possible to conclude that further investigation is necessary.

3.2 Discussion

Although the set of included papers discusses various decision-making aspects (see Table 41), many of them need further investigation – for example, the level of participation of stakeholders in the decision-making process.

Regarding the personality aspects extracted from the included studies, many others require investigation. For example, the California Psychological Inventory has 20 different personality core scales, but only the flexibility scale has been investigated.

However, since the studies employed different instruments, it is necessary to aggregate the personality aspects to understand the gaps. Table 50 presents an aggregation of personality aspects under five factors: agreeableness, conscientiousness, extraversion, neuroticism, and openness. The reference used to make each association is also mentioned.

In Table 50, some personality aspects do not have any association; these cases are marked with “NF.” Table 51 shows the coverage of the five factors. Note that the items marked with “NF” in Table 50 are not included in the aggregation in Table 51. Considering the association presented in Table 50, the most commonly investigated factor is openness, and the least is extraversion.

There is a wide range of decision-making aspects investigated; however, there are some topics with a small number of studies or no studies at all. For example, consider group decision making (when the decision is made for a group of people): only 5 of the 15 included papers discuss aspects related to this type of decision (S6, S7, S8, S9, and S12). The decision-making aspects discussed in these papers are: timing of agenda setting (S7), number of strategic alternatives (S7), strategic decision-making speed (S7), board member’s interaction (S6), cognitive conflict (S6), decision quality (S8, S9), perceived decision effectiveness (S9), and strategical decision process characteristics (comprehensiveness/rationality, hierarchical decentralization, lateral communication, and politicization; S12).

Table 50. Personality aspects identified in this SLR and the associated FFM factor.

| Instrument | Personality Aspect | Association | Ref ¹ |
|--|-------------------------------------|---------------------------------|-----------------------------------|
| MBTI | Sensing/Intuition | O | (Furnham, Moutafi, & Crump, 2003) |
| | Thinking/feeling | A ² | (Furnham et al., 2003) |
| | Extra/introversion | N ³ , E ³ | (Furnham et al., 2003) |
| | Judging/perceiving | C ⁵ | (Furnham et al., 2003) |
| | Sensing-thinking | O ⁶ and A | (Furnham et al., 2003) |
| | Intuition-thinking | O and A | (Furnham et al., 2003) |
| | Sensing-feeling | O and A | (Furnham et al., 2003) |
| | Intuition-feeling | O and A | (Furnham et al., 2003) |
| | Analytic | - ⁷ | NF ⁸ |
| | Intuitive | - | NF |
| | Mixed-type (analytic and intuitive) | - | NF |
| Steers and Braunstein Instrument | Need of achievement | C | (Abatecola et al., 2013) |
| Business-focused Inventory of Personality | Flexibility | O | (Abatecola et al., 2013) |
| Personality | Achievement motivation | - | NF |
| | Networking abilities | A | (Abatecola et al., 2013) |
| | Action orientation | A | (Abatecola et al., 2013) |
| Flexibility Scales of the California Psychological Inventory | Flexibility | O | (Abatecola et al., 2013) |
| Rotter's Locus of Control Instrument | Locus of control | N, E | (Abatecola et al., 2013) |
| Jackson Personality Inventory + Eysenck and Eysenck Instrument | Risk propensity | - | NF |
| Hyrsky and Tuunanen Instrument | Risk attitude | E | (Furnham et al., 2003) |
| No mention of the instrument | Personality differences | All | - |
| | Diversity in personality | All | - |

¹ Reference that justifies the association to the FFM factor, ² Agreeableness, ³ Neuroticism, ⁴ Extroversion, ⁵ Conscientiousness, ⁶ Openness, ⁷ Many: The personality aspect is associated with many different FFM factors, ⁸ It was not possible to find a reference to support the association with any FFM factor

Table 51. Aggregated factors and their association with the papers included.

| Personality Trait | References | Number of relationships |
|-------------------|------------------------|-------------------------|
| Openness | S7, S8, S9, S10, S4 | 11 |
| Agreeableness | S5, S7, S9, S14 | 10 |
| Conscientiousness | S9, S10, S12, S14, S15 | 10 |
| Neuroticism | S2, S3, S5, S10, S14 | 9 |
| Extraversion | S5, S14, S15 | 4 |

There is a wide range of decision-making aspects investigated; however, there are some topics with a small number of studies or no studies at all. For example, consider group decision making (when the decision is made for a group of people): only 5 of the 15 included papers discuss aspects related to this type of decision (S6, S7, S8, S9, and S12). The decision-making aspects discussed in these papers are: timing of agenda setting (S7), number of strategic alternatives (S7), strategic decision-making speed (S7), board member's interaction (S6), cognitive conflict (S6), decision quality (S8, S9), perceived decision effectiveness (S9), and strategic decision process characteristics (comprehensiveness/rationality, hierarchical decentralization, lateral communication, and politicization; S12).

Therefore, if someone wants to investigate a specific decision-making aspect, there is a high probability that the aspect will not be found on our list. This means that further research on this topic is necessary to investigate a broader range of decision-making aspects and better explore their relationship with the personality aspects.

The results presented here are important to researchers studying human factors that can influence decision-making. The results can be used, for example, to decide which personality or decision-making aspect warrants further investigation. An individual or organization can also use the results to improve the decision-making process, for example, by helping to choose the best candidates to lead an important decision.

3.3 Limitations of the SLR

The most common limitations in an SLR are the biases introduced during the execution. These are also limitations in this work.

In order to prevent bias in general, we developed a detailed plan considering the guidelines presented by Kitchenham et al. (2015). Furthermore, to prevent selection bias, two experienced researchers (the main and co-supervisors) validated the selection phase. A detailed description of the validation process is presented in Section 2.2.1.

Bias related to poor coverage of the articles was prevented by employing a strategy for database selection. The strategy used other literature reviews to define the database list (see Section 2.2.4). The search string was also built considering the same literature reviews and calibrated using the principles defined by Zhang, Babar, and Tell (2011). Furthermore, the search strategy included backward and forward snowballing rather than only electronic-database searching.

With regard to the data extraction and quality assessment bias, two experienced researchers also reviewed part of the extracted data and judged it to be adequate.

However, even with all these strategies, there is still a probability that some studies on the relationship between decision-making and personality aspects were not included in this SLR. The same is true for the selection (perhaps a paper that should be included was omitted) and data-extraction data processes (some mistakes might have been introduced during the data extraction from the papers included).

3.4 Summary of the chapter

This chapter presented the results of an SLR conducted for this Ph.D. research. First, the SLR timeline was presented, followed by the list of the included studies. In total, considering all three search strategies adopted in this SLR, 3847 studies were analyzed; however, only 15 were included.

The included papers were then characterized by database and time. The oldest included study was published in 1986 and the newest one in 2016; however, there is a publication gap (of more than 10 years) in between.

The included studies were also characterized by the research method used and through an analysis of the publication venues. Most of the included papers employed surveys and experiments as research methods. In terms of the venues, the included papers were published in nine different journals and one conference; only one paper was not published in a venue within the management field. This chapter also presented a report of the quality assessment. Three papers were excluded due to their poor quality.

Finally, the answer to the research questions was presented. The included papers used eight different instruments to assess personality and studied 28 personality aspects. For decision-making, they studied 30 different aspects. A total of 75 relationships were identified, mostly via quantitative methods. We also identified four variables that moderate (two variables) or mediate (two variables) the relationship between personality and decision-making.

By the end of this chapter, some gaps were highlighted, as well as some limitations of this SLR.

4 Descriptive statistics of survey variables

This chapter discusses the characterization of each survey variable defined in Section 2.3.5. First, we introduce the demographics variables, followed by the personality and decision-making variables.

4.1 Demographic data

Table 52 displays the total number and corresponding percentages for each variable, measured as part of the demographics data. Most respondents are male (72.59%), ranging from 26 to 35 years old (57.84%). The most common role is technical (50%), and the most frequent education level is a bachelor's degree (62.75%). Furthermore, when the survey data were gathered, most participants had between two and five years of experience in software-engineering-related activities (35.29%).

Table 52. Demographic characteristics of survey participants.

| Gender | # | % | Experience | # | % |
|------------|----|--------|-----------------|----|--------|
| Male | 72 | 70.59% | Internship | 4 | 3.92% |
| Female | 30 | 29.41% | < 2 years | 7 | 6.86% |
| | | | 2 – 5 years | 36 | 35.29% |
| | | | 6 – 10 years | 20 | 19.61% |
| | | | 11 – 15 years | 20 | 19.61% |
| | | | > 15 years | 15 | 14.71% |
| Role | # | % | Education Level | # | % |
| Business | 6 | 5.88% | High School | 5 | 4.90% |
| Management | 18 | 17.65% | Bachelor's | 64 | 62.75% |
| Technical | 51 | 50.00% | Master's | 24 | 23.53% |
| Mixed | 27 | 26.47% | Ph. D. | 9 | 8.82% |
| Age Group | # | % | | | |
| ≤ 25 | 16 | 15.69% | | | |
| 26 – 35 | 59 | 57.84% | | | |
| 36 – 45 | 14 | 13.73% | | | |
| 46 – 55 | 9 | 8.82% | | | |
| > 55 | 4 | 3.92% | | | |

With regard to the education level, most respondents have at least a bachelor's degree. One exception in our data is a participant who has worked in software engineering for 11 to 15 years and only has a high-school degree.

Another finding is the number of responses in the “mixed”-role group, which represents participants who usually perform more than one role (e.g., technical and managerial). Many participants selected this option, which suggests that respondents may have a wide range of skills.

Fig. 18 shows the age distribution across gender and roles. The left-hand side of the figure indicates that, proportionally, the distribution of gender across age groups is similar. Although the number of responses is always greater for males, the percentage distribution is similar; for example, looking at the age group “25–35 years old,” there are 43 male respondents (59.7%) and 16 female respondents (53.3%). Such a trend runs across all age groups.

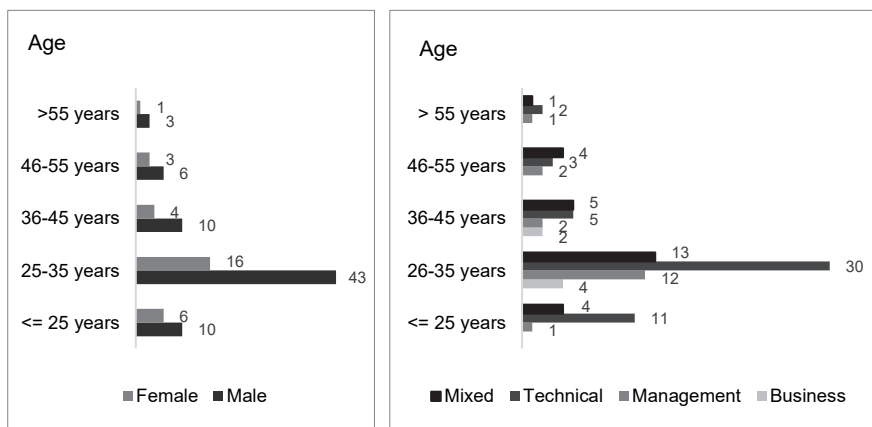


Fig. 18. Distribution of age groups by gender and role.

The right-hand side of Fig. 18 shows that the *technical* role has the highest number of both male and female respondents, which is not surprising, since this is the largest group in the survey sample. However, in the “36 – 45 years old” group, the number of answers to the *mixed* and *technical* role categories is the same, suggesting that *mixed* roles are more common among older respondents.

In all the roles, the “26 – 35 years old” group always has the greatest number of participants; this making sense, as this is the group with the largest number of respondents. Another observation is that participants who perform the business-related roles are between 25 and 46 years of age; in other words, *no participant below 25 or over 46 executes business roles*. Fig. 19 shows the *role* distribution across education and experience levels.

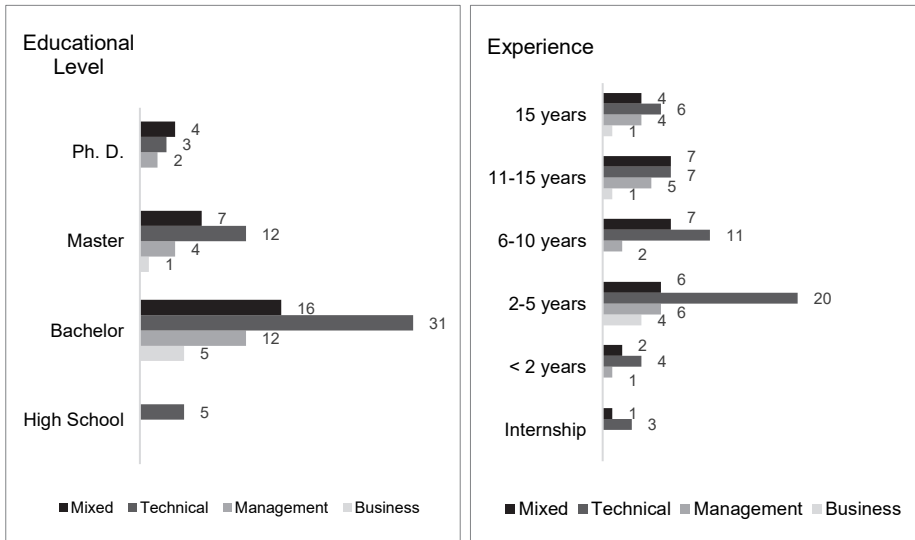


Fig. 19. Distribution of roles across education and experience levels.

The left-hand side of Fig. 19 shows the role distribution by education level. Note that all the participants with high-school degrees perform technical roles. Respondents who perform *business-related* roles have either *bachelor's* or *master's* degrees. Furthermore, the number of participants with *bachelor's* degrees is the largest in the listed roles, which is expected, since this is the degree that most of the survey participants have.

In terms of the role distribution by experience (Fig. 19; right-hand side), it seems that, as experience grows, the number of respondents in *technical* roles decreases. With *11 to 15 years* of experience, both *mixed* and *technical* roles had the same number of respondents. The *mixed* role does not seem to vary across experience level groups above 2 to 5 years. The next section presents descriptive statistics related to personality variables.

4.2 Personality

We received 102 responses to the personality questionnaire; this number is the sample size for each personality factor and facet. The personality score characterizes a participant's personality; a high score represents a high level in a particular factor or facet, and a low number indicates a low level. Each personality factor has a theoretical scoring range between 24 and 120, and each personality

facet between 4 and 20 (see Section 2.3.5 for details). Each factor is further subdivided into facets.

Fig. 20 illustrates the score distribution for each personality factor in boxplots, and Table 53 shows the numbers related to each plot. Among the personality factors, *agreeableness* has the highest maximum score; *extraversion* and *neuroticism* have the lowest ones. *Agreeableness* also has the highest median and *neuroticism* the lowest. In terms of the minimum score, *conscientiousness* has the greatest number, and *neuroticism* the smallest.

If outliers are included, the spread of *agreeableness* is the largest; if not, then *neuroticism* has the greatest spread. *Openness* has the smallest spread with outliers; however, *conscientiousness* has the smallest spread if we discard them.

Table 53. Descriptive statistics for each personality factor.

| Personality Factors | Min | Lower-Q | Median | Upper-Q | Max |
|-----------------------|-----|---------|--------|---------|-----|
| Agreeableness (A) | 48 | 85 | 92 | 98.25 | 114 |
| Conscientiousness (C) | 59 | 84 | 91 | 100 | 112 |
| Extraversion (E) | 45 | 69 | 78 | 87 | 99 |
| Neuroticism (N) | 36 | 56 | 65.5 | 75 | 99 |
| Openness (O) | 54 | 74 | 82.5 | 90 | 105 |

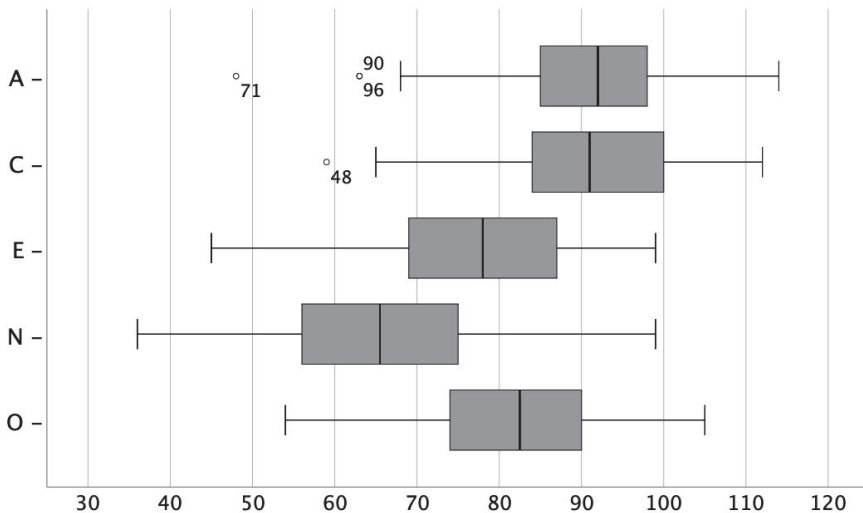


Fig. 20. Distribution of personality factors scores.

From Fig. 20, it is possible to note that agreeableness, along with all other factors, is left-skewed; the only exception is neuroticism, which is slightly right-skewed. Neuroticism is the personality factor with the distribution closest to the normal. The following sections show the score distribution for each personality facet, considering the personality factor that they pertain to.

4.2.1 Agreeableness

Agreeableness is the factor related to a *prosocial and communal orientation toward others* (John, Robins, & Pervin, 2010, p. 120), and it includes six facets: trust (A1), morality (A2), altruism (A3), cooperation (A4), modesty (A5), and sympathy (A6). The theoretical scores of the facets range between 4 and 20 (see Section 2.3.5 for details); a high score indicate a high level in the facet, and a low score signals a low level. Fig. 21 shows the boxplots for every agreeableness facet, and the corresponding numbers are shown in Table 54.

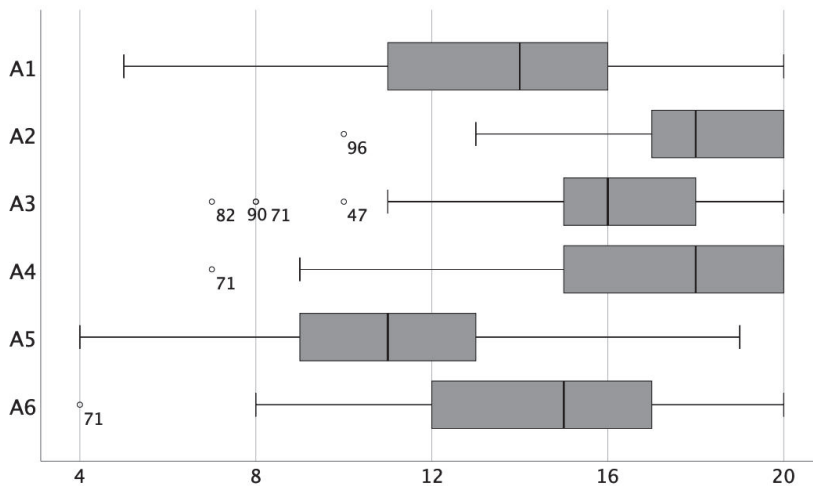


Fig. 21. Distribution of agreeableness facet scores.

Table 54. Descriptive statistics for each agreeableness facet.

| Agreeableness facet | Min | Lower-Q | Median | Upper-Q | Max |
|---------------------|-------|---------|--------|---------|-------|
| Trust (A1) | 5.00 | 11.00 | 14.00 | 16.00 | 20.00 |
| Morality (A2) | 10.00 | 17.00 | 18.00 | 20.00 | 20.00 |
| Altruism (A3) | 7.00 | 15.00 | 16.00 | 18.00 | 20.00 |
| Cooperation (A4) | 7.00 | 15.00 | 18.00 | 20.00 | 20.00 |
| Modesty (A5) | 4.00 | 9.00 | 11.00 | 13.25 | 19.00 |
| Sympathy (A6) | 4.00 | 12.00 | 15.00 | 17.00 | 20.00 |

All the agreeableness facets have the highest theoretical score, except for *modesty* (A5). *Morality* (A2) and cooperation (A4) have the highest median, and *modesty* has the lowest. Regarding the minimum score, morality has the highest number. The facets A5 and A6 have the lowest minimum score, which is also the lowest theoretical score.

If outliers are included, the spread for sympathy is the largest; otherwise, trust has the greatest spread. *Morality* has the smallest spread, even if outliers are not discarded.

Fig. 21 also provides some information about the skewness of the agreeableness facet scores. All the facets are left-skewed except for A5, which is slightly right-skewed. The following section presents the score distribution for the conscientiousness facets.

4.2.2 Conscientiousness

Conscientiousness describes *impulse control that results in a task and goal control behavior* (John et al., 2010, p. 120). It also has six facets: self-efficacy (C1), orderliness (C2), dutifulness (C3), achievement-striving (C4), self-discipline (C5), and cautiousness (C6). Table 55 and Fig. 22 show the score distribution for each of these six conscientiousness facets.

Table 55. Descriptive statistics for each conscientiousness facet.

| Conscientiousness Facets | Min | Lower-Q | Median | Upper-Q | Max |
|---------------------------|-------|---------|--------|---------|-------|
| Self-efficacy (C1) | 8.00 | 14.00 | 16.00 | 17.00 | 20.00 |
| Orderliness (C2) | 5.00 | 12.00 | 15.00 | 18.00 | 20.00 |
| Dutifulness (C3) | 10.00 | 15.00 | 16.50 | 18.00 | 20.00 |
| Achievement-striving (C4) | 11.00 | 15.00 | 16.50 | 18.00 | 20.00 |
| Self-discipline (C5) | 4.00 | 12.00 | 14.00 | 16.00 | 20.00 |
| Cautiousness (C6) | 4.00 | 12.00 | 15.00 | 17.00 | 20.00 |

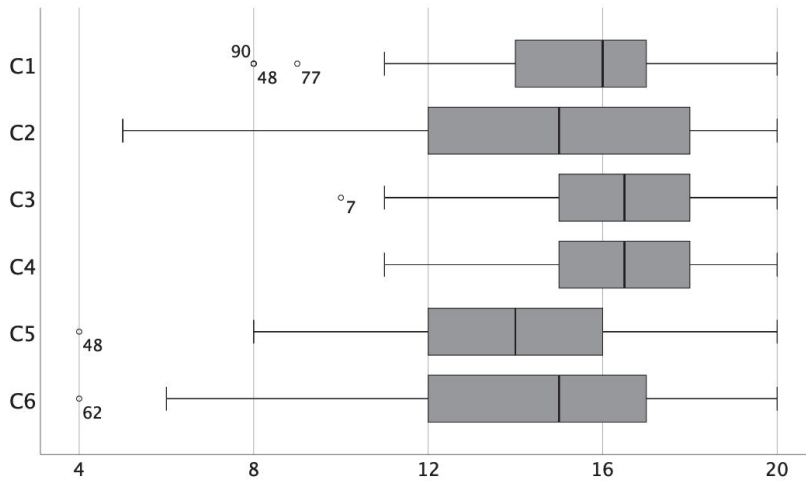


Fig. 22. Distribution of conscientiousness facets scores.

All the conscientiousness facets have the highest theoretical score, which is 20. *Dutifulness* (C3) and *achievement-striving* (C4) have the highest median, while *self-discipline* (C5) has the lowest. With regard to the minimum score, *achievement-striving* has the highest number. The *self-discipline* and *cautiousness* facets have the lowest minimum score, which is also the lowest theoretical score.

If outliers are included, the spreads of *self-discipline* and *cautiousness* (C6) are the largest; otherwise, *orderliness* (C2) has the greatest spread. *Achievement-striving* has the smallest spread.

Fig. 22 also highlights some information about the skewness of the conscientiousness facets scores. All the facets are left-skewed; however, C3 and C5 have an almost symmetric distribution. The next section presents the score distribution of the extraversion facets.

4.2.3 Extraversion

Extraversion *implies an energetic approach towards the social and material world* (John et al., 2010, p. 120). It includes six facets: friendliness (E1), gregariousness (E2), assertiveness (E3), activity level (E4), excitement-seeking (E5), and cheerfulness (E6). Table 56 and Fig. 23 show the score distribution in the survey sample for each extraversion facet.

Table 56. Descriptive statistics for each extraversion facet.

| Extraversion Facets | Min | Lower-Q | Median | Upper-Q | Max |
|-------------------------|------|---------|--------|---------|-------|
| Friendliness (E1) | 6.00 | 12.00 | 15.00 | 17.00 | 20.00 |
| Gregariousness (E2) | 4.00 | 8.00 | 11.00 | 13.00 | 19.00 |
| Assertiveness (E3) | 6.00 | 12.75 | 15.00 | 16.00 | 20.00 |
| Activity level (E4) | 7.00 | 11.00 | 13.00 | 15.00 | 19.00 |
| Excitement-seeking (E5) | 4.00 | 7.00 | 9.00 | 10.25 | 17.00 |
| Cheerfulness (E6) | 8.00 | 14.00 | 15.00 | 17.00 | 20.00 |

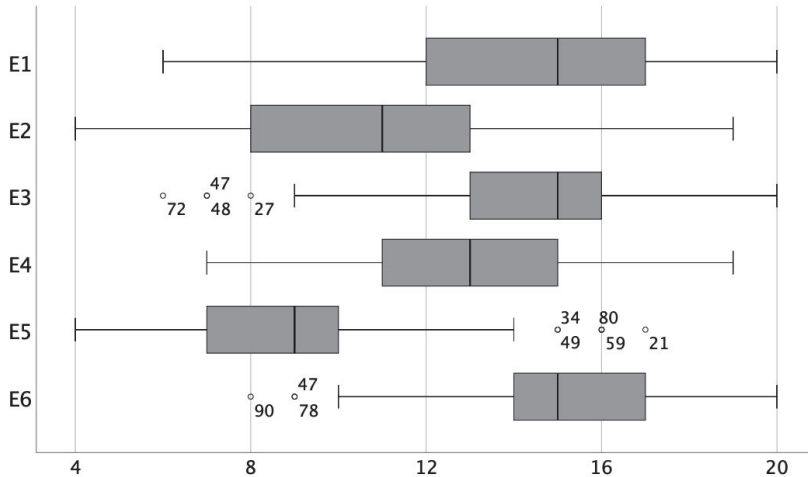


Fig. 23. Distribution of extraversion facet scores.

Three of the extraversion facets have the highest theoretical score: E1, E3, and E6. *Friendliness* (E1) and *assertiveness* (E3) have the highest median, and *excitement-seeking* (E5) has the lowest. As for the minimum score, *excitement-seeking* also has the lowest number; on the other hand, *cheerfulness* (E4) has the highest minimum score.

Gregariousness (E6) has the largest spread, while the facets E4 and E6 have the smallest. Fig. 23 also provides some information about the skewness of the extraversion facet scores. All the facets are left-skewed except for E4 and E5, which have a slightly right-skewed distribution. The following section presents the score distribution for the neuroticism facets.

4.2.4 Neuroticism

Neuroticism is the factor that *contrasts emotional stability with negative emotionality* (John et al., 2010, p. 120). It is composed of six facets: anxiety (N1), anger (N2), depression (N3), self-consciousness (N4), immoderation (N5), and vulnerability (N6). Table 57 and Fig. 24 present the score distribution for each neuroticism facet.

Table 57. Descriptive statistics for each neuroticism facet.

| Neuroticism Facets | Min | Lower-Q | Median | Upper-Q | Max |
|-------------------------|------|---------|--------|---------|-------|
| Anxiety (N1) | 6.00 | 10.00 | 13.00 | 15.00 | 19.00 |
| Anger (N2) | 4.00 | 7.00 | 9.00 | 13.00 | 19.00 |
| Depression (N3) | 4.00 | 5.75 | 8.00 | 10.00 | 20.00 |
| Self-consciousness (N4) | 7.00 | 11.00 | 13.00 | 15.00 | 20.00 |
| Immoderation (N5) | 6.00 | 9.00 | 11.00 | 12.00 | 18.00 |
| Vulnerability (N6) | 5.00 | 9.00 | 11.00 | 13.00 | 19.00 |

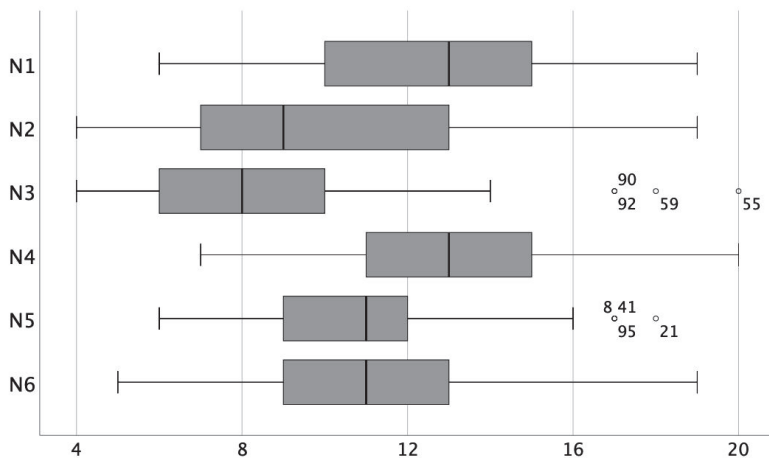


Fig. 24. Distribution of neuroticism facets scores.

Depression (N3) and *self-consciousness* (N4) have the highest theoretical score of 20. *Anxiety* (N1) and *self-consciousness* have the highest median, and *depression* has the lowest. With regard to the minimum score, *self-consciousness* has the largest number. The *anger* (N2) and *depression* facets have the lowest minimum score, which is also the lowest theoretical score. *Anger* has the largest spread, while *immoderation* has the smallest.

Fig. 24 presents some information about the skewness of the neuroticism facet scores. Except for *anxiety*, all the other facets are right-skewed; however, *self-consciousness* has an almost symmetric distribution. The next section explores the score distribution of the openness facets.

4.2.5 Openness

Openness describes the *breadth, depth, originality, and complexity of an individual's mental and experiential life* (John et al., 2010, p. 120). It is composed of six facets: imagination (O1), artistic interests (O2), emotionality (O3), adventurousness (O4), intellect (O5), and liberalism (O6). Table 58 and Fig. 25 present the score distribution of the openness facets.

Table 58. Descriptive statistics for each openness facet.

| Openness Facets | Min | Upper-Q | Median | Lower-Q | Max |
|-------------------------|------|---------|--------|---------|-------|
| Imagination (O1) | 8.00 | 17.00 | 15.00 | 13.00 | 20.00 |
| Artistic interests (O2) | 4.00 | 17.00 | 14.50 | 11.00 | 20.00 |
| Emotionality (O3) | 6.00 | 17.00 | 15.00 | 12.00 | 20.00 |
| Adventurousness (O4) | 5.00 | 15.00 | 13.00 | 10.00 | 19.00 |
| Intellect (O5) | 6.00 | 16.00 | 15.00 | 12.00 | 20.00 |
| Liberalism (O6) | 4.00 | 11.00 | 13.00 | 14.00 | 19.00 |

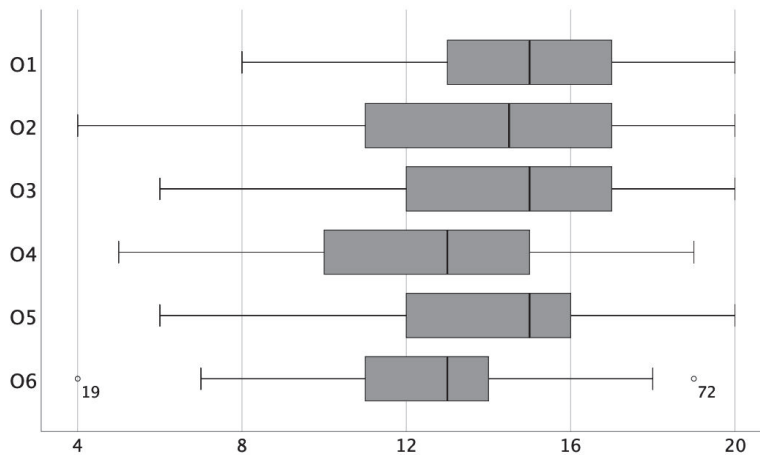


Fig. 25. Distribution of openness facets scores.

Except for *adventurousness* (O4) and *liberalism* (O6), all the other openness facets have the highest theoretical score (20). *Imagination* (O1), *emotionality* (O3), and *intellect* (O6) have the highest median, and *adventurousness* and *liberalism* have the lowest. *Artistic interests* (O2) and *liberalism* have the lowest minimum score, which is also the lowest theoretical score. *Imagination* has the smallest spread, and *artistic interests*, the largest.

Fig. 25 also provides some information about the skewness of the openness facets score. All the facets are left-skewed; however, *imagination* has an almost symmetric distribution. The next section presents the score distribution for decision-making style.

4.3 Decision-making style

In total, we received 63 responses to the decision-making style questionnaire. Since this is the most time-consuming questionnaire (see Section 2.3 for details), we expected a smaller number of responses.

The questionnaire was designed to give scores between 0 and 300 (see Section 2.3.5 for details on the calculations); however, our sample's minimum score is 77, and the maximum is 266. The mean is 172.45, the median is 175, and the standard deviation is 41.78. Fig. 26 presents the histogram of the decision-making style scores.

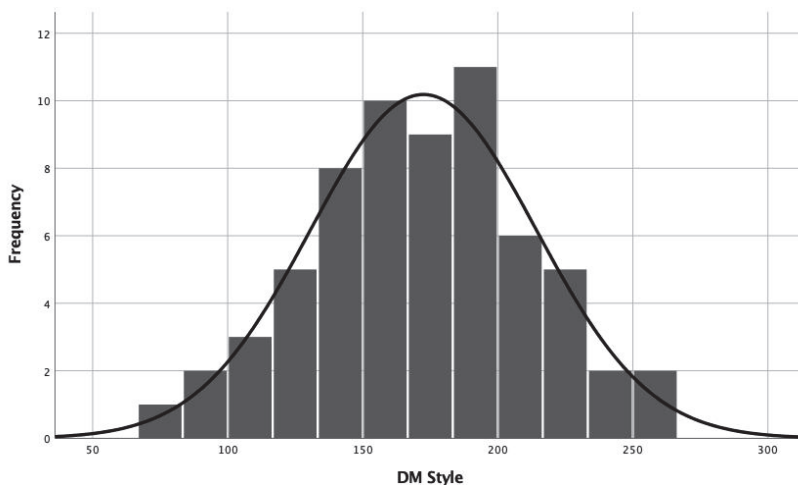


Fig. 26. Distribution of decision-making style scores.

Fig. 26 suggests that the decision-making style data are approximately normally distributed. Percentile analysis reveals that most respondents scored between 142 (the 25th percentile) and 198 (the 75th percentile). Since the maximum possible score is 300, we conclude that the survey sample has a moderate participative decision-making style. This distribution led to the characterization of a CI or CII decision-making style (Table 3) for most of the respondents, as defined below (Vroom & Jago, 1988).

The CI decision-making style is characterized by leaders who consult each stakeholder individually before deciding, taking into account the analysis of the collected information. Conversely, CII describes leaders who share the problem in a meeting with the stakeholders and decide in light of the discussion during this meeting. In this scenario, a discussion between the stakeholders is possible, unlike in the CI decision-making style. The following section presents information about the decision-making self-efficacy variables.

4.4 Decision-making self-efficacy

In total, 102 participants answered the decision-making self-efficacy questionnaire, which contains 30 items and generates a score from 0 to 100 for each decision-making self-efficacy domain (see Section 2.3.5 for details on how we calculated the scores). For each item, the participants selected a number from 0 to 100 that expresses how sure they are that they perform the described action regularly. Table 59 and Fig. 27 show the score distribution for each decision-making self-efficacy domain.

Table 59. Descriptive statistics for each decision-making self-efficacy domain.

| Decision-Making Self-Efficacy Domain | Min | Lower-Q | Median | Upper-Q | Max |
|---|-------|---------|--------|---------|-------|
| Affect control efficacy (ACE) | 43.33 | 64.16 | 71.66 | 82.49 | 95.56 |
| Analytical and inferential efficacy (AIE) | 36.36 | 66.13 | 75.45 | 81.82 | 100 |
| Social control efficacy (SIE) | 12.00 | 44.00 | 56.00 | 68.00 | 94.00 |
| Thought control efficacy (TCE) | 16.00 | 38.00 | 48.00 | 58.00 | 80.00 |

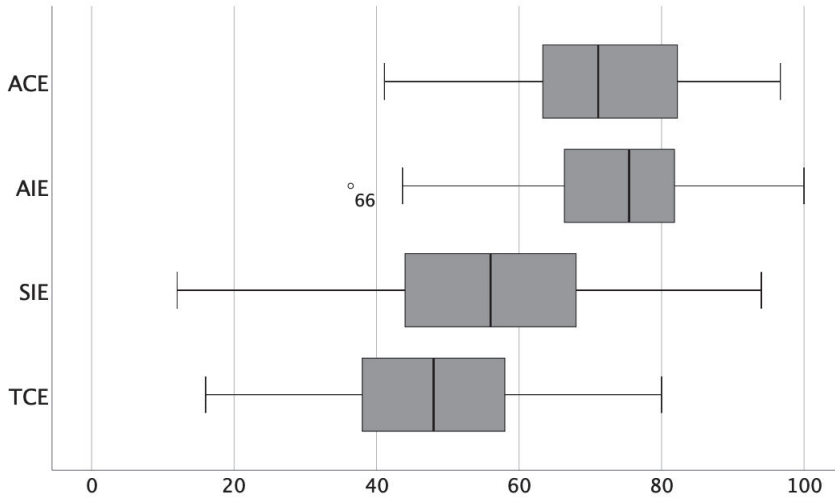


Fig. 27. Score distribution of decision-making self-efficacy domains.

Fig. 27 shows the distributions for affect control efficacy (ACE), analytical and inferential efficacy (AIE), social influence efficacy (SIE), and thought control efficacy (TCE). Specifically, ACE and AIE show similar data distribution, despite differences in their skewness (ACE is slightly left-skewed, and AIE is slightly right-skewed). As for SIE and TCE, their distribution is close to normal. Meanwhile, AIE shows a more peaked distribution overall, followed by AIE, TCE, and finally, SIE. Table 59 shows the numbers related to each boxplot presented in Fig. 27.

The figures presented in Table 59, along with the boxplots in Fig. 27, show that the respondents were more certain of performing AIE and ACE tasks regularly compared to SIE and TCE.

Response #66 appears as an outlier in Fig. 27. This participant has a lower-than-median score in all four domains; he scored higher in agreeableness and extraversion than the median and low in neuroticism.

During the analysis phase, we interviewed this person to determine the reason behind the low values for the decision-making self-efficacy domains. We confirmed that the participant understood the questions and that the responses reflect his beliefs. Therefore, we could not explain why his answers differ so much from most of the survey sample. The next section presents a summary of this chapter.

4.5 Summary of the chapter

This chapter presented a descriptive analysis of all variables studied, including demographic ones (gender, age, role, education level, and experience).

In Section 4.1, the frequency of responses for each demographic variable was presented, followed by an analysis of age-group distribution by gender. Furthermore, we also provided a summary of role distribution by age group, education level, and experience.

Section 4.2 presented the score distribution for each personality factor, followed by the facets of each factor. The decision-making style variable was discussed in Section 4.3, followed by decision-making self-efficacy domains (Section 4.4).

5 Survey data analysis approaches

In the previous chapter, we conducted a descriptive analysis of all the data collected for this study, considering each survey variable's nature. This chapter aims to present the data-analysis approaches used to answer the survey questions presented in Table 23.

The research described in this document has correlational nature; in other words, the main goal is to determine the relationship between variables (Marczyk, DeMatteo, & Festinger, 2005, p. 3). The most common data-analysis approaches in this type of research are correlation and regression (Kothari, 2004, p. 138); therefore, the data-analysis approaches adopted include these strategies.

The research questions presented in Table 23 have three objectives for each one. For each objective, we defined a different statistical approach; these are detailed in the following sections.

5.1 Analysis of correlation

The first objective of the survey analysis is to determine if a relationship exists between the decision-making (DMS and DMSE) and personality variables (factor and facets). We employed a correlational approach to check this and, if the link exists, to quantify its strength.

The correlational techniques usually aim to answer three questions about two variables a and b : (1) Is there a relationship between a and b ? (2) If so, what is the direction? (3) What is the magnitude (or strength) of the relationship? (Cohen, Manion, & Morrison, 2007, p. 530).

The output of a correlation test is the test significance (p) and correlation coefficient (r). If $p \leq 0.05$, then the test is statistically significant; therefore, we can interpret the correlation coefficient.

The correlation coefficient (r) ranges from -1.0 to 1.0 . If $r = 0$, then we can conclude that there is **no relationship** between the variables; in other words, they are independent (Casson & Farmer, 2014). If $r = 1$ or $r = -1$, then there is a **perfect correlation** between the variables, and if $r > 0.7$ (or $r < -0.7$), then we conclude that there is a **strong correlation**.

Note that the r -value can be positive or negative; the sign indicates the direction of the relationship. If it is positive, then the values of the variables vary in the same direction; in other words, if one value increases, the other also increases. On the

other hand, if the coefficient is negative, the values vary in opposite directions; when one increases, the other decreases (Casson & Farmer, 2014).

As mentioned previously, our survey analysis verifies the existence of a relationship between decision-making (DMS and DMSE) and personality variables (personality factors and facets), which means 175 different pairs of variables⁸. The scale for all these variables is continuous; however, some of them are not normally distributed, and some of the relationships are non-linear (see Appendixes 2 and 3). Hence, we decided to employ Spearman's correlation for all pairs of variables because it is an approach that does not require variables assuming normality and relationships assuming linearity. Furthermore, in order to compare and make a conclusion on the results, it is important to employ the same technique.

It is important to highlight that a statistically significant correlation between two variables **does not suggest causality or prediction**. A significant correlation only suggests that the variables grow similarly (in the same direction or opposite directions) and quantifies the strength of this similarity. For this reason, the analysis presented in the following section is necessary.

5.2 Predicting variation in decision-making

The analysis described in this section aims at: (1) verifying whether personality factors predict the variation in the decision-making variables (DMS and DMSE domains), (2) providing the amount of explained variation using personality factors as predictors, and (3) estimating the accuracy of the model obtained.

In order to reach (1) and (2), we employed a linear regression approach with backward elimination of variables. In addition, cross-validation was used to further assess the model's accuracy according to (3) and support our results.

Personality facets were not utilized in this analysis for the reasons below. Historically, personality factors have been derived from lexical terms commonly used to describe individuals and their personalities. The five personality factors resulted from applying clustering techniques (such as factor analysis) to these lexical terms (John et al., 2010, pp. 114–148).

Goldberg (1992) later proposed creating a lower level of personality characteristics known as personality facets. He proposed a hierarchical organization of personality characteristics, in which the five personality factors are at the top level and the personality facets on the lower one. Thus, the essence of

⁸ Five dependent variables and 35 independent variables ($5 * 35 = 175$).

personality facets is already included in the personality factors utilized in the analyses.

Another reason not to include the facets in the regression relates to the survey sample size ($S = 63$ or 102), which limits the number of predictor variables that we could include in the linear regression models. According to Babyak (2004), for each response variable in a model, we would need fewer than $S/10$ predictor variables to include in this model. Considering the number of personality facets that we gathered (30), we would need a sample size of at least 300 datapoints to include all the personality facets as predictor variables.

Multiple linear regression with backward elimination of variables was the approach chosen to analyze our datasets (i.e., DMS, DMSE domains, and personality factors). In the backward procedure, all the predictors are initially added to the regression; at each step, one variable is eliminated based on its significance to the prediction (Hair, 2009, pp. 153, 185). The backward elimination was chosen, because we wanted to consider all the potential predictors in order to further decide whether to include or eliminate target variables in the models. We also wanted to avoid the *suppressor effect*: this occurs when a predictor is significant only when another variable is held constant (Field, 2009, p. 213).

Linear regression assumptions (i.e., linearity, normality, homoscedasticity, and independence of errors) are important aspects to be followed and respected when running linear regressions. In order to ensure that we did not violate any assumptions, we performed tests to check all of them.

Table 60 shows the tests that we performed to explore those assumptions. We also conducted a visual inspection of normality (histograms and P-P plots), homoscedasticity (scatterplots), and linearity (scatterplots), but the graphs are not included in the results (Chapters 6 and 7).

Multicollinearity is a problem that also needs to be addressed in multiple linear regression. It occurs when one or more predictor(s) is/are strongly correlated. In such a case, it is challenging to obtain a unique estimate of the regression coefficients (Field, 2009, pp. 223–224). We diagnosed collinearity with the variation inflation factor (VIF), using a threshold of $VIF < 10$ (Hair, 2009, p. 200).

When running linear regressions, it is advisable to check the accuracy of the model generated. The cross-validation approach was used to do this; it consists of a random split of the dataset and a comparison between the collected values with the values generated by the predicted equations (Field, 2009, p. 222).

Table 60. Summary of the statistical tests employed to check linear regression assumptions.

| Linear Regression Assumption | Assumption detailing (Hair, 2009, pp. 177–182) | Statistical test | Assumption met |
|---|--|-------------------------------|---------------------|
| Linearity of the phenomenon measured | The relationship between the dependent and independent variable is linear. | Deviation from linearity test | $p > 0.05$ |
| Normality of the error-terms distribution | The error terms (e) are normally distributed. | Shapiro-Wilk test | $p > 0.05$ |
| A constant variance of error terms (homoscedasticity) | The variance of the error terms (e) appears constant over the range of values of the independent variance. | Breusch-Pagan test | $p > 0.05$ |
| Independence of error terms | Each predicted value is independent; in other words, the predicted values are not sequenced by any variable. | Durbin-Watson test | DW value close to 2 |

Firstly, we randomly split our dataset into five or ten folds, depending on its sample size. Regarding the regression with DMS as a dependent variable, we split this dataset into five-folds, because the sample size is 63 (Section 4.3). According to Babyak (2004), a regression with five predictors (the five personality factors) needs a data size of at least 50 datapoints (training-set size). The regressions with one of the DMSE domains as the dependent variable were split into 10 folds (102 datapoints; five predictors). Fig. 28 illustrates the cross-validation procedure in the five-fold case.

The 10-fold procedure is not illustrated in Fig. 28, since it is similar to the five-fold one. The difference is that the dataset was split randomly into 10 folds, and we ran 10 iterations instead of five.

Note in Fig. 28 that the folds were used to build the mean model and the predicted model. The mean model was created by filling each dataset entry in the fold with the fold's mean value. The predicted model was created as follows: one fold was reserved for testing and the remaining ones for training at each iteration.

The training set was used to estimate an equation, which was then tested using the remaining fold. For each iteration, four accuracy measures were calculated: the mean magnitude of relative error (MMRE), the median magnitude of relative error (MdmRE), the percentage of the estimate under 25% error or Pred(25), and mean absolute residual (MAR). We also calculated the same measures for the median model. The definition and interpretation of each measure are presented in Table 61.

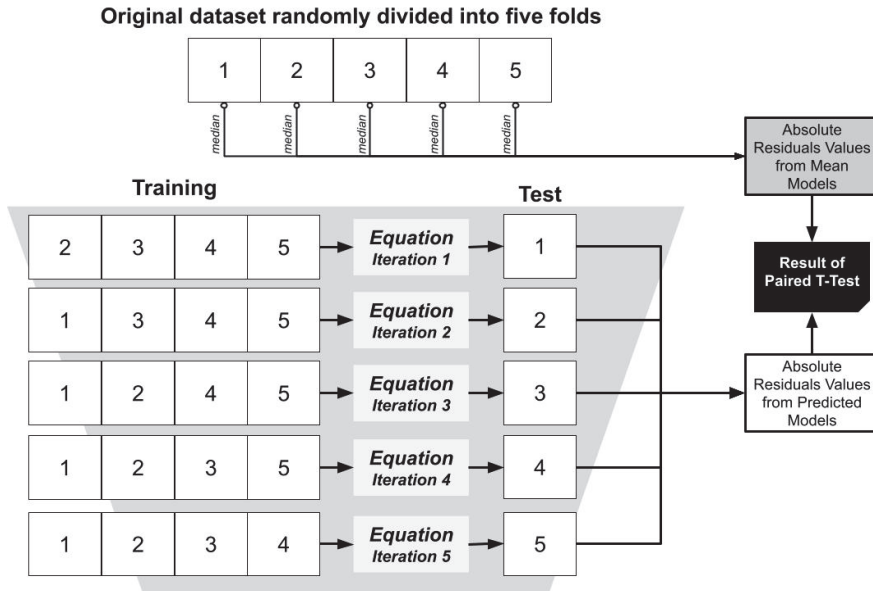


Fig. 28. Cross-validation procedure – five folds.

Table 61. Definitions and interpretations of accuracy measures according to Shepperd and MacDonnell (2012) and Kitchenham et al. (2001).

| Measure | Definition | Interpretation |
|----------|---|---|
| MRE | $\frac{ x_a - x_e }{x_a}$ <p> x_a = actual value x_e = estimated value n = size of the dataset </p> | Difference between the actual and estimated value divided by the actual value. It represents how close the estimative is to the real value in percentage. Therefore, the closer this value is to zero, the greater the accuracy |
| MMRE | Mean of MRE all values | The closer this value is to zero, the greater the accuracy. |
| MdMRE | Median of MRE values | The closer this value is to zero, the greater the accuracy. |
| Pred(25) | Percentage of estimates whose error is less than or equal to 25% | The closer this value is to 100%, the greater the accuracy. |
| MAR | $\frac{1}{n} \sum_{i=1}^n x_i - x $ <p> x_i = actual value x = estimated value n = size of the dataset </p> | Smaller values indicate higher accuracy. In order to interpret this measure, the reader needs to know the variable range. For example, if the variable range is from 0 to 100, a MAR of 50 is bad; however, if the range is from 0 to 1000, a MAR of 50 is a good result. |

Although Shepperd and MacDonnell (2012) advocate that the MMRE can lead to bias towards an under-estimated model prediction, we decided to include this

measure, as it has a more straightforward interpretation than MAR. We used the measures – MMRE, MdMRE, Pred(25), and MAR – and the result of paired T-Test to compare the accuracy estimates and decide our regression equations' overall accuracy.

The paired T-Test was used to compare the difference between the median and predicted model, in other words, to check if there is a statistically significant difference between the mean and the predicted model. The test helped to check if the predicted model could be used (E. Mendes, Di Martino, Ferrucci, & Gravino, 2007).

The T-Test's null hypothesis is that the mean difference is zero (Landau & Everitt, 2003, p. 41). In other words, the rejection of the null hypothesis implies a similarity of the two variables. Therefore, $p > 0.05$ means that the median and predicted models are similar.

5.3 Analyzing the effects of moderators

The approach presented herein aimed at checking whether demographic variables (i.e., age, role, education level, and experience) moderate the relationship between decision-making (DMS and DMSE) and personality factors. A moderator is any variable that affects the strength and/or the direction of a linear relationship. Fig. 29 illustrates a conceptual model of the basic moderation effect.

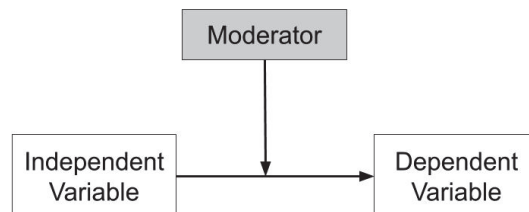


Fig. 29. Conceptual model of a basic moderation effect.

Moderation studies are a common practice in the field of psychology (Fairchild McQuillin, 2010). According to these authors, multiple linear regression (with or without hierarchical models) is the typical approach adopted in most studies (82%). In software engineering, it is also a common practice to employ multiple linear regression in moderation studies (Arisholm, Gallis, Dyba, & Sjoberg, 2007; Banker & Slaughter, 2000; Dybå, 2003; Sulayman & Mendes, 2010; Teller, Unger, Kock,

& Gemünden, 2012). Based on this, we decided to evaluate the moderation effect of demographic variables on the relationship between DMS and personality factors using a hierarchical linear regression approach.

The moderation analysis used here (based on linear regression) has the same assumptions as a regression analysis (i.e., normality, linearity, homoscedasticity, and error independence) (Hayes, 2017, pp. 68–73). Therefore, we used the same tests presented in the previous section to check that these assumptions were not violated (Table 60).

When using hierarchical linear regression to inspect the moderating effect of a variable M , the moderator is included in the predictor terms (IV) along with the interaction term ($IV \times M$). Fig. 30 shows a diagram and a regression equation that illustrate the moderation effect.

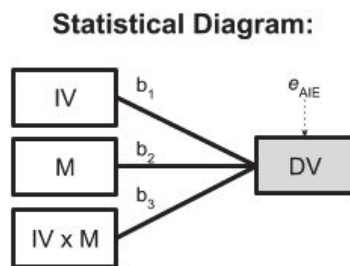


Fig. 30. The statistical diagram in a moderation analysis using hierarchical regression (Jose, 2013, pp. 155–157).

In the regression equation presented in Fig. 30, b_0 is the intercept, b_1IV and b_2M represent the linear effects of IV and M (respectively), and b_3IVM represents the moderator or interaction effect (Hair, 2009, pp. 176–177).

The terms were entered into the model in two steps. First, the linear effect was added to the model (IV and M), followed by the interaction ($IV \times M$). In order to decide the moderation effect of M in the relationship between DV and IV , the model resulting from the second step needs to be statistically significant, along with the interaction term coefficient. The change in the R^2 values (between the first and second steps) was used to calculate the effect size of the moderator (Dawson, 2014).

Because the moderating terms (age, education level, experience, and role) are on nominal or ordinal scales (Section 2.3.5), we created dummies variables to represent them in the regression analysis.

Hayes and Preacher (2014) recommend indicator coding for nominal variables and sequential coding for the ordinal ones. Indicator coding creates dummy variables that consider each variable category without any order between the values. On the other hand, a sequential system considers the order between the variables (Hayes & Montoya, 2017), as shown in Table 62.

Table 62. Example of indicator and sequential coding.

| Type | w1 | w2 | w3 |
|-------------------|----|----|----|
| Indicator coding | | | |
| Role | | | |
| Management | 0 | 0 | |
| Technical | 1 | 0 | |
| Mixed | 0 | 1 | |
| Sequential coding | | | |
| Educational Level | | | |
| High school | 0 | 0 | 0 |
| Bachelor's degree | 1 | 0 | 0 |
| Master's degree | 1 | 1 | 0 |
| Ph.D. | 1 | 1 | 1 |

We decided to use two different coding systems, because we wanted to preserve the order of the variables on the ordinal scale. Therefore, we used sequential coding to represent the variables on the ordinal scale (i.e., age, education level, and experience) and indicator coding to represent role, which is the only variable on a nominal scale.

5.4 Summary of the chapter

This chapter presented the statistical approaches used to analyze the survey data. Each section herein focused on one goal presented in Table 23. Section 5.1 focused on techniques to explore a possible relationship between the decision-making and personality variable. Section 5.2 investigated if personality factors could explain the variation in decision-making variables, along with the percentage of explanation and the accuracy of the predicted model. Finally, Section 5.3 showed the statistical approaches to investigating the moderating effect of age, education level, experience, and role in the relationship between decision-making and personality variables.

6 The relationship between decision-making style and personality

This chapter aims to analyze the relationship between DMS and personality factors, which is based on one of the research questions (RQ-SRV1) of our survey investigation: “*What is the relationship between decision-making style and personality?*” This question is answered according to three objectives:

1. **The presence of a relationship:** The purpose is to identify whether DMS and personality co-vary (Section 6.1).
2. **The possibility of explaining the variation in DMS values using personality factors:** If an explanation is possible, then quantify the percentage of explained variance and the model's accuracy (Section 6.2).
3. **The effect of variables (i.e., moderators) that modify the relationship between DMS and personality factors:** The objective here is to verify whether the demographic variables (i.e., age, education level, experience, and role) moderate the relationship between DMS and personality factors (Section 6.3).

Descriptions of all the statistical approaches employed herein were detailed and motivated in Chapter 5. Section 6.4 discusses the results presented in Sections 6.1, 6.2, and 6.3.

6.1 Correlation between decision-making style and personality factors and facets

A potential relationship between DMS and personality variables (the personality factors and facets) was determined using Spearman's correlation (details provided in Section 5.1). Table 63 shows the correlation coefficients (r), the level of significance ($p < 0.05$), and the number of datapoints used (n) for the correlation analysis between DMS and personality variables.

Table 63. Spearman's correlation results between personality variables and DMS.

| Personality Variable | | | Decision-Making Style | | |
|--------------------------|----------------------|----|-----------------------|--------|-----|
| | | | r^1 | p^2 | n |
| Personality factors | Agreeableness | A | 0.224* | 0.039* | 63 |
| | Conscientiousness | C | -0.084 | 0.258 | 63 |
| | Extraversion | E | 0.100 | 0.219 | 63 |
| | Neuroticism | N | -0.049 | 0.352 | 63 |
| | Openness | O | 0.191 | 0.067 | 63 |
| Agreeableness facets | Trust | A1 | 0.231* | 0.034* | 63 |
| | Morality | A2 | 0.051 | 0.345 | 63 |
| | Altruism | A3 | 0.307* | 0.007* | 63 |
| | Cooperation | A4 | 0.250* | 0.024* | 63 |
| | Modesty | A5 | 0.077 | 0.275 | 63 |
| | Sympathy | A6 | 0.078 | 0.272 | 63 |
| Conscientiousness facets | Self-efficacy | C1 | -0.209 | 0.050 | 63 |
| | Orderliness | C2 | -0.031 | 0.403 | 63 |
| | Dutifulness | C3 | 0.061 | 0.316 | 63 |
| | Achievement-striving | C4 | -0.009 | 0.473 | 63 |
| | Self-discipline | C5 | -0.189 | 0.069 | 63 |
| | Cautiousness | C6 | -0.068 | 0.299 | 63 |
| Extraversion facets | Friendliness | E1 | 0.081 | 0.263 | 63 |
| | Gregariousness | E2 | 0.108 | 0.200 | 63 |
| | Assertiveness | E3 | -0.016 | 0.452 | 63 |
| | Activity level | E4 | 0.007 | 0.479 | 63 |
| | Excitement-Seeking | E5 | 0.143 | 0.132 | 63 |
| | Cheerfulness | E6 | 0.182 | 0.077 | 63 |
| Neuroticism facets | Anxiety | N1 | -0.110 | 0.196 | 63 |
| | Anger | N2 | -0.240* | 0.029* | 63 |
| | Depression | N3 | 0.055 | 0.335 | 63 |
| | Self-consciousness | N4 | 0.208 | 0.051 | 63 |
| | Immoderation | N5 | -0.050 | 0.348 | 63 |
| | Vulnerability | N6 | 0.108 | 0.199 | 63 |
| Openness facets | Imagination | O1 | 0.141 | 0.136 | 63 |
| | Artistic interests | O2 | 0.020 | 0.437 | 63 |
| | Emotionality | O3 | 0.230* | 0.035* | 63 |
| | Adventurousness | O4 | 0.085 | 0.255 | 63 |
| | Intellect | O5 | -0.016 | 0.452 | 63 |
| | Liberalism | O6 | 0.332* | 0.004* | 63 |

¹ correlation coefficient, ² Sig. (one-tailed), *significant at the 0.05 level

The statistically significant correlations are those with $p < 0.05$, marked with asterisks in Table 63. The results show that agreeableness is the only personality

factor significantly correlated with DMS ($r(63) = 0.224, p = 0.039$), and that six personality facets are also statistically significantly correlated with DMS:

1. Anger (N2; $r(63) = -0.240, p = 0.029$). This personality facet is the only one with a negative correlation coefficient, which means that the higher the DMS, the lower the N2 score, and vice-versa.
2. Three agreeableness facets are significantly correlated with DMS: trust (A1; $r(63) = 0.231, p = 0.034$), altruism (A3; $r(63) = 0.307, p = 0.007$), and cooperation (A4; $r(63) = 0.250, p = 0.024$).
3. Two openness facets are also statistically significantly correlated with DMS: emotionality (O3; $r(63) = 0.230, p = 0.035$) and liberalism (O6; $r(63) = 0.332, p = 0.004$).

The following section presents the regression analysis results, considering the DMS as the response variable and the personality factors as predictor variables.

6.2 Decision-making style regression results

In order to investigate whether personality factors could predict DMS, we carried out a multiple linear regression (MLR) analysis with backward elimination of variables (details provided in Section 5.1). In this analysis, DMS was the response variable, and four personality factors were used as independent variables (agreeableness, conscientiousness, extraversion, and openness). Neuroticism was not included in the analysis, because it does not have a linear relationship with DMS (see Appendix 3).⁹

No multicollinearity was observed ($VIF < 1.5$ in all iterations and for all variables). The data meet the assumption of error independence (Durbin-Watson value = 1.772); furthermore, errors do not show a significant deviation from a normal distribution ($W(62) = 0.987, p = 0.760$), and they are homogeneously distributed (Breusch-Pagan test, $F(1, 61) = 0.335; p = 0.565$)¹⁰. Table 64 presents the results of the MLR with backward elimination of variables.

⁹ We checked different combinations of transformations on DMS and all personality factors. Only the transformation $1/x^4$ on DMS and N solves the linearity problem. However, with this transformation, none of the factors were selected in the backward regression. Therefore, we decided to exclude N from the analysis.

¹⁰ One datapoint was removed to keep the homoscedasticity of the error distribution.

Table 64. Regression results for DMS predicted by personality factors.

| Predictor | Iteration 1 | | | Iteration 2 | | | Iteration 3 | | | Iteration 4 | | |
|--------------------|-------------|-------|-------|-------------|-------|-------|-------------|-------|-------|-------------|-------|-------|
| | B | SE | p | B | SE | p | B | SE | p | B | SE | p |
| Const | 93.76 | 65.59 | 0.273 | 87.76 | 63.52 | 0.296 | 58.54 | 49.86 | 0.445 | 92.32 | 42.29 | 0.080 |
| A | 0.778 | 0.532 | 0.128 | 0.729 | 0.515 | 0.146 | 0.663 | 0.505 | 0.175 | 0.908 | 0.469 | 0.081 |
| C | -0.353 | 0.463 | 0.442 | -0.343 | 0.459 | 0.454 | - | - | - | - | - | - |
| E | -0.238 | 0.575 | 0.625 | - | - | - | - | - | - | - | - | - |
| O | 0.754 | 0.609 | 0.191 | 0.754 | 0.609 | 0.220 | 0.687 | 0.544 | 0.192 | - | - | - |
| R ² | | 0.094 | | | 0.091 | | | 0.082 | | | 0.058 | |
| Adj R ² | | 0.031 | | | 0.045 | | | 0.052 | | | 0.042 | |
| F | | 1.496 | | | 1.966 | | | 2.689 | | | 3.745 | |
| p | | 0.215 | | | 0.129 | | | 0.076 | | | 0.058 | |

$n = 62$

Table 64 shows that the backward elimination procedure removed one variable per iteration, resulting in an MLR with four iterations. Only agreeableness was selected to explain the variation in DMS (Adj. $R^2 = 0.04$, $p = 0.05$). We employed five-fold cross-validation to assess predicted model accuracy and to compare it to the median model (see Section 5.2 for details on how this procedure was used). The results are shown in Table 65.

Table 65 shows a predicted model with overall good accuracy. The MMRE values range from 11.71% to 30.44%, and MdMRE values range from 7.84% to 20.98%. The Pred(25) values show that at least 63.64% of the prediction error is lower than 25%. Finally, the MAR shows the errors in absolute numbers, and it ranges from 20.655 to 37.869.

However, these values do not differ widely from the median model accuracy values. Therefore, we run a paired T-Test to compare the absolute residuals values from the mean model and the same values produced by the predicted models. We did not find a significant difference in the values predicted model ($M = 32.07$, $SD = 25.14$) and the mean model ($M = 32.49$, $SD = 26.09$); $t(62) = 0.309$, $p = 0.759$. A discussion of these results is presented in Section 6.4.

Table 65. Accuracy of the predicted DMS model.

| Model | Fold | Equation | | Accuracy Measures | | | |
|-----------------|------|----------------|-------|-------------------|--------|------------------|----------|
| | | A ¹ | Const | MMRE | MdMRE | MAR ² | Pred(25) |
| Predicted Model | 1 | 0.8 | 101.9 | 19.91% | 20.98% | 36.278 | 76.92% |
| | 2 | 1.1 | 77.43 | 11.71% | 7.84% | 20.655 | 100.00% |
| | 3 | 1.1 | 81.31 | 30.44% | 8.41% | 34.003 | 63.64% |
| | 4 | 0.8 | 105.5 | 18.36% | 15.93% | 28.600 | 78.57% |
| | 5 | 0.9 | 88.56 | 24.22% | 17.07% | 37.869 | 66.67% |
| Median Model | 1 | - | - | 19.15% | 21.53% | 37.077 | 69.23% |
| | 2 | - | - | 9.89% | 6.58% | 16.400 | 80.00% |
| | 3 | - | - | 27.67% | 10.26% | 31.182 | 63.64% |
| | 4 | - | - | 19.15% | 14.57% | 30.071 | 85.71% |
| | 5 | - | - | 27.73% | 20.28% | 42.467 | 60.00% |

¹ Agreeableness, ² DMS scores vary from 30 to 300

6.3 Moderation effect of demographic variables in the decision-making style relationship

We also ran a hierarchical linear regression to inspect the moderation effect of demographic variables (i.e., age, education level, experience, and role) in the relationship between agreeableness (A) and DMS. An illustration of the model and equation from our analysis is presented in Fig. 31. Details about the data analysis approach can be found in Chapter 5.

We ran four hierarchical linear regressions, one for each moderator (i.e., age, education level, experience, and role). Due to the nature of the moderator data (ordinal or nominal scale), we created dummy variables to represent them, as explained in Section 5.2.

The data met all the regression assumptions (normality, linearity, independence error, and homoscedasticity) for all four hierarchical regressions. The results related to the moderation effect of age and experience on DMS are presented in Table 66, and those associated with the effect of education level and role on DMS are presented in Table 67.

The hierarchical model we ran using **age, experience, and education level** as moderators (left-hand side of Table 66 and Table 67) resulted in a non-significant model ($p > 0.05$). This means that those variables (i.e., age, experience, and education level) **do not find a significant effect on moderating** the relationship between DMS and agreeableness. However, the hierarchical model we ran for the “role” variable provided different results.

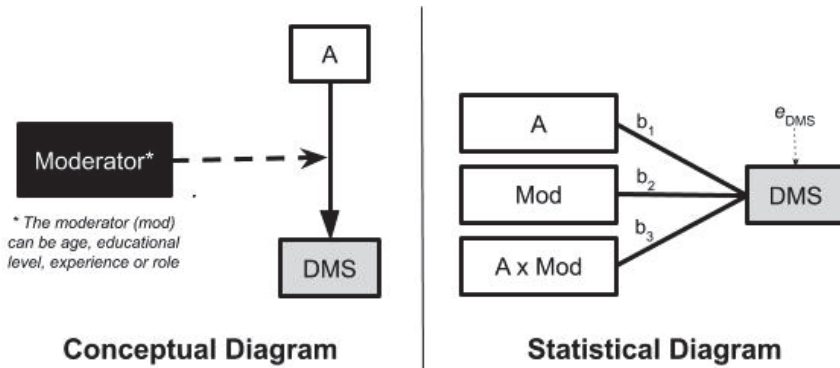


Fig. 31. Conceptual and statistical diagrams of the moderation analysis.

Table 67 (right-hand side) shows the hierarchical regression for inspecting the moderation effect of the “role” variable. Both steps resulted in statistically significant models ($p < 0.05$). The coefficient of interaction *intl* has a significance slightly superior to 0.05 ($B = 2.16$, $p = 0.065$), and the change in the R^2 is close to 5% ($\Delta R^2 = 0.049$). Therefore, we decided to visualize the effect of role on the DMS-A relationship.

The “role” variable is nominal and can assume four different values: business, management, technical, and mixed. As mentioned in Table 63 (right-hand side), we did not consider the value of “business” in the analysis, because it has only one datapoint, which makes predictions impossible.

Table 66. Summary of results related to the moderating effect of age and experience on the DMS-A relationship.

| Predictor | Age | | | | Experience | | | | | | | |
|-----------------------|--------|--------|--------|--------|------------|-------|-----------------------|--------|--------|---------|--------|-------|
| | Step 1 | | Step 2 | | Step 1 | | Step 2 | | | | | |
| | B | SE | p | B | SE | p | B | SE | p | | | |
| Step 1: | | | | | | | | | | | | |
| Constant | 67.860 | 44.041 | 0.130 | 41.110 | 54.055 | 0.451 | 136.08 | 59.738 | 0.027 | 150.76 | 103.68 | 0.153 |
| A | 1.261 | 0.490 | 0.013 | 1.561 | 0.603 | 0.013 | 0.449 | 0.655 | 0.496 | 0.286 | 1.147 | 0.804 |
| Age (dummies) | | | | | | | | | | | | |
| w1 | -3.617 | 13.111 | 0.784 | 42.086 | 138.161 | 0.762 | 4.730 | 19.114 | 0.806 | 153.47 | 433.11 | 0.725 |
| w2 | -1.628 | 17.604 | 0.927 | 62.496 | 164.569 | 0.706 | 1.153 | 19.722 | 0.954 | -182.79 | 429.76 | 0.673 |
| w3 | | | | | | | -7.185 | 16.490 | 0.665 | 19.250 | 179.25 | 0.915 |
| Step 2: | | | | | | | | | | | | |
| int1 (A x w1) | | | | -0.509 | 1.516 | 0.739 | int1 (A x w1) | | | -1.542 | 4.531 | 0.735 |
| int2 (A x w2) | | | | -0.686 | 1.784 | 0.702 | int2 (A x w2) | | | 1.936 | 4.494 | 0.669 |
| | | | | | | | int3 (A x w3) | | | -0.294 | 1.928 | 0.880 |
| R ² | | 0.126 | | | 0.144 | | R ² | | 0.015 | | 0.020 | |
| Adj R ² | | 0.096 | | | 0.047 | | Adj R ² | | -0.066 | | -0.130 | |
| p | | 0.099 | | | 0.216 | | p | | 0.946 | | 0.995 | |
| ΔR ² | | 0.126 | | | 0.018 | | ΔR ² | | 0.015 | | 0.005 | |
| F for ΔR ² | | 2.213 | | | 0.457 | | F for ΔR ² | | 0.183 | | 0.076 | |

n = 50. Two dummy variables were created to represent age values.

The age categories '≤ 25' and '> 55' were removed due to their low frequencies (five and four datapoints, respectively).

n = 54. Three dummies variables were created to represent experience

values. The experience categories "internship" and "< 2" were removed due to their low frequencies (two and three datapoints, respectively).

Table 67. Summary of results related to the moderating effect of education level and role on the DMS-A relationship.

| Predictor | Education Level | | | | | | Role | | | | | | |
|---------------------|-----------------|--------|-------|---------|--------|-------|--------------------|--------|--------|--------|---------|--------|-------|
| | Step 1 | | | Step 2 | | | Step 1 | | | Step 2 | | | |
| | B | SE | p | B | SE | p | B | SE | p | B | SE | p | |
| Step 1: | | | | | | | | | | | | | |
| Constant | 113.70 | 57.74 | 0.054 | 83.962 | 63.493 | 0.192 | Constant | 17.840 | 41.729 | 0.671 | 151.74 | 86.52 | 0.085 |
| A | 0.688 | 0.643 | 0.290 | 1.021 | 0.707 | 0.155 | A | 1.476 | 0.444 | 0.002 | 0.012 | 0.940 | 0.990 |
| Ed. Level (dummies) | Role (dummies) | | | | | | | | | | | | |
| w1 | -9.702 | 13.09 | 0.462 | 225.47 | 173.93 | 0.201 | w1 | 24.314 | 11.204 | 0.034 | -173.28 | 105.27 | 0.106 |
| w2 | 28.06 | 23.64 | 0.241 | -248.31 | 353.84 | 0.486 | w2 | 35.093 | 12.297 | 0.006 | -100.39 | 109.50 | 0.364 |
| Step 2: | | | | | | | | | | | | | |
| int1 (A x w1) | | | | -2.541 | 1.875 | 0.181 | int1 (A x w1) | | | | 2.16 | 1.14 | 0.065 |
| int2 (A x w2) | | | | 2.976 | 3.820 | 0.440 | int2 (A x w2) | | | | 1.48 | 1.20 | 0.224 |
| R ² | | 0.046 | | | 0.081 | | R ² | | 0.251 | | | 0.300 | |
| Adj R ² | | -0.009 | | | -0.011 | | Adj R ² | | 0.209 | | | 0.232 | |
| p | | 0.480 | | | 0.502 | | p | | 0.001 | | | 0.002 | |
| ΔR^2 | | 0.046 | | | 0.035 | | ΔR^2 | | 0.251 | | | 0.049 | |
| F for ΔR^2 | | 0.836 | | | 0.945 | | F for ΔR^2 | | 5.931 | | | 1.78 | |

$n = 56$. Two dummy variables were created to represent education-level values. The "high school" category was removed due to its low frequency (two datapoints).

$n = 57$. Two dummy variables were created to represent role values. The "business" category was removed due to its low frequency (one datapoint).

In order to illustrate the moderating effect of *role*, we created a graph of the equation predicted by the second step of the hierarchical regression. This is shown in Fig. 32.

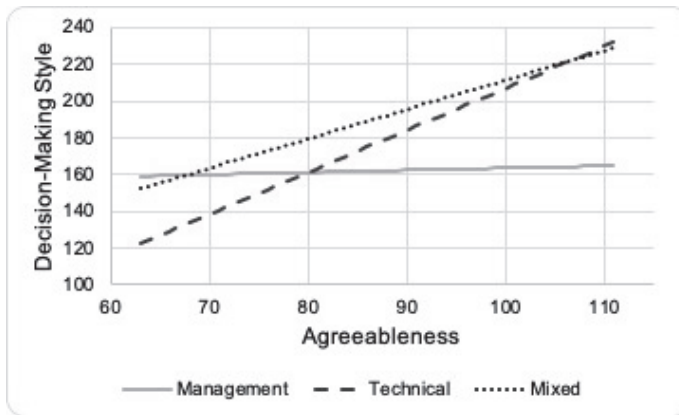


Fig. 32. Moderating effect of role on the relationship between decision-making style and agreeableness.

Fig. 32 shows that when the role is technical or mixed, the relationship between DMS and Agreeableness is stronger. However, this is not valid when the role is management-related; i.e., there is almost no effect on the abovementioned relationship. Comparing the slopes of the lines that represent technical and mixed roles, it is evident that the effect of technical roles is even greater than that of mixed roles.

6.4 Discussion

The decision-making style accounts for how much the leader allows others to participate in the decision-making process (Vroom & Jago, 1974). A low DMS score indicates a low participation level (i.e., a more autocratic style), while higher scores point to the opposite (a more participative style).

In order to fulfill the first objective of the analysis of the relationship between DMS and personality, we applied a correlation approach (Section 6.1). This analysis shows that six personality facets are statistically significantly correlated with DMS (Section 6.1). However, the highest correlation coefficient is 0.332,

meaning that DMS is not strongly correlated ($r < 0.7$) with any personality variable (factor or facet).

Concerning the relationships' direction, five of the relationships identified have a positive correlation coefficient, meaning that the scores grow in the same direction. The left-hand side of Table 68 shows all the personality facets with a positive correlation coefficient with DMS, along with the characteristics of people with a high score in the related personality facet.

Table 68. Individual characteristics that vary similarly to the DMS score.

| Positive correlation coefficient | | Negative correlation coefficient | |
|--|---|---|--|
| Facet | Characteristics | Facet | Characteristics |
| A1 | Fair, honest, and have good intentions. ¹¹ | N2 | Feel enraged when things do not go in their way. ¹¹ |
| A3 | Like to assist other people. ¹¹ | | |
| A4 | Dislike confrontation; they can easily compromise their own needs to get along with others. ¹¹ | | |
| O3 | Aware of own feelings. ¹¹ | | |
| O6 | Ready to challenge authority, convention, and traditional values. ¹¹ | | |
| People with a <i>more</i> participative DMS (high DMS score) tend to have <i>more</i> of these individual characteristics. | | People with a <i>less</i> participative DMS (low DMS score) tend to have <i>more</i> of these individual characteristics. | |

Only one personality facet (N2, anger) has a negative correlation coefficient (Table 68, on the right-hand side), meaning that the N2 and DMS scores grow in different directions; or in other words, when the N2 score is high, the DMS score tends to be low.

It is important to highlight that a significant correlation does not mean a cause-effect relationship. The correlation merely indicates that two variables grow in a similar pattern: in the same direction or opposite directions. Our analysis shows that the similarity between personality facets and DMS is low, because the correlation coefficient is lower than 0.7 in all cases.

In relation to the personality factors, only agreeableness is statistically significantly correlated with DMS (Section 6.1). It has a positive correlation coefficient and a not strong correlation ($r(63) = 0.224 < 0.7, p = 0.039$).

¹¹ Characterization of people with high scores in this facet. The definition can be found in Johnson (n.d.).

Agreeableness was also selected in the regression presented in Section 6.2 to explain 4.2% of the variation in DMS ($F(1, 61) = 3.745$, Adj. $R^2 = 0.042$, $p = 0.058$), as shown in Table 64. The coefficient of agreeableness in the regression model is positive ($B = 0.908$, $p = 0.081$), which means that the increase in the agreeableness level impacts the increase in DMS score (more participative style).

The decision-making style (DMS) relates to how much the stakeholders participate in the decision-making process. A high level of agreeableness describes people who always assume the best in others (Costa & McCrae, 2000). Thus, it is easier for people with high agreeableness levels to believe that others' participation in the decision-making process will contribute positively to the decision.

Observe that the significance of the model selected by the regression procedure (Table 64) is slightly superior to the threshold (0.05) as well as the coefficient significance of agreeableness. Furthermore, the percentage of explanation is low at only 4.2%. However, the cross-validation procedure (Table 65) shows a satisfactory prediction accuracy, with absolute error numbers (MAR) ranging from 20.65 to 37.869. Considering that the DMS score ranges from 30 to 300, an error between 20 and 40 units is small.

We also compared the median and predicted models using paired T-Test, which showed no statistically significant difference between them. Therefore, our tests showed using the mean model has the same prediction accuracy as the model herein predicted. Therefore, further investigation is needed, using a larger dataset, and also perhaps by gathering data from a more diverse population within Brazil, and worldwide.

In terms of the moderating effect of demographic variables on the relationship between DMS and A (Section 6.3), our analysis showed that age, education level, and experience do not modify the abovementioned relationship.

However, the “*role*” variable moderates the relationship between DMS and A. The results show that, when the value of “*role*” is management, no effect on the DMS-A relationship is observed. However, when “*role*” assumes a value of “*technical*” or “*mixed*”, the relationship becomes stronger, as illustrated in Fig. 33.

This result makes sense, because people who perform “*technical*” or “*mixed*” roles have not necessarily been trained in management skills (including those related to decision-making). Therefore, perhaps the lack of training can impact the preference for a more participative decision-making process (high DMS scores). In this way, the decision-maker leaders can get some help from others on the team.

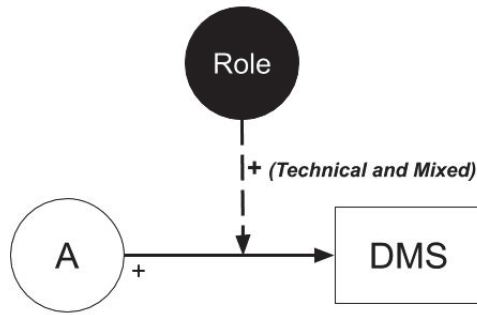


Fig. 33. Moderating effect of role on the relationship between DMS and agreeableness.

6.5 Summary of the chapter

This chapter presented an analysis of the relationship between DMS and personality variables (factors and facets). Initially, we explored whether there is a link between the two abovementioned variables through Spearman's correlation (Section 6.1). We then verified whether any personality factor could explain the variation in DMS (Section 6.2). Finally, we inspected whether demographic variables (age, education level, experience, and role) moderate the relationship between DMS and agreeableness (Section 6.3). The chapter ended with a discussion related to each analysis performed (Section 6.4).

7 The relationship between decision-making self-efficacy domains and personality

This chapter presents the results of the analysis on the relationship between DMSE domains and personality, which is based on one of the research questions (RQ-SRV2) of our survey investigation: “*What is the relationship between DMSE and personality?*” The question is answered based on three objectives:

1. **The presence of a relationship:** The purpose is to identify whether DMSE domains and personality co-vary.
2. **The possibility of using personality factors to explain the variation in the DMSE domains values:** If an explanation is possible, then quantify the percentage of explained variance and the model accuracy.
3. **The effect of variables (i.e., moderators) that modify the relationship between DMSE and personality:** The objective here is to verify whether demographic variables (i.e., age, education level, experience, and role) moderate the relationship between DMSE and personality.

The DMSE has four domains: affect control efficacy (ACE), analytical and inferential efficacy (AIE), social influence efficacy (SIE), and thought control efficacy (TCE). Each domain score is treated as a variable. Section 7.1 shows the findings related to ACE; Section 7.2 contains the AIE results; Section 7.3 presents results associated with SIE, and, finally, Section 7.4 shows the results related to TCE. Each section also includes a section that discusses the findings related to the DMSE domain under discussion. Section 7.5 aggregates the results associated with each DMSE domain and discusses them.

Descriptions of the statistical approaches used to analyze the relationship between the DMSE and personality are found in Chapter 5.

7.1 Affect control efficacy

This section presents the analysis of the relationship between one of the DMSE domains (i.e., ACE) and personality. Affect control efficacy refers to the ability to influence people or situations for the benefit of decision-making (Myburgh et al., 2015). Section 7.1.1 presents the correlation, followed by the regression (Section 7.1.2) and moderation results (Section Table 71). These results are summarized and discussed in Section 7.1.4.

7.1.1 Correlation between ACE and personality factors and facets

A potential relationship between ACE and personality (both factors and facets) was assessed using Spearman's correlation (Section 5.1). Table 69 shows the correlation coefficients (r), the level of significance ($p < 0.05$), and the sample size (n) of each relationship between the ACE and the personality variables.

The significant correlations ($p < 0.05$) are presented in Table 69 marked with asterisks. Two personality factors, conscientiousness and neuroticism, are significantly correlated with ACE (C – $r(102) = 0.419$, $p = 0.000$; N – $r(102) = -0.383$, $p = 0.00$), and 18 out of 30 personality facets are significantly correlated with ACE as well. The results show that more than half of the personality facets are significantly correlated with ACE, and seven of them have a negative correlation coefficient.

The highest correlation coefficient was found in the relationship between ACE and self-efficacy (C1; $r(102) = 0.48$, $p = 0.00$), followed by conscientiousness (C; $r(102) = 0.419$, $p = 0.00$) and vulnerability (N6; $r(102) = -0.413$, $p = 0.00$). All the other personality factors and facets have coefficients lower than 0.4.

Conscientiousness has the largest number of facets that are statistically and significantly correlated with ACE (five out of six). Agreeableness, extraversion, and neuroticism have the same number of facets that are statistically significant correlated with ACE (four out of six). Openness has only one facet significantly correlated with ACE.

The following section shows the regression analysis results, considering ACE as the response variable and the personality factors as predictor variables.

Table 69. Spearman's correlation results between personality variables and ACE.

| Personality Variable | | | ACE | | |
|--------------------------|----------------------|----|----------|----------|----------|
| | | | <i>r</i> | <i>p</i> | <i>n</i> |
| Personality factors | Agreeableness | A | 0.070 | 0.241 | 102 |
| | Conscientiousness | C | 0.419* | 0.000* | 102 |
| | Extraversion | E | 0.138 | 0.083 | 102 |
| | Neuroticism | N | -0.383* | 0.000* | 102 |
| | Openness | O | -0.039 | 0.349 | 102 |
| Agreeableness facets | Trust | A1 | 0.186* | 0.030* | 102 |
| | Morality | A2 | 0.244* | 0.007* | 102 |
| | Altruism | A3 | -0.071 | 0.240 | 102 |
| | Cooperation | A4 | 0.036 | 0.358 | 102 |
| | Modesty | A5 | -0.167* | 0.047* | 102 |
| | Sympathy | A6 | -0.167* | 0.047* | 102 |
| Conscientiousness facets | Self-efficacy | C1 | 0.480* | 0.000* | 102 |
| | Orderliness | C2 | 0.157 | 0.057 | 102 |
| | Dutifulness | C3 | 0.204* | 0.020* | 102 |
| | Achievement-striving | C4 | 0.211* | 0.017* | 102 |
| | Self-discipline | C5 | 0.351* | 0.000* | 102 |
| | Cautiousness | C6 | 0.335* | 0.000* | 102 |
| Extraversion facets | Friendliness | E1 | 0.213* | 0.016* | 102 |
| | Gregariousness | E2 | 0.106 | 0.145 | 102 |
| | Assertiveness | E3 | 0.316* | 0.001* | 102 |
| | Activity level | E4 | -0.125 | 0.104 | 102 |
| | Excitement-seeking | E5 | -0.190* | 0.028* | 102 |
| | Cheerfulness | E6 | 0.216* | 0.015* | 102 |
| Neuroticism facets | Anxiety | N1 | -0.162 | 0.052 | 102 |
| | Anger | N2 | -0.134 | 0.090 | 102 |
| | Depression | N3 | -0.327* | 0.000* | 102 |
| | Self-Consciousness | N4 | -0.303* | 0.001* | 102 |
| | Immoderation | N5 | -0.328* | 0.000* | 102 |
| | Vulnerability | N6 | -0.413* | 0.000* | 102 |
| Openness facets | Imagination | O1 | -0.115 | 0.124 | 102 |
| | Artistic interests | O2 | 0.092 | 0.178 | 102 |
| | Emotionality | O3 | -0.083 | 0.205 | 102 |
| | Adventurousness | O4 | 0.239* | 0.008* | 102 |
| | Intellect | O5 | -0.099 | 0.161 | 102 |
| | Liberalism | O6 | -0.156 | 0.059 | 102 |

¹ correlation coefficient, ² Sig. (one-tailed), *significant at the 0.05 level

7.1.2 Affect control efficacy regression results

In order to explore the relationship between ACE and personality, we ran multiple linear regression (MLR) with backward elimination of variables. In this analysis, ACE was the response variable, and the personality factors were the candidates for the predictors.

Since agreeableness does not have a linear relationship with ACE (Appendix 3), we applied a transformation to this $A_{transf} = 10^{42}/A^{20}$ before including it in the regression.

The regression does not suffer the multicollinearity effect due to the small value of the VIF (i.e., $VIF < 1.3$) in all iterations and for all variables. The data met the assumption of independence of errors (Durbin-Watson value = 2.115), and the errors do not significantly deviation from a normal distribution ($W(99) = 0.984$, $p = 0.291$); the data are also homogeneously distributed (Breusch-Pagan test, $F(1, 98) = 0.142$; $p = 0.867$)¹².

Table 70 shows the results of the MLR model with backward elimination. The backward procedure removed one variable per iteration, resulting in an MLR with four iterations. Conscientiousness (C , $B = 0.392$; $\rho = 0.000 < 0.05$) and neuroticism (N , $B = -0.283$; $\rho = 0.001 < 0.05$) were selected to explain 30.6% of the variation in ACE ($F(2, 98) = 22.612$; $\text{Adj } R^2 = 0.306$; $p = 0.000$).

We employed 10-fold cross-validation to assess the model accuracy (for details, see Section 5.2), and we compared it to the median model. The results are shown in Table 71.

¹² Three datapoints were removed to keep the homoscedasticity of the error distribution.

Table 70. Regression results for ACE predicted by personality factors.

| Predictor | Iteration 1 | | | Iteration 2 | | | Iteration 3 | | | Iteration 4 | | |
|-----------------------|------------------------|--------|-------|------------------------|--------|-------|------------------------|--------|-------|-------------|--------|-------|
| | B | SE | p | B | SE | p | B | SE | p | B | SE | p |
| Const | 56.611 | 16.639 | 0.001 | 58.833 | 15.722 | 0.000 | 54.194 | 12.247 | 0.000 | 53.958 | 12.184 | 0.000 |
| A_{transf}^1 | -5.15×10^{-3} | 0.000 | 0.595 | -4.96×10^{-3} | 0.000 | 0.607 | -4.15×10^{-3} | 0.000 | 0.660 | - | - | - |
| C | 0.387 | 0.098 | 0.000 | 0.388 | 0.098 | 0.000 | 0.391 | 0.097 | 0.000 | 0.392 | 0.097 | 0.000 |
| E | 0.041 | 0.097 | 0.673 | - | - | - | - | - | - | - | - | - |
| N | -0.280 | 0.089 | 0.002 | -0.289 | 0.086 | 0.001 | -0.284 | 0.085 | 0.001 | -0.283 | 0.084 | 0.001 |
| O | -0.066 | 0.111 | 0.552 | -0.048 | 0.102 | 0.637 | - | - | - | - | - | - |
| R2 | | 0.325 | | | 0.323 | | | 0.322 | | | 0.320 | |
| Adj R2 | | 0.288 | | | 0.294 | | | 0.300 | | | 0.306 | |
| F | | 8.937 | | | 11.224 | | | 15.013 | | | 22.612 | |
| p | | 0.000 | | | 0.000 | | | 0.000 | | | 0.000 | |

$n = 99, ^1 10^{42}/A^{20}$

Table 71. Accuracy of the ACE predicted model.

| Model | Fold | Equation | | | Accuracy Measures | | | |
|-----------|--------|----------------|----------------|-------|-------------------|--------|------------------|----------|
| | | C ¹ | N ² | Const | MMRE | MdMRE | MAR ³ | Pred(25) |
| Predicted | 1 | 0.4168 | -0.269 | 50.72 | 10.75% | 12.79% | 8.33888 | 100.00% |
| Model | 2 | 0.3893 | -0.2748 | 54.13 | 12.27% | 6.62% | 7.34789 | 80.00% |
| | 3 | 0.3395 | -0.3132 | 60.67 | 12.42% | 12.50% | 9.439825 | 100.00% |
| | 4 | 0.483 | -0.123 | 35.75 | 21.82% | 14.35% | 12.25318 | 63.64% |
| | 5 | 0.369 | -0.266 | 54.4 | 12.55% | 11.82% | 9.6616 | 100.00% |
| | 6 | 0.4072 | -0.2974 | 53.27 | 8.76% | 5.84% | 6.73642 | 100.00% |
| | 7 | 0.3795 | -0.3232 | 57.73 | 11.28% | 7.68% | 7.384409 | 90.91% |
| | 8 | 0.3825 | -0.2935 | 55.92 | 10.77% | 10.80% | 7.166667 | 100.00% |
| | 9 | 0.3824 | -0.3154 | 56.4 | 12.19% | 10.42% | 8.5111 | 90.00% |
| | 10 | 0.3865 | -0.3305 | 58.03 | 13.21% | 8.76% | 8.77705 | 90.00% |
| | Median | 1 | - | - | - | 9.46% | 9.68% | 7.4446 |
| Model | 2 | - | - | - | 13.61% | 8.65% | 8.2223 | 80.00% |
| | 3 | - | - | - | 11.69% | 8.22% | 9.722125 | 87.50% |
| | 4 | - | - | - | 19.72% | 21.28% | 12.22227 | 72.73% |
| | 5 | - | - | - | 14.29% | 13.47% | 10.2223 | 90.00% |
| | 6 | - | - | - | 7.98% | 5.28% | 5.6668 | 100.00% |
| | 7 | - | - | - | 11.83% | 8.82% | 8.080909 | 90.91% |
| | 8 | - | - | - | 12.44% | 11.59% | 8.271667 | 88.89% |
| | 9 | - | - | - | 15.97% | 11.75% | 10.1109 | 90.00% |
| | 10 | - | - | - | 11.96% | 8.39% | 7.8888 | 80.00% |

¹ Conscientiousness, ² Neuroticism, ³ ACE scores vary from 0 to 100

The prediction model's MMRE values range from 8.76% to 21.82%, and MdMRE values range from 5.84% to 14.35%. Pred(25) values show that at least 63.64% of the errors are lower than 25%. Finally, the MAR shows the errors in absolute numbers, and they range from 6.73 to 12.25; considering the ACE score range (0 to 100) these values are small.

Table 71 also shows the median model's accuracy values, and they do not differ significantly from the predicted model. A paired T-Test was conducted to compare the absolute residuals values from the mean model and the same values produced by the predicted models. There was not a significant difference in the values predicted model (M = 8.58, SD = 5.77) and the mean model (M = 8.79, SD = 7.15); $t(98) = -0,315, p = 0.754$. Section 7.1.4 discusses the accuracy results.

7.1.3 Moderating effect of demographic variables in the ACE relationship

We also ran a hierarchical linear regression to inspect the moderating effect of age, education level, experience, and role on the relationship between ACE and two personality factors (conscientiousness and neuroticism), which are the factors included in the regression model presented in the previous section. An illustration of the model and equation explored in our analysis is shown in Fig. 34. Details about the data analysis approach can be found in Chapter 5.

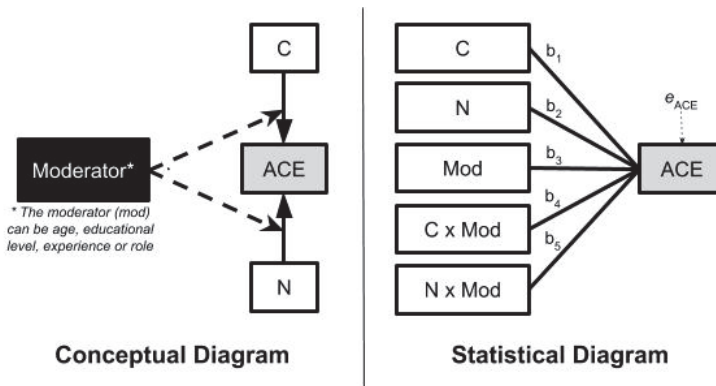


Fig. 34. Conceptual and statistical diagrams of the moderation analysis – ACE.

We ran four hierarchical linear regression, one for each moderator (i.e., age, education level, experience, and role). Due to the nature of moderator data (ordinal or nominal scale), we created dummy variables to represent them, as explained in Section 5.2.

The data met all the regression assumptions (normality, linearity, independence of error, and homoscedasticity) for all four hierarchical regressions. The results related to the moderating effects of age and experience are presented in Table 66, and those for education level and role in Table 67.

The hierarchical approach that analyzed the moderating effect of age, experience, and education level (Table 72 and Table 73) resulted in significant models ($p < 0.05$). However, in all cases, the p -values of interaction terms were significantly higher than 0.05. Thus, the demographic variables **age, experience, education level, and role do not moderate** our target relationship.

Table 72. Results related to the moderating effects of age and experience on the relationship between ACE and Conscientiousness and Neuroticism.

| Predictor | Age | | | Experience | | |
|-----------------------------|---------------|--------|--------|---------------|--------|--------|
| | Step 1 | | Step 2 | Step 1 | | Step 2 |
| | B | SE | p | B | SE | p |
| Step 1: | | | | | | |
| Constant | 54.76 | 12.147 | 0.000 | 9.885 | 43.081 | 0.819 |
| C | 0.352 | 0.103 | 0.001 | 0.535 | 0.359 | 0.140 |
| N | -0.286 | 0.085 | 0.001 | 0.165 | 0.274 | 0.549 |
| Age (dummies) | | | | | | |
| w1 | 3.426 | 2.864 | 0.235 | 55.01 | 45.975 | 0.235 |
| w2 | -0.731 | 3.097 | 0.814 | -22.17 | 40.211 | 0.583 |
| w3 | 1.270 | 4.367 | 0.772 | 20.047 | 59.925 | 0.739 |
| Step 2: | | | | | | |
| int1 (C x w1) | | | | -0.203 | 0.380 | 0.595 |
| int2 (C x w2) | | | | 0.213 | 0.383 | 0.580 |
| int3 (C x w3) | | | | -0.261 | 0.520 | 0.617 |
| Int4 (N x w1) | | | | -0.524 | 0.297 | 0.082 |
| Int5 (N x w2) | | | | 0.004* | 0.205 | 0.985 |
| Int6 (N x w3) | | | | 0.114 | 0.340 | 0.738 |
| R ² | | 0.326 | | | 0.288 | |
| Adj R ² | | 0.355 | | | 0.270 | |
| p | | 0.000 | | | 0.000 | |
| ΔR ² | | 0.326 | | | 0.030 | |
| F for ΔR ² | | 8.594 | | | 0.641 | |
| Predictor | | | | | | |
| | Step 1 | | | Step 1 | | |
| | B | SE | p | B | SE | p |
| Constant | 56.463 | 12.442 | 0.000 | 53.642 | 22.138 | 0.018 |
| C | 0.375 | 0.104 | 0.001 | 0.289 | 0.180 | 0.113 |
| N | -0.291 | 0.086 | 0.001 | -0.143 | 0.158 | 0.370 |
| Experience (dummies) | | | | | | |
| w1 | 1.142 | 2.733 | 0.677 | -7.247 | 33.853 | 0.831 |
| w2 | -2.519 | 3.107 | 0.420 | 18.362 | 35.818 | 0.610 |
| w3 | 1.452 | 3.390 | 0.670 | -10.022 | 44.861 | 0.824 |
| Step 2: | | | | | | |
| int1 (C x w1) | | | | 0.219 | 0.268 | 0.417 |
| int2 (C x w2) | | | | -0.165 | 0.293 | 0.575 |
| int3 (C x w3) | | | | 0.084 | 0.376 | 0.825 |
| Int4 (N x w1) | | | | -0.160 | 0.248 | 0.520 |
| Int5 (N x w2) | | | | -0.090 | 0.243 | 0.711 |
| Int6 (N x w3) | | | | 0.049 | 0.276 | 0.861 |
| R ² | | 0.335 | | | 0.358 | |
| Adj R ² | | 0.295 | | | 0.266 | |
| p | | 0.000 | | | 0.000 | |
| ΔR ² | | 0.335 | | | 0.023 | |
| F for ΔR ² | | 8.353 | | | 0.023 | |

n = 95. Three dummy variables were created to represent age values. The "> 55" category was removed due to its low frequency (four datapoints).

n = 89. Three dummy variables were created to represent experience values. The "internship" and "< 2" categories were removed due to their low frequencies (four and six datapoints, respectively).

Table 73. Results related to the moderating effects of education level and role on the relationship between ACE and Conscientiousness and Neuroticism.

| Predictor | Education Level | | | | | | Role | | | | | |
|-----------------------|-----------------|-------|-------|---------|--------|-------|--------|--------|-------|--------|--------|-------|
| | Step 1 | | | Step 2 | | | Step 1 | | | Step 2 | | |
| | B | SE | p | B | SE | p | B | SE | p | B | SE | p |
| Step 1: | | | | | | | | | | | | |
| Constant | 47.66 | 13.39 | 0.001 | 39.75 | 18.04 | 0.031 | 49.356 | 14.241 | 0.001 | 71.934 | 54.224 | 0.188 |
| C | 0.424 | 0.110 | 0.000 | 0.472 | 0.148 | 0.002 | 0.408* | 0.104 | 0.000 | 0.238 | 0.418 | 0.571 |
| N | -0.221 | 0.089 | 0.008 | -0.166 | 0.109 | 0.133 | -0.266 | 0.093 | 0.005 | -0.355 | 0.251 | 0.161 |
| Ed. Level (dummies) | | | | | | | | | | | | |
| w1 | -0.446 | 2.533 | 0.835 | 25.361 | 30.971 | 0.418 | 1.945 | 2.950 | 0.511 | 0.186 | 0.440 | 0.720 |
| w2 | -4.021 | 4.136 | 0.159 | -24.164 | 48.405 | 0.696 | 3.968 | 3.255 | 0.226 | 0.154 | 0.459 | 0.726 |
| Step 2: | | | | | | | | | | | | |
| int1 (C x w1) | | | | -0.098 | 0.247 | 0.693 | | | | 0.186 | 0.440 | 0.674 |
| int2 (C x w2) | | | | -0.066 | 0.438 | 0.661 | | | | 0.154 | 0.459 | 0.738 |
| int3 (N x w1) | | | | -0.261 | 0.227 | 0.257 | | | | 0.067 | 0.288 | 0.816 |
| int4 (N x w2) | | | | 0.400 | 0.472 | 0.937 | | | | 0.143 | 0.297 | 0.631 |
| R ² | | 0.286 | | | 0.299 | | | 0.328 | | | 0.331 | |
| Adj R ² | | 0.253 | | | 0.232 | | | 0.297 | | | 0.267 | |
| p | | 0.000 | | | 0.000 | | | 0.000 | | | 0.000 | |
| ΔR ² | | 0.286 | | | 0.013 | | | 0.328 | | | 0.003 | |
| F for ΔR ² | | 8.802 | | | 0.394 | | | 10.720 | | | 0.098 | |

n = 93. Two dummy variables using sequential coding were created to represent the values for "education level." The "high school" category was removed due to its low frequency (five datapoints).

n = 93. Two dummy variables using indicator coding were created to represent the values for "role." The "business" category was removed due to its low frequency (six datapoints).

7.1.4 Discussion

An important characteristic of the decision-maker is the ability to influence people or situations in order to make a successful decision; in our study, this is called affect control efficacy (ACE). Decision-makers with high ACE scores tend to be sure that they are making the right decision; therefore, they remain confident after deciding and know what to do next. On the other hand, low ACE scores characterize those who do not trust their own judgments and have difficulty making decisions under pressure (Myburgh et al., 2015).

The correlational analysis (Section 7.1.1) shows 18 statistically significant correlations between the ACE and the personality facets. The coefficients vary between 0.167 and 0.480 (absolute numbers; see Table 69). Among these, only three personality facets have coefficients greater than 0.4. The correlational coefficients indicate how one variable co-varies with others. Values close to 1 indicate a strong similarity in the direction of change, while values close to 0 indicate that the variances are not similar. Therefore, despite statistically significant correlations between ACE and some personality facets, the correlation is not strong ($r < 0.7$).

Among the personality facets that are statistically significantly correlated with ACE, 11 have positive correlation coefficients, meaning that these facets scores vary in the same direction as the ACE. The other seven facets have negative correlation coefficients, meaning they vary in the opposite direction. Table 74 shows all the personality facets with a significant correlation with ACE, along with the characteristics of people with high scores in the related personality facet. On the left-hand side are those facets with positive correlation coefficients, and on the right are those with negative ones.

With regard to personality factors, conscientiousness (C) and neuroticism (N) are statistically significant correlated with ACE. The correlation coefficient on C is positive, meaning that C and ACE scores vary in the same direction. Conversely, N has a negative correlation coefficient, implying that the scores change in opposite directions.

Table 74. Individual characteristics that vary similarly to ACE score.

| Positive correlation coefficient | | Negative correlation coefficient | |
|----------------------------------|--|----------------------------------|---|
| Facet | Characteristics | Facet | Characteristics |
| A1 | Assumes that people are fair, honest, and have good intentions. ¹³ | A5 | Does not claim to be better than other people. ¹³ |
| A2 | Sees no need for pretense or manipulation when dealing with others. and is, therefore, candid, frank and sincere ¹³ | A6 | Feels the pain of others vicariously and is easily moved to pity. ¹³ |
| C1 | Confident that he/she can accomplish things. ¹³ | E5 | Is quickly bored without high levels of stimulation. Is likely to take risks and seek thrills. ¹³ |
| C3 | Has a strong sense of duty and obligation. ¹³ | N3 | Tends to feel sad, dejected, and discouraged, Lacks energy, and has difficulty initiating things. ¹³ |
| C4 | Works hard to achieve excellence and be successful at his/her goals. ¹³ | N4 | Is sensitive about what others think about him/her. ¹³ |
| C5 | Persists at difficult or unpleasant tasks until they are completed. ¹³ | N5 | Tends to be oriented toward short-term pleasures and rewards rather than long-term consequences. ¹³ |
| C6 | Thinks through possibilities before acting. ¹³ | N6 | Experience's panic, confusion, and helplessness when under pressure or stress. ¹³ |
| E1 | Genuinely likes other people and openly demonstrates positive feelings toward them. ¹³ | | |
| E3 | Likes to speak out, take charge, and direct the activities of others. ¹³ | | |
| E6 | Has positives mood and feelings, not negative emotions. Usually, optimistic. ¹³ | | |
| O4 | Eager to try new activities and experience different things. ¹³ | | |

People who have greater influence on the decision-making process (high ACE scores) tend to have *more* of these individual characteristics.

People who have less influence on the decision-making process (low ACE scores) tend to have *more* of these individual characteristics.

A significant correlation does not imply a causal relationship; it only indicates the directionality in which the variables change with respect to one another. However, since none of the correlation coefficients are greater than 0.7, the degree of correlation is low.

We also conducted a regression analysis to inspect whether personality factors can explain the ACE variation (Section 7.1.2). Two personality factors

¹³ Characterization of people with high scores in this facet. The definition can be found in (Johnson (n.d.)).

(conscientiousness and neuroticism) were selected by backward linear regression to explain 30.6% of the ACE variation ($F(2, 97) = 22.612$, $\text{Adj } R^2 = 0.306$, $p = 0.000$), as shown in the regression results (Table 70). Note that the same factors statistically significant correlated with ACE were also those selected by backward regression.

Conscientiousness has a positive coefficient (C, $B = 0.392$, $p = 0.000$), which means that an increase in the C score contributes to an increase in ACE. On the other hand, neuroticism has a negative coefficient (N, $B = -0.283$, $p = 0.001$), and an increase in the N score relates to a decrease in ACE.

Therefore, the results show that a combination of high conscientiousness and low neuroticism maximizes the ACE score. According to Feist and Feist (2008, p. 422), such individuals are characterized as hard-working, well-organized, punctual, ambitious, persevering (high conscientiousness), calm, self-satisfied, comfortable, unemotional, and hardy (low neuroticism). The amount of these individual characteristics, according to the results, explains the variation in ACE level.

Another interesting result is that the conscientiousness coefficient is higher than that of neuroticism, which indicates that conscientiousness has a more significant influence on the ACE score than neuroticism does.

The cross-validation of the predicted model shows that it has a satisfactory accuracy; because, in the worst case, MMRE is 21.82%, MdmRE is 14.35%, and Pred(25) is 63.64% (Table 71). Furthermore, MAR values range from 6.73 to 12.25 low units because ACE scores range from 0 to 100.

However, a comparison between the absolute residuals of predicted and median models showed that they are not statistically significant different. This result point indicates no advantage to use the predicted model instead of the median model. Therefore, further investigation is needed, using a larger dataset, and also perhaps by gathering data from a more diverse population within Brazil, and worldwide.

In terms of the moderating effects of age, experience, education level, and role on the relationship between ACE and the personality factors (C and N), our analysis shows that these demographic variables have no impact.

In other words, if a person is 20 or 50 years old; or if someone had started his/her career a year ago or 20 years ago; or if the person holds a bachelor's degree or Ph.D. degree; or if someone performs a technical or managerial role; none of these characteristics have any effect on the relationship between ACE and

conscientiousness nor on that between ACE and neuroticism. The next section presents the results related to the AIE domain.

7.2 Analytical and inferential efficacy

This section analyzes the relationship between analytical and inferential efficacy (AIE) and personality. This decision-making self-efficacy domain involves the ability to analyze and make inferences from data related to a decision (Myburgh et al., 2015). Section 7.2.1 presents the correlation, and a discussion of the results is presented in Section 7.2.3.

7.2.1 Correlation between analytical and inferential efficacy and personality factor and facets

A potential relationship between AIE and the personality variables (factors and facets) was examined using Spearman's correlation. Table 75 presents the correlation coefficient (r), the level of significance ($p < 0.05$), and the sample size (n) of each relationship.

The significant correlations ($p < 0.05$) are shown in Table 75. Only one personality factor (conscientiousness) is significantly correlated with AIE, and 9 out of 30 personality facets are correlated with AIE as well. Among all the personality variables significantly correlated with AIE, only one has a negative coefficient (N4; $r(102) = -0.238, p = 0.008$).

The largest correlation coefficient is that between AIE and conscientiousness (C; $r(102) = 0.305, p = 0.001$). Conscientiousness also has the highest number of facets significantly correlated with AIE (five out of six), followed by neuroticism (two out of six). Extraversion and openness have only one facet (each) that is statistically significant correlated with AIE, and agreeableness does not have any.

The following section shows the regression analysis results, considering AIE as the response variable and the personality factors as predictor variables.

The significant correlations ($p < 0.05$) are marked with asterisks in Table 75. Only one personality factor (conscientiousness) is significantly correlated with AIE, and 9 out of 30 personality facets are correlated with AIE as well. Among all the personality variables significantly correlated with AIE, only one has a negative coefficient (N4; $r(102) = -0.238, p = 0.008$).

Table 75. Spearman's correlation results between personality variables and AIE.

| Personality Variable | | | AIE | | |
|--------------------------|----------------------|----|---------|--------|-----|
| | | | r^1 | p^2 | n |
| Personality factors | Agreeableness | A | 0.056 | 0.288 | 102 |
| | Conscientiousness | C | 0.305* | 0.001* | 102 |
| | Extraversion | E | -0.005 | 0.479 | 102 |
| | Neuroticism | N | 0.051 | 0.307 | 102 |
| | Openness | O | 0.153 | 0.062 | 102 |
| Agreeableness facets | Trust | A1 | -0.001 | 0.495 | 102 |
| | Morality | A2 | 0.065 | 0.258 | 102 |
| | Altruism | A3 | 0.087 | 0.193 | 102 |
| | Cooperation | A4 | -0.058 | 0.283 | 102 |
| | Modesty | A5 | 0.056 | 0.287 | 102 |
| | Sympathy | A6 | -0.031 | 0.379 | 102 |
| Conscientiousness facets | Self-efficacy | C1 | 0.207* | 0.019* | 102 |
| | Orderliness | C2 | 0.088 | 0.189 | 102 |
| | Dutifulness | C3 | 0.302* | 0.001* | 102 |
| | Achievement-striving | C4 | 0.218* | 0.014* | 102 |
| | Self-discipline | C5 | 0.184* | 0.032* | 102 |
| | Cautiousness | C6 | 0.194* | 0.026* | 102 |
| Extraversion facets | Friendliness | E1 | 0.007 | 0.470 | 102 |
| | Gregariousness | E2 | 0.016 | 0.435 | 102 |
| | Assertiveness | E3 | 0.304* | 0.001* | 102 |
| | Activity Level | E4 | 0.042 | 0.336 | 102 |
| | Excitement-seeking | E5 | -0.150 | 0.066 | 102 |
| | Cheerfulness | E6 | -0.082 | 0.205 | 102 |
| Neuroticism facets | Anxiety | N1 | 0.269* | 0.003* | 102 |
| | Anger | N2 | 0.053 | 0.297 | 102 |
| | Depression | N3 | 0.137 | 0.084 | 102 |
| | Self-consciousness | N4 | -0.238* | 0.008* | 102 |
| | Immoderation | N5 | -0.136 | 0.087 | 102 |
| | Vulnerability | N6 | 0.024 | 0.407 | 102 |
| Openness facets | Imagination | O1 | 0.065 | 0.257 | 102 |
| | Artistic interests | O2 | 0.190* | 0.028* | 102 |
| | Emotionality | O3 | 0.123 | 0.109 | 102 |
| | Adventurousness | O4 | 0.072 | 0.237 | 102 |
| | Intellect | O5 | 0.132 | 0.094 | 102 |
| | Liberalism | O6 | -0.048 | 0.317 | 102 |

¹ correlation coefficient, ² Sig. (one-tailed); * significant at the 0.05 level.

The largest correlation coefficient is that between AIE and conscientiousness (C; $r(102) = 0.305, p = 0.001$). Conscientiousness also has the highest number of facets

significantly correlated with AIE (five out of six), followed by neuroticism (two out of six). Extraversion and openness have only one facet (each) that is statistically significant correlated with AIE, and agreeableness does not have any.

The following section shows the regression analysis results, considering AIE as the response variable and the personality factors as predictor variables.

7.2.2 Analytical and inferential efficacy regression results

In order to explore the relationship between AIE and personality, we ran a multiple linear regression with backward elimination of variables. In this analysis, AIE was the response variable, and all five personality factors were the candidates for predictor variables.

Since conscientiousness does not have a linear relationship with AIE (Appendix 3), we tried many different transformations to correct it. The cubic was the only one that fixed the issue; however, this transformation brought many problems on results interpretation. Therefore, we decided to exclude this variable from analysis,

The multiple linear regression with backward elimination, however, did not select any variable to the model. Therefore, it was not possible to verify any model's accuracy neither check the moderation effect of age, educational level, experience, and role on the relationship between AIE and personality.

7.2.3 Discussion

The ability to analyze and make inferences from data related to a decision is an important characteristic of the decision-maker, and this is precisely what AIE measures. Decision-makers with high AIE scores tend to be more effective in searching for relevant information and evaluating alternatives for making decisions (Myburgh et al., 2015).

The correlational analysis shows nine statistically significant correlations between AIE and the personality facets. The coefficients range from 0.190 to 0.305 (absolute values; Table 75), indicating that the AIE scores have some associations with personality facets; however, the relationship is not strong (i.e., $r < 0.7$).

Among the personality facets that are statistically significant correlated with AIE, eight show a positive correlation, meaning that the facet scores vary in the same direction as AIE. Only one facet has a negative coefficient, indicating that

this facet varies in the opposite direction. Table 76 summarizes all the personality facets with a significant correlation with AIE.

Table 76 shows the personality facets organized according to the correlation coefficient's signal: relationships with positive coefficients are on the left-hand side, and the one with a negative coefficient is on the right. This table also shows the main characteristic of people with high scores in the relevant personality facets.

Table 76. Individual characteristics that vary similarly to AIE score.

| Positive correlation coefficient | | Negative correlation coefficient | |
|---|---|--|---|
| Facet | Characteristics | Facet | Characteristics |
| C1 | Confident that he/she can accomplish things. ¹⁴ | N4 | Is sensitive about what others think about him/her. ¹⁴ |
| C3 | Has a strong sense of duty and obligation. ¹⁴ | | |
| C4 | Works hard to achieve excellence and be successful at his/her goals. ¹⁴ | | |
| C5 | Persists at difficult or unpleasant tasks until they are completed. ¹⁴ | | |
| C6 | Thinks through possibilities before acting. ¹⁴ | | |
| E3 | Likes to speak out, take charge, and direct the activities of others. ¹⁴ | | |
| N1 | Often feels like something dangerous is about to happen. May be afraid of specific situations or be generally fearful. Feels tense, jittery, and nervous. ¹⁴ | | |
| O2 | Eager to try new activities and experience different things. ¹⁴ | | |
| <i>Greater</i> effectiveness in information analysis and inference implies <i>more</i> of these individual characteristics. | | <i>Less</i> effectiveness in information analysis and inference implies <i>more</i> of these individual characteristics. | |

The results show a positive correlation between N1 (anxiety) and AIE, which is intriguing. However, according to Matthews (2008), high anxiety contributes to the development of skills to anticipate salient traits and hence more systematic decision-making. On the other hand, information processing can be affected by a selective bias: for example, perhaps some non-salient threats may be overlooked. Therefore, our survey results align with these characteristics highlighted by Matthews (2008).

¹⁴ Characterization of people with high scores in this facet. The definition can be found in Johnson (n.d.).

With regard to personality factors, conscientiousness (C) is the only one that is statistically significantly correlated with AIE. Goldberg (2008) describes people with high conscientiousness as systematic, efficient, and practical – characteristics that, according to our results, those with high AIE scores also possess.

The multiple linear regression with backward elimination did not select any model to explain the variation on AIE. Therefore, it was not possible to assess any model accuracy. Furthermore, since moderation analysis input requires the regression model, it was also not possible to inspect the moderation effect of age, education level, experience, and role on the relationship between AIE and personality.

There are at least two possible solutions to this problem: (1) collect more data and rerun the multiple regression analysis, and (2) explore other alternatives of statistical techniques to analyze the data.

7.3 Social influence efficacy

This section presents an analysis of the relationship between social influence efficacy (SIE) and personality. This domain refers to using social skills to acquire information and influence divergent interests in implementing decisions (Myburgh et al., 2015). Section 7.3.1 presents the correlation results, followed by the regression (Section 7.3.2) and moderation findings (Section 7.3.3). These results are discussed in Section 7.3.4. The details on the analytic approaches adopted here are presented in Chapter 5.

7.3.1 Correlation between SIE and personality factor and facets

A potential relationship between SIE and personality variables (factors and facets) was assessed using Spearman's correlation (Section 5.1). Table 77 presents the correlation coefficient (r), level of significance ($p < 0.05$), and sample size (n) of each relationship between the SIE and the personality variables.

Table 77. Spearman's correlation results between personality variables and SIE.

| Personality Variable | | | SIE | | |
|--------------------------|----------------------|----|---------|--------|-----|
| | | | r^1 | p^2 | n |
| Personality factors | Agreeableness | A | -0.119 | 0.116 | 102 |
| | Conscientiousness | C | 0.026 | 0.399 | 102 |
| | Extraversion | E | -0.041 | 0.341 | 102 |
| | Neuroticism | N | -0.065 | 0.258 | 102 |
| | Openness | O | 0.156 | 0.058 | 102 |
| Agreeableness facets | Trust | A1 | -0.027 | 0.395 | 102 |
| | Morality | A2 | -0.120 | 0.115 | 102 |
| | Altruism | A3 | -0.025 | 0.400 | 102 |
| | Cooperation | A4 | -0.038 | 0.354 | 102 |
| | Modesty | A5 | -0.233* | 0.009 | 102 |
| | Sympathy | A6 | -0.027 | 0.392 | 102 |
| Conscientiousness facets | Self-efficacy | C1 | 0.154 | 0.062 | 102 |
| | Orderliness | C2 | -0.118 | 0.118 | 102 |
| | Dutifulness | C3 | -0.034 | 0.366 | 102 |
| | Achievement-striving | C4 | 0.049 | 0.311 | 102 |
| | Self-discipline | C5 | 0.057 | 0.286 | 102 |
| | Cautiousness | C6 | -0.008 | 0.468 | 102 |
| Extraversion facets | Friendliness | E1 | -0.084 | 0.200 | 102 |
| | Gregariousness | E2 | -0.126 | 0.104 | 102 |
| | Assertiveness | E3 | 0.250* | 0.006* | 102 |
| | Activity level | E4 | -0.011 | 0.458 | 102 |
| | Excitement-seeking | E5 | -0.115 | 0.125 | 102 |
| | Cheerfulness | E6 | -0.059 | 0.277 | 102 |
| Neuroticism facets | Anxiety | N1 | 0.045 | 0.327 | 102 |
| | Anger | N2 | 0.010 | 0.459 | 102 |
| | Depression | N3 | -0.051 | 0.306 | 102 |
| | Self-consciousness | N4 | -0.131 | 0.096 | 102 |
| | Immoderation | N5 | -0.181* | 0.034* | 102 |
| | Vulnerability | N6 | -0.046 | 0.322 | 102 |
| Openness facets | Imagination | O1 | 0.136 | 0.086 | 102 |
| | Artistic interests | O2 | 0.125 | 0.104 | 102 |
| | Emotionality | O3 | -0.048 | 0.316 | 102 |
| | Adventurousness | O4 | 0.120 | 0.114 | 102 |
| | Intellect | O5 | 0.098 | 0.163 | 102 |
| | Liberalism | O6 | 0.109 | 0.138 | 102 |

¹ correlation coefficient, ² Sig. (one-tailed), * significant at the 0.05 level.

The significant correlations ($p < 0.05$) are shown in Table 77 marked with asterisks. No personality factor, and 3 out of 30 facets, are significantly correlated with SIE.

Among all the correlated personality variables, only one is positively correlated (i.e., assertiveness).

Assertiveness (E3) has the highest correlation coefficient (E3; $r(102) = 0.25$, $p = 0.006$), followed by modesty (A5; $r(102) = -0.233$, $p = 0.009$), and immoderation (N5; $r(102) = -0.181$, $p = 0.034$).

The following section shows the regression analysis results, considering SIE as the response variable and the personality factors as the predictors.

7.3.2 Social influence efficacy regression results

In order to explore the relationship between SIE and personality factors, we run multiple linear regression with backward elimination of variables. In this analysis, SIE was the response variable, and the five personality factors were the candidates for the predictors.

The regression does not suffer the multicollinearity effect, because $VIF < 1.5$ in all iterations and for all variables. The data met the assumption of independence of errors (Durbin-Watson value = 1.966) and homogeneity of error variances (Breusch-Pagan test, $F(2, 99) = 0.300$; $p = 0.742$)¹⁵. Finally, the error distribution does not significantly deviate from normality ($W(100) = 0.992$, $p = 0.853$). Table 78 shows the results of the backward linear regression.

Table 78 shows that that the backward procedure removed one variable per iteration, resulting in an MLR with four iterations. Agreeableness (A, $B = -0.378$; $\rho = 0.024 < 0.05$) and Openness (O, $B = 0.416$; $\rho = 0.019 < 0.05$) were selected to explain 5.5% of SIE variation ($F(2, 98) = 3.874$; $p = 0.024$; $Adj R^2 = 0.055$).

We conducted 10-fold cross-validation to assess the predicted model's accuracy (see Section 5.2 for procedure details). The model accuracy values are shown in Table 79, with Pred(25) ranging from 40% to 90%, MMRE values between 17.43% and 52.11%, and MdMRE between 11.30 and 32.04. The MAR values of the predicted model are, in the worst case, equal to 19.04, which indicates a satisfactory prediction accuracy because SIE scores range between 0 and 100.

¹⁵ Two datapoints were removed to keep the homoscedasticity of the error distribution.

Table 78. Regression results for SIE predicted by personality factors.

| Predictor | Iteration 1 | | | Iteration 2 | | | Iteration 3 | | | Iteration 4 | | |
|--------------------|-------------|--------|-------|-------------|--------|-------|-------------|--------|-------|-------------|--------|-------|
| | B | SE | p | B | SE | p | B | SE | p | B | SE | p |
| Constant | 68.211 | 28.530 | 0.019 | 77.375 | 21.645 | 0.001 | 69.772 | 19.998 | 0.001 | 55.729 | 16.077 | 0.001 |
| A | -0.403 | 0.170 | 0.020 | -0.391 | 0.168 | 0.022 | -0.407 | 0.167 | 0.016 | -0.378 | 0.165 | 0.024 |
| C | 0.081 | 0.164 | 0.621 | - | - | - | - | - | - | - | - | - |
| E | -0.151 | 0.164 | 0.361 | -0.151 | 0.164 | 0.359 | - | - | - | - | - | - |
| N | -0.164 | 0.149 | 0.274 | -0.190 | 0.139 | 0.173 | -0.158 | 0.134 | 0.242 | - | - | - |
| O | 0.474 | 0.188 | 0.013 | 0.461 | 0.185 | 0.015 | 0.404 | 0.174 | 0.023 | 0.416 | 0.174 | 0.019 |
| R ² | | 0.098 | | | 0.095 | | | 0.087 | | | 0.074 | |
| Adj R ² | | 0.050 | | | 0.057 | | | 0.059 | | | 0.055 | |
| F | | 2.033 | | | 2.500 | | | 3.054 | | | 3.874 | |
| p | | 0.081 | | | 0.048 | | | 0.032 | | | 0.024 | |

n = 100

The median model's accuracy measures are similar to the predicted model, which was confirmed by paired T-Test. We compared the absolute residuals values from the mean model and the same values produced by the predicted models. We did not find a significant difference in the values predicted model ($M = 13.96$, $SD = 9.91$) and the mean model ($M = 12.92$, $SD = 10.90$); $t(99) = 1.491$, $p = 0.139$. A further discussion of this issue is presented in Section 7.3.4.

Table 79. Accuracy of the SIE predicted model.

| Model | Fold | Equation | | | Accuracy Measures | | | |
|-----------|--------|----------------|----------------|-------|-------------------|--------|------------------|----------|
| | | A ¹ | O ² | Const | MMRE | MdMRE | MAR ³ | Pred(25) |
| Predicted | 1 | -0.4386 | 0.5105 | 54.01 | 28.22% | 25.80% | 13.4159 | 50.00% |
| Model | 2 | -0.318 | 0.4022 | 51.89 | 26.78% | 11.30% | 9.62036 | 80.00% |
| | 3 | -0.3375 | 0.3975 | 53.58 | 38.07% | 25.01% | 16.1025 | 50.00% |
| | 4 | -0.3855 | 0.4213 | 55.89 | 39.41% | 32.04% | 19.04727 | 40.00% |
| | 5 | -0.3912 | 0.3738 | 61.01 | 35.89% | 21.88% | 13.59306 | 50.00% |
| | 6 | -0.3662 | 0.3773 | 57.04 | 17.43% | 18.60% | 11.70535 | 90.00% |
| | 7 | -0.3496 | 0.4738 | 48.84 | 52.11% | 16.29% | 12.6217 | 80.00% |
| | 8 | -0.349 | 0.4676 | 47.76 | 18.22% | 20.28% | 12.94198 | 60.00% |
| | 9 | -0.4796 | 0.3353 | 71.27 | 28.95% | 14.16% | 14.64283 | 70.00% |
| | 10 | -0.3511 | 0.3989 | 55.37 | 49.67% | 21.38% | 15.98699 | 60.00% |
| | Median | 1 | - | - | - | 18.58% | 18.23% | 10.4 |
| Model | 2 | - | - | - | 27.15% | 14.16% | 9.8 | 80.00% |
| | 3 | - | - | - | 40.32% | 21.98% | 16.8 | 60.00% |
| | 4 | - | - | - | 41.18% | 25.42% | 17.4 | 50.00% |
| | 5 | - | - | - | 31.22% | 30.93% | 13.2 | 40.00% |
| | 6 | - | - | - | 17.82% | 19.70% | 12.6 | 70.00% |
| | 7 | - | - | - | 47.63% | 10.65% | 10.6 | 70.00% |
| | 8 | - | - | - | 20.53% | 18.75% | 12 | 70.00% |
| | 9 | - | - | - | 26.06% | 10.52% | 12.2 | 70.00% |
| | 10 | - | - | - | 43.10% | 24.33% | 14.2 | 50.00% |

¹ Agreeableness, ² Openness, ³ SIE scores vary from 0 to 100

7.3.3 Moderating effect of demographic variables on the SIE relationship

We ran a hierarchical linear regression to inspect the moderating effect of demographic variables (i.e., age, education level, experience, and role) on the relationship between SIE and two personality factors (A and O), which are the factors included in the regression model from the previous section. An illustration

of the model and equation explored in our analysis is shown in Fig. 35. Details about the data analysis approach can be found in Chapter 5.

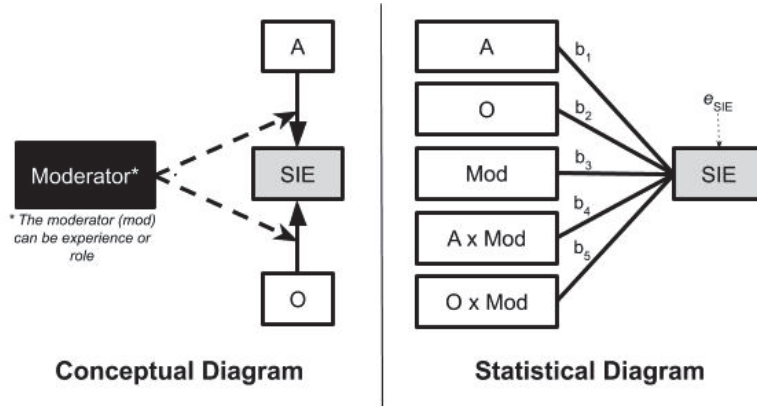


Fig. 35. Conceptual diagram, statistical diagram, and regression equation of the moderation analysis – SIE.

The relationship between SIE and age (deviation from linearity test, $F(2, 94) = 5.022, p = 0.027 < 0.05$) and that between SIE and education level are non-linear (deviation from linearity test, $F(2, 99) = 3.370, p = 0.038 < 0.05$). Although we tried many transformations on SIE, they all led to non-significant models. Therefore, we did not check the moderating effects of age and education level.

We ran two hierarchical linear regression: one each for the moderating effects of experience and of role. Due to the nature of the moderator data (ordinal or nominal scale), we created dummy variables to represent them, as explained in Section 5.2.

The data met all the regression assumptions (normality, linearity, independence of errors, and homoscedasticity) for both hierarchical regressions. The results are presented in Table 80.

The results show that experience and role do not moderate the relationship between SIE and two personality factors (A and O); the hierarchical regressions models and the coefficients of interaction terms are both non-significant.

Table 80. Results of the moderating effects of experience and role on the relationship between SIE and A and O.

| Predictor | Experience | | | | | | Role | | | | | |
|-----------------------|------------|--------|-------|--------|--------|-------|--------|-------|-------|---------|-------|-------|
| | Step 1 | | | Step 2 | | | Step 1 | | | Step 2 | | |
| | B | SE | p | B | SE | p | B | SE | p | B | SE | p |
| Step 1: | | | | | | | | | | | | |
| Constant | 66.316 | 18.314 | 0.001 | 76.308 | 24.179 | 0.002 | 47.92* | 19.40 | 0.016 | 116.12 | 51.52 | 0.027 |
| A | -0.458 | 0.186 | 0.016 | -0.564 | 0.292 | 0.058 | -0.203 | 0.196 | 0.306 | -1.73 | 1.04 | 0.101 |
| O | 0.343 | 0.202 | 0.093 | 0.339 | 0.277 | 0.225 | 0.336 | 0.191 | 0.082 | 1.32 | 1.11 | 0.238 |
| Experience (dummies) | | | | | | | | | | | | |
| w1 | 4.972 | 4.901 | 0.314 | -61.97 | 49.116 | 0.211 | -4.48 | 5.60 | 0.426 | -102.01 | 56.56 | 0.075 |
| w2 | -4.063 | 5.524 | 0.464 | 52.763 | 64.540 | 0.416 | 0.237 | 6.21 | 0.970 | -35.36 | 61.99 | 0.570 |
| w3 | 8.840 | 7.029 | 0.165 | 110.62 | 92.266 | 0.234 | | | | | | |
| Step 2: | | | | | | | | | | | | |
| int1 (A x w1) | | | | 0.349 | 0.575 | 0.546 | | | | 1.878 | 1.07 | 0.085 |
| int2 (A x w2) | | | | -0.189 | 0.602 | 0.754 | | | | 1.133 | 1.09 | 0.305 |
| int3 (A x w3) | | | | -1.187 | 1.031 | 0.253 | | | | -1.021 | 1.13 | 0.370 |
| Int4 (O x w1) | | | | 0.434 | 0.759 | 0.569 | | | | -0.952 | 1.16 | 0.415 |
| Int5 (O x w2) | | | | -0.487 | 0.817 | 0.553 | | | | | | |
| Int6 (O x w3) | | | | 0.207 | 10.308 | 0.875 | | | | | | |
| R ² | | | | 0.089 | | | | | | 0.063 | | |
| Adj R ² | | | | 0.031 | | | | | | 0.016 | | |
| p | | | | 0.191 | | | | | | 0.257 | | |
| ΔR ² | | | | 0.089 | | | | | | 0.063 | | |
| F for ΔR ² | | | | 1.527 | | | | | | 1.355 | | |

n = 84. Three dummy variables were created to represent experience values.

n = 86. Two dummy variables were created to represent role values. The

The "internship" and "<2" categories were removed due to their low frequencies (four and six datapoints, respectively).

"business" category was removed due to its low frequency (six datapoints).

7.3.4 Discussion

The SIE (one of the DMSE domains) refers to the ability to use social skills to acquire information and influence interests for implementing decisions (Myburgh et al., 2015).

Regarding the personality factors, we found that none of them are statistically significantly correlated with SIE. The correlation analysis shows three statistically significant correlations (i.e., $p < 0.05$) between SIE and personality facets. The coefficients range from 0.181 to 0.250 (absolute values; see Table 77), indicating that SIE scores vary in the same direction as personality facets; however, the relationship is not strong, as indicated by the correlation coefficients ($r < 0.7$).

Among the personality facets statistically significantly correlated with SIE, only one has a positive correlation coefficient. The remaining two facets show a negative correlation coefficient, which means that they vary in opposite directions.

Assertiveness (E3) is the only personality facet positively correlated with SIE, and it characterizes individuals who like to speak out, take charge, and direct others' activities (Johnson, n.d.). Extraversion is a factor related to social skills (Burger, 2010, p. 160); since assertiveness is a facet of extraversion, the latter is also related to social skills. Therefore, the significant correlation with SIE is expected.

People with a high level of modesty (A5) do not claim to be better than others, while those who are high in immoderation (N5) have difficulty resisting temptations and are more oriented toward short-term pleasure (Johnson, n.d.). These facets (A5 and N5) are negatively correlated with SIE, meaning that when the A5 and/or N5 score(s) is/are high, the SIE score tends to be low.

It is important to highlight that a significant correlation between two variables does not mean a cause-effect relationship; it just means that the values vary in the same direction or the opposite directions.

Section 7.3.2 presents a regression analysis that inspected if any personality factor could explain variations in SIE. Agreeableness and openness were found to explain 5.5% of SIE variation ($F(2, 98) = 3.874$; $p = 0.024$; Adj $R^2 = 0.055$), as shown in the regression results (Table 78).

The linear model has a negative coefficient for agreeableness ($B = -0.378$; $\rho = 0.024 < 0.05$) and a positive one for openness ($B = 0.416$; $\rho = 0.019 < 0.05$). In other words, a combination of low agreeableness and high openness maximizes the SIE score.

Intriguingly, people with low agreeableness have higher SIE. These people are typically characterized as rude, uncooperative, irritable, and manipulative (Cervone & Pervin, 2012, p. 265). However, SIE also relates to the ability to convince others and persevere in an attempt to persuade others (Myburgh et al., 2015); thus, these additional characteristics support our results.

Individuals with high levels of openness are characterized as curious, creative, original, imaginative, and non-traditional (Cervone & Pervin, 2012, p. 265). These characteristics are essential, because people with high SIE scores tend to *make decisions that contain risks and unfavorable consequences* (Myburgh et al., 2015).

The percentage of variation explained by the model is small (5.5%), and cross-validation indicates a satisfactory accuracy (Table 79). The MMRE values range from 17.43% to 52.11% and indicate that the percentages of errors are low in some equations but high in others. On the other hand, the MdmRE values range from 11.3% to 32.04% and indicate that the median of error percentage has similar behavior to MMRE, however, in a shorter range.

Pred(25) values show that at least 40% of the prediction errors are lower than 25%. Finally, the MAR shows the errors in absolute numbers, and it ranges from 9.62 to 19.04. Considering that the SIE score ranges from 0 to 100, an error between 9 and 20 units is low.

We also compared the predicted model to the median model by employing a paired T-Test. We compared the absolute residuals values of the median model and the same values of the predicted model. We did not find a statistically significant difference between the predicted model and the mean model. The result indicates no difference between using the predicted model and the mean model in a practical way. Therefore, further investigation is needed, using a larger dataset, and also perhaps by gathering data from a more diverse population within Brazil, and worldwide.

With regard to the relationship between SIE and agreeableness and between SIE and openness, it was not possible to verify the moderating effects of age and education level, because these variables do not have a linear relationship with SIE. The hierarchical regressions we ran to inspect the effect of experience and role shows that they do not moderate the target relationships. The next section presents the analysis pertaining to TCE.

7.4 Thought control efficacy

This section presents the analysis of the relationship between thought control efficacy (TCE) and personality; TCE refers to the ability to control intrusive thoughts (Myburgh et al., 2015). Section 7.4.1 presents the correlation results, followed by the regression (Section 7.4.2) and moderation findings (Section 7.4.3). These are discussed in Section 7.4.4.

7.4.1 Correlation between TCE and personality factors and facets

A potential relationship between TCE and personality variables (factors and facets) was assessed using Spearman's correlation (Section 5.1). Table 81 presents the correlation coefficient (r), level of significance ($p < 0.05$), and sample size (n) of each relationship between TCE and the personality variables.

The significant correlations ($p < 0.05$) are presented in Table 81 marked with asterisks. Two personality factors (conscientiousness and neuroticism) are significantly correlated with TCE ($r(102) = 0.268, p < 0.05$ for C; $r(102) = -0.198, p < 0.05$ for N), and 9 out of 30 personality facets are also correlated with TCE. Among the personality variables that are significantly correlated with TCE, six have negative correlation coefficients.

The largest correlation coefficient is between TCE and self-efficacy (C1; $r(102) = 0.335, p = 0.00$). Conscientiousness and neuroticism provide the greatest number of facets significantly correlated with TCE (three out of six for each one), followed by neuroticism with two out of six facets each. Agreeableness, extraversion, and openness have only one facet (each) that is significantly correlated with TCE.

The following section shows the regression analysis results, considering TCE as the DV and the personality factors as the IVs.

Table 81. Spearman's correlation results between personality variables and TCE.

| Personality Variable | | | TCE | | |
|--------------------------|----------------------|----|---------|--------|-----|
| | | | r^1 | p^2 | n |
| Personality factors | Agreeableness | A | -0.131 | 0.094 | 102 |
| | Conscientiousness | C | 0.268* | 0.003* | 102 |
| | Extraversion | E | 0.049 | 0.313 | 102 |
| | Neuroticism | N | -0.198* | 0.023* | 102 |
| | Openness | O | -0.040 | 0.346 | 102 |
| Agreeableness facets | Trust | A1 | -0.067 | 0.251 | 102 |
| | Morality | A2 | 0.124 | 0.108 | 102 |
| | Altruism | A3 | -0.227* | 0.011* | 102 |
| | Cooperation | A4 | -0.116 | 0.123 | 102 |
| | Modesty | A5 | -0.046 | 0.322 | 102 |
| | Sympathy | A6 | -0.097 | 0.165 | 102 |
| Conscientiousness facets | Self-efficacy | C1 | 0.335** | 0.000* | 102 |
| | Orderliness | C2 | 0.109 | 0.137 | 102 |
| | Dutifulness | C3 | 0.085 | 0.198 | 102 |
| | Achievement-striving | C4 | 0.099 | 0.162 | 102 |
| | Self-discipline | C5 | 0.275* | 0.003* | 102 |
| | Cautiousness | C6 | 0.192* | 0.026* | 102 |
| Extraversion facets | Friendliness | E1 | -0.008 | 0.468 | 102 |
| | Gregariousness | E2 | -0.062 | 0.268 | 102 |
| | Assertiveness | E3 | 0.200* | 0.022* | 102 |
| | Activity level | E4 | -0.028 | 0.391 | 102 |
| | Excitement-seeking | E5 | -0.118 | 0.119 | 102 |
| | Cheerfulness | E6 | 0.120 | 0.114 | 102 |
| Neuroticism facets | Anxiety | N1 | -0.086 | 0.195 | 102 |
| | Anger | N2 | 0.063 | 0.266 | 102 |
| | Depression | N3 | -0.237* | 0.008* | 102 |
| | Self-consciousness | N4 | -0.078 | 0.219 | 102 |
| | Immoderation | N5 | -0.309* | 0.001* | 102 |
| | Vulnerability | N6 | -0.274* | 0.003* | 102 |
| Openness facets | Imagination | O1 | 0.019 | 0.423 | 102 |
| | Artistic interests | O2 | 0.056 | 0.287 | 102 |
| | Emotionality | O3 | -0.112 | 0.130 | 102 |
| | Adventurousness | O4 | 0.090 | 0.184 | 102 |
| | Intellect | O5 | -0.060 | 0.274 | 102 |
| | Liberalism | O6 | -0.172* | 0.042* | 102 |

¹ correlation coefficient, ² sig. (one-tailed), *significant at the 0.05 level.

7.4.2 Thought control efficacy regression results

In order to explore the relationship between TCE and personality factors, we ran a multiple linear regression (MLR) with backward elimination of variables. In this analysis, TCE was the response variable, and the five personality factors were the candidates for the predictor variables.

The regression does not suffer the multicollinearity effect, because $VIF < 1.5$ for all iterations and variables. The data met the assumption of independence of errors (Durbin-Watson value = 1.986), the errors do not show a significant deviation from a normal distribution ($W(101) = 0.981$, $p = 0.164$), and they are homogeneously distributed (Breusch-Pagan test, $F(3, 97) = 0.218$; $p = 0.884$)¹⁶. Table 82 shows the results of the MLR with backward elimination.

Table 82. Regression results for TCE predicted by the personality factors.

| Predictor | Iteration 1 | | | Iteration 2 | | | Iteration 3 | | |
|--------------------|-------------|-------|--------|-------------|-------|--------|-------------|-------|--------|
| | B | SE | ρ | B | SE | ρ | B | SE | ρ |
| Constant | 55.82 | 23.23 | 0.018 | 53.04 | 22.11 | 0.018 | 63.06 | 19.92 | 0.002 |
| A | -359 | 0.134 | 0.009 | -0.364 | 0.133 | 0.007 | -0.312 | 0.123 | 0.013 |
| C | 0.340 | 0.133 | 0.013 | 0.340 | 0.133 | 0.012 | 0.316 | 0.131 | 0.018 |
| E | -0.055 | 0.136 | 0.686 | - | - | - | - | - | - |
| N | -0.244 | 0.120 | 0.046 | -0.231 | 0.116 | 0.049 | -0.240 | 0.116 | 0.041 |
| O | 0.168 | 0.151 | 0.269 | 0.146 | 0.141 | 0.301 | - | - | - |
| R ² | | 0.172 | | | 0.171 | | | 0.161 | |
| Adj R ² | | 0.128 | | | 0.136 | | | 0.135 | |
| F | | 3.948 | | | 4.937 | | | 6.217 | |
| p | | 0.003 | | | 0.001 | | | 0.001 | |

$n = 101$

Table 82 shows that the backward procedure removed one variable per iteration, resulting in an MLR with three iterations. Three personality factors explain 13.5% of the TCE variation ($F(3, 98) = 6.217$, Adj. $R^2 = 0.135$, $p = 0.001$): agreeableness (A, $B = -0.312$; $\rho = 0.013 < 0.05$), conscientiousness (C, $B = 0.316$; $\rho = 0.018 < 0.05$), and neuroticism (N, $B = -0.240$; $\rho = 0.041 < 0.05$).

We employed 10-fold cross-validation to assess the model accuracy (see Section 5.2 for procedure details). The results are shown in Table 83.

¹⁶ One datapoint was removed to keep the homoscedasticity of the error distribution.

Table 83. Accuracy of the TCE predicted model.

| Model | Fold | Equation | | | | Accuracy Measures | | | |
|-----------|--------|----------------|----------------|----------------|-------|-------------------|--------|------------------|----------|
| | | A ¹ | C ² | N ³ | Const | MMRE | MdMRE | MAR ⁴ | Pred(25) |
| Predicted | 1 | -0.1583 | 0.2573 | -0.1875 | 51.01 | 14.39% | 12.83% | 12.92 | 50.00% |
| Model | 2 | -0.333 | 0.345 | -0.2248 | 60.97 | 8.25% | 4.61% | 6.73 | 90.00% |
| | 3 | -0.2929 | 0.3323 | -0.2065 | 58.12 | 13.50% | 10.50% | 12.10 | 70.00% |
| | 4 | -0.3426 | 0.3795 | -0.2148 | 59.06 | 12.56% | 10.44% | 11.14 | 90.91% |
| | 5 | -0.2895 | 0.2608 | -0.2967 | 69.07 | 11.28% | 10.31% | 10.10 | 80.00% |
| | 6 | -0.3771 | 0.2905 | -0.2928 | 74.71 | 13.14% | 10.68% | 12.53 | 90.00% |
| | 7 | -0.3744 | 0.3383 | -0.2859 | 69.54 | 14.47% | 11.92% | 12.32 | 90.00% |
| | 8 | -0.2751 | 0.3051 | -0.2542 | 61.61 | 12.89% | 12.05% | 12.05 | 90.00% |
| | 9 | -0.3453 | 0.338 | -0.2087 | 61.68 | 12.42% | 8.40% | 11.12 | 80.00% |
| | 10 | -0.3117 | 0.3103 | -0.2267 | 63.1 | 10.86% | 7.69% | 10.41 | 90.00% |
| | Median | 1 | - | - | - | - | 17.02% | 20.75% | 15.40 |
| Model | 2 | - | - | - | - | 9.46% | 5.20% | 7.40 | 90.00% |
| | 3 | - | - | - | - | 13.34% | 11.35% | 12.20 | 70.00% |
| | 4 | - | - | - | - | 12.17% | 8.33% | 10.18 | 90.91% |
| | 5 | - | - | - | - | 9.84% | 4.79% | 8.00 | 80.00% |
| | 6 | - | - | - | - | 13.34% | 11.16% | 12.40 | 90.00% |
| | 7 | - | - | - | - | 13.39% | 12.19% | 11.40 | 90.00% |
| | 8 | - | - | - | - | 13.56% | 14.42% | 12.60 | 90.00% |
| | 9 | - | - | - | - | 11.09% | 9.80% | 10.20 | 80.00% |
| | 10 | - | - | - | - | 13.44% | 11.54% | 13.00 | 90.00% |

¹ Agreeableness, ² Conscientiousness, ³ Neuroticism, ⁴ TCE scores vary from 0 to 100

Concerning the prediction model, Table 83 shows that the MMRE values range from 8.25% to 14.47%, MdMRE between 4.61% and 12.83, and MAR, in the worst case, equal to 12.92. These values point to satisfactory prediction accuracy.

However, the mean model accuracy measures do not differ significantly from the predicted model values. Therefore, we run a paired T-Test to compare the absolute residuals values from the mean model and the same values produced by the predicted models. There was not a significant difference in the values predicted model (M = 11.14, SD = 8.5) and the mean model (M = 11.27, SD = 8.96); $t(100) = -0.163, p = 0.851$. We discuss this issue in Section 7.4.4

7.4.3 Moderating effect of demographic variables on the TCE relationship

We also ran a hierarchical linear regression to inspect the moderating effect of demographic variables (i.e., age, education level, experience, and role) on the relationship between TCE and three personality factors (A, C, and N), which are the factors included in the regression model presented in the previous section. An illustration of the model and equation explored in our analysis is presented in Fig. 36. Details about the data analysis can be found in Chapter 5.

We ran four hierarchical linear regression, one for each moderator. Due to the nature of the moderator data (ordinal or nominal scale), we created dummy variables to represent them, as explained in Section 5.3.

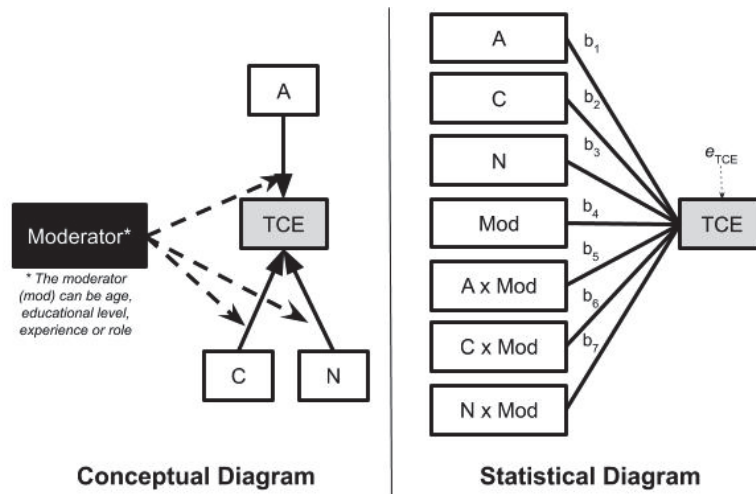


Fig. 36. Conceptual diagram, statistical diagram, and regression equation of the moderation analysis – TCE.

The data met all the regression assumptions (normality, linearity, independence of errors, and homoscedasticity) for the four hierarchical regressions. The results related to the moderating effects of age and experience are presented in Table 84, and those of education level and role are shown in Table 85. Observe that the interaction terms were added in the second step of the regression. This procedure helps to quantify the moderating effect (if it exists), as explained in Section 5.3.

Table 84. Results of the moderating effects of age and experience on the relationship between TCE and A, C, and N.

| Predictor | Age | | | Experience | | |
|-----------------------------|--------|--------|--------|------------|--------|--------|
| | Step 1 | | Step 2 | Step 1 | | Step 2 |
| | B | SE | p | B | SE | p |
| Step 1: | | | | | | |
| Constant | 69.2 | 20.30 | 0.001 | 60.76 | 82.409 | 0.463 |
| A | -0.312 | 0.125 | 0.014 | -0.091 | 0.402 | 0.822 |
| C | 0.196 | 0.144 | 0.177 | -0.008 | 0.515 | 0.987 |
| N | -0.224 | 0.120 | 0.065 | -0.138 | 0.400 | 0.732 |
| Age (dummies) | | | | | | |
| w1 | 3.322 | 3.983 | 0.407 | 14.647 | 87.245 | 0.867 |
| w2 | 0.413 | 4.603 | 0.929 | -68.18 | 78.145 | 0.386 |
| w3 | 0.744 | 6.259 | 0.906 | 70.53 | 97.256 | 0.470 |
| Step 2: | | | | | | |
| int1 (A x w1) | | | | -0.293 | 0.438 | 0.505 |
| int2 (A x w2) | | | | 0.189 | 0.313 | 0.548 |
| int3 (A x w3) | | | | 0.014 | 0.541 | 0.979 |
| int4 (C x w1) | | | | 0.296 | 0.545 | 0.589 |
| int5 (C x w2) | | | | 0.590 | 0.842 | 0.486 |
| int6 (C x w3) | | | | -1.116 | 0.922 | 0.230 |
| int7 (N x w1) | | | | -0.154 | 0.435 | 0.724 |
| int8 (N x w2) | | | | -0.077 | 0.318 | 0.808 |
| int9 (N x w3) | | | | 0.578 | 0.526 | 0.275 |
| R ² | | 0.132 | | | 0.188 | |
| Adj R ² | | 0.073 | | | 0.032 | |
| p | | 0.049 | | | 0.287 | |
| ΔR ² | | 0.132 | | | 0.055 | |
| F for ΔR ² | | 2.215 | | | 0.591 | |
| Predictor | | | | | | |
| Step 1: | | | | | | |
| Constant | 67.655 | 210.38 | 0.002 | 137.983 | 42.410 | 0.002 |
| A | -0.328 | 0.140 | 0.021 | -0.718 | 0.246 | 0.005 |
| C | 0.223 | 0.139 | 0.113 | 0.149 | 0.244 | 0.545 |
| N | -0.170 | 0.121 | 0.164 | -0.575 | 0.224 | 0.012 |
| Experience (dummies) | | | | | | |
| w1 | 0.303 | 3.858 | 0.938 | -130.390 | 59.970 | 0.033 |
| w2 | 2.739 | 4.315 | 0.527 | 62.125 | 55.698 | 0.268 |
| w3 | 3.822 | 4.719 | 0.420 | -10.588 | 61.382 | 0.864 |
| Step 2: | | | | | | |
| int1 (A x w1) | | | | 0.858 | 0.355 | 0.018 |
| int2 (A x w2) | | | | -0.481 | 0.378 | 0.207 |
| int3 (A x w3) | | | | 0.094 | 0.508 | 0.853 |
| int4 (C x w1) | | | | 0.167 | 0.358 | 0.642 |
| int5 (C x w2) | | | | -0.087 | 0.403 | 0.829 |
| int6 (C x w3) | | | | -0.255 | 0.464 | 0.584 |
| int7 (N x w1) | | | | 0.555 | 0.342 | 0.108 |
| int8 (N x w2) | | | | -0.124 | 0.324 | 0.703 |
| int9 (N x w3) | | | | 0.519 | 0.374 | 0.169 |
| R ² | | 0.170 | | | 0.295 | |
| Adj R ² | | 0.108 | | | 0.147 | |
| p | | 0.018 | | | 0.028 | |
| ΔR ² | | 0.170 | | | 0.125 | |
| F for ΔR ² | | 2.733 | | | 1.404 | |

n = 94. Three dummy variables were created to represent age values. The "> 55" category was removed due to its low frequency (four datapoints).
 n = 87. Three dummy variables were created to represent experience values. The "internship" and "< 2" categories were removed due to their low frequencies (four and seven datapoints, respectively).

Table 85. Results of the moderating effects of education level and role on the relationship between TCE and A, C, and N.

| Predictor | Education Level | | | | | | Predictor | | | | | | Role | | | | | | |
|-----------------------|-----------------|--------|-------|---------|---------|-------|-----------------------|--------|--------|--------|---------|--------|--------|----|---|--------|----|---|--|
| | Step 1 | | | Step 2 | | | Step 1 | | | Step 2 | | | Step 1 | | | Step 2 | | | |
| | B | SE | p | B | SE | p | B | SE | p | B | SE | p | B | SE | p | B | SE | p | |
| Step 1: | | | | | | | | | | | | | | | | | | | |
| Constant | 72.776 | 20.996 | 0.001 | 93.234 | 27.213 | 0.001 | Constant | 54.184 | 23.573 | 0.024 | 74.026 | 66232 | 0.268 | | | | | | |
| A | -0.291 | 0.124 | 0.021 | -0.170 | 0.162 | 0.298 | A | -0.176 | 0.156 | 0.262 | -0.466 | 0.326 | 0.157 | | | | | | |
| C | 0.220 | 0.144 | 0.132 | -0.016 | 0.201 | 0.938 | C | 0.215 | 0.136 | 0.118 | 0.306 | 0.571 | 0.594 | | | | | | |
| N | -0.300 | 0.120 | 0.014 | -0.456 | 0.146 | 0.002 | N | -0.141 | 0.132 | 0.290 | -0.169 | 0.320 | 0.599 | | | | | | |
| Ed. Level (dummies) | | | | | | | | | | | | | | | | | | | |
| w1 | 4.592 | 3.336 | 0.172 | -36.615 | 46.706 | 0.435 | w1 | -1.298 | 38.03 | 0.734 | -59.841 | 73.064 | 0.416 | | | | | | |
| w2 | -2.964 | 5.603 | 0.598 | -12.111 | 10.2956 | 0.907 | w2 | -0.030 | 46.18 | 0.995 | 75.601 | 93.672 | 0.422 | | | | | | |
| Step 2: | | | | | | | | | | | | | | | | | | | |
| int1 (A x w1) | | | | -0.183 | 0.276 | 0.509 | int1 (A x w1) | | | | 0.494 | 0.379 | 0.197 | | | | | | |
| int2 (A x w2) | | | | -0.163 | 0.530 | 0.759 | int2 (A x w2) | | | | -0.507 | 0.748 | 0.501 | | | | | | |
| int3 (C x w1) | | | | 0.397 | 0.315 | 0.211 | int3 (C x w1) | | | | -0.002 | 0.596 | 0.998 | | | | | | |
| int4 (C x w2) | | | | -0.171 | 0.622 | 0.785 | int4 (C x w2) | | | | 0.136 | 0.653 | 0.836 | | | | | | |
| int5 (N x w1) | | | | 0.330 | 0.306 | 0.283 | int5 (N x w1) | | | | 0.207 | 0.369 | 0.577 | | | | | | |
| int6 (N x w2) | | | | 0.574 | 0.661 | 0.387 | int6 (N x w2) | | | | -0.608 | 0.475 | 0.205 | | | | | | |
| R ² | | 0.175 | | | 0.227 | | R ² | | | | | 0.072 | | | | | | | |
| Adj R ² | | 0.128 | | | 0.124 | | Adj R ² | | | | | 0.011 | | | | | | | |
| p | | 0.004 | | | 0.021 | | p | | | | | 0.324 | | | | | | | |
| ΔR ² | | 0.175 | | | 0.052 | | ΔR ² | | | | | 0.072 | | | | | | | |
| F for ΔR ² | | 3.770 | | | 0.932 | | F for ΔR ² | | | | | 1.187 | | | | | | | |

n = 95. Two dummy variables were created to represent values for education level. The "high school" category was removed due to its low frequency (five datapoints).

n = 82. Two dummy variables were created to represent role values. The "business" category was removed due to its low frequency (six datapoints).

The hierarchical regression that we ran for age (left-hand side of Table 84) returned a significant model in the first step; however, the second step (in which we included the interaction terms) returned non-statistically significant models. Moreover, all the values of the interaction-term coefficients are significantly higher than 0.05. Therefore, we conclude that **age does not moderate** our target relationship.

Similarly, the **education level does not moderate** the relationship between TCE and personality factors (left-hand side of Table 85). Although the hierarchical regression returned a statistically significant model in both steps, none of the interaction-term coefficients is statistically significant.

With regard to role (right-hand side of Table 85), none of the steps returned a significant model or interaction-term coefficients. Therefore, we conclude that **role does not moderate** the relationship between TCE and the three personality factors (agreeableness, conscientiousness, and neuroticism).

Finally, the hierarchical regression we ran for **experience** (right-hand side of Table 84) returned a significant model in both steps; however, only the coefficient of int1 ($A \times w1$, $B = 0.858$, $p = 0.018$) is statistically significant. Therefore, we conclude that experience does not moderate the relationship between TCE and conscientiousness, nor that between TCE and neuroticism. However, we decided to run another hierarchical regression to check the moderating effect of experience on the relationship between TCE and agreeableness only. The results are presented in Table 86. The data met all the regression assumptions (normality, linearity, independence of errors, and homoscedasticity).

Table 86 shows that none of the steps returned a statistically significant result ($p < 0.05$) or the coefficient of interaction terms. Therefore, we conclude that experience does not moderate the relationship between TCE and agreeableness.

Table 86. Results of the moderating effect of experience on the relationship between TCE and agreeableness.

| Predictor | Step 1 | | | Step 2 | | |
|-----------------------|--------|--------|----------|---------|--------|----------|
| | B | SE | <i>p</i> | B | SE | <i>p</i> |
| Step 1: | | | | | | |
| Constant | 60.646 | 13.232 | 0.000 | 99.774 | 27.213 | 0.000 |
| A | -0.158 | 0.144 | 0.277 | -0.592 | 0.301 | 0.053 |
| Experience (dummies) | | | | | | |
| w1 | 0.919 | 3.909 | 0.815 | -66.028 | 35.906 | 0.070 |
| w2 | 6.929 | 3.864 | 0.077 | 36.227 | 31.049 | 0.247 |
| w3 | | | | | | |
| Step 2: | | | | | | |
| int1 (A × w1) | | | | 0.744 | 0.397 | 0.065 |
| int2 (A × w2) | | | | -0.335 | 0.343 | 0.331 |
| int3 (A × w3) | | | | 0.022 | 0.051 | 0.670 |
| R ² | | 0.080 | | | 0.123 | |
| Adj R ² | | 0.044 | | | 0.053 | |
| <i>p</i> | | 0.089 | | | 0.120 | |
| ΔR ² | | 0.080 | | | 0.043 | |
| F for ΔR ² | | 2.254 | | | 1.234 | |

n = 82. Three dummy variables were created to represent experience values. The categories "internship" and "< 2" were removed due to their low frequencies (four and seven datapoints, respectively).

7.4.4 Discussion

Thought control efficacy measures the ability to control intrusive thoughts. Decision-makers with high TCE scores tend to be more effective in refraining from negative thoughts, doubts, and worries related to the decision (Myburgh et al., 2015).

In terms of personality factors, conscientiousness and neuroticism are the only personality factors significantly correlated with TCE. The correlation coefficient for conscientiousness is positive, and neuroticism has a negative coefficient; however, neither factor shows a strong correlation with TCE (C, $r(102) = 0.268 < 0.7$; N, $r(102) = -0.198 > -0.7$).

The correlation analysis also shows nine statistically significant correlations between TCE and personality facets. The coefficients vary from 0.172 to 0.335 (absolute values; see Table 81), which indicates that TCE scores vary in the same direction as some personality facets; however, the strength of the relationship is considered weak ($r < 0.7$).

Among the personality facets that are statistically significantly correlated with TCE, four show a positive correlation coefficient, meaning that the facet scores vary in the same direction as TCE. The remaining five personality facets display a negative correlation coefficient; they vary in opposite directions. Table 87 summarizes the personality traits that have similar behavior to the TCE score.

In Table 87, the personality facets are presented according to the correlation coefficient sign (positive or negative). The table also briefly describes people with high scores in the relevant personality facets.

Table 87. Individual characteristics that vary similarly to TCE score.

| Positive correlation coefficient | | Negative correlation coefficient | |
|---|---|---|--|
| Facet | Characteristics | Facet | Characteristics |
| C1 | Confident that he/she can accomplish things. ¹⁷ | A3 | Feels rewarded when helping others. ¹⁷ |
| C5 | Persists at difficult or unpleasant tasks until they are completed. ¹⁷ | N3 | Tends to feel sad, dejected, and discouraged, Lacks energy, and has difficult initiating things. ¹⁷ |
| C6 | Thinks through possibilities before acting. ¹⁷ | N5 | Tends to be oriented toward short-term pleasures and rewards rather than long-term consequences. ¹⁷ |
| E3 | Likes to speak out, take charge, and direct the activities of others. ¹⁷ | N6 | Experiences panic, confusion, and helplessness when under pressure or stress. ¹⁷ |
| | | O6 | Ready to challenge authority, convention, and traditional values. ¹⁷ |
| <i>Someone with greater</i> thought control ability tends to have these individual characteristics. | | <i>Someone with lower</i> thought control ability tends to have these individual characteristics. | |

Since our analysis's correlation coefficients are not high (< 0.7), the relationship that we found is not strong. It is important to highlight that a significant correlation does not imply a cause-effect relationship. The existence of a significant correlation between two variables indicates that their values grow similarly.

We also conducted a regression analysis to determine if any personality factor can explain TCE variations (Section 7.4.2). Conscientiousness, neuroticism and agreeableness were identified in the backward linear regression to account for 13.5% of TCE variations ($F(3, 98) = 6.217$, Adj. $R^2 = 0.135$, $p = 0.001$), as shown in the regression results (Table 82).

¹⁷ Characterization of people with high scores in this facet. The definition can be found in Johnson (n.d.).

Conscientiousness has a positive coefficient ($C, B = 0.316; \rho = 0.018 < 0.05$), meaning that an increase in the conscientiousness level is associated with an increase in the TCE score. On the other hand, agreeableness and neuroticism have negative coefficients ($A, B = -0.312; \rho = 0.013 < 0.05$; $N, B = -0.240; \rho = 0.041 < 0.05$), meaning that an increment in A and/or N level(s) correlates with a decrease in TCE value.

Therefore, the regression results indicate that a combination of high conscientiousness and low agreeableness and neuroticism levels maximize the TCE score. People with a high score in conscientiousness are organized, reliable, hard-working, and persevering. Low neuroticism and agreeableness manifest in being calm, relaxed, secure, manipulative, uncooperative, and irritable (Cervone & Pervin, 2012, p. 265). These characteristics, according to our results, help explain the ability to limit negative thoughts. However, it is important to highlight that the percentage of the explained variance is low, at only 13.5%.

Cross-validation was conducted to verify the accuracy of the predicted model. The analysis shows that MAR values range from 6.73 to 12.92, MMRE between 8.25% and 14.47%, and MdmRE between 4.61% and 12.83%. Furthermore, for the worst equation, the Pred(25) value is 50%, which means that only 50% of the predicted values have an error lower than 25%. These values point to a satisfactory prediction accuracy; however, these values do not differ widely from the mean model accuracy values.

The paired T-Test was conducted to check a statistically significant difference between the mean and predicted model. We compared the absolute residuals generated by both models. The test showed that these models are not different, which means that there is no advantage in using the predicted model instead of the median model. Therefore, further investigation is needed, using a larger dataset, and also perhaps by gathering data from a more diverse population within Brazil, and worldwide.

Regarding the moderating effect of age, experience, education level, and role on the relationships between TCE and agreeableness, TCE and conscientiousness, and TCE and neuroticism; our analysis show no effect.

The next section summarizes and discusses the overall results presented in this chapter.

7.5 Overall discussion

Among the four DMSE domains, ACE has the highest number of significantly correlated personality variables (20), followed by TCE (11), AIE (10), and SIE (3). Affect control efficacy also has the highest correlation coefficient with a personality variable (ACE \times C1, $r(102) = 0.480$). Based on these findings, ACE is the domain whose score varies most closely with personality; this relationship, however, is not strong ($r_{max} < 0.7$).

With regard to the personality facets, E3 (assertiveness) is the only facet significantly correlated with all four DMSE domains, and it has positive coefficients in all cases. The correlation coefficients range from 0.2 to 0.316, indicating weak relationships ($r < 0.7$). These results show that assertive individuals tend to have high decision-making self-efficacy scores. Individuals with high assertiveness levels tend to take charge in situations, and it makes sense that people with this characteristic tend to be better decision-makers.

Self-efficacy (C1), self-discipline (C5), and immoderation (N5) are significantly correlated with three out of four DMSE domains; therefore, these traits also demonstrate some characteristics of good decision-makers. The facets C1 and C5 have positive coefficients in all cases, meaning that people with high scores in these facets also tend to possess high DMSE scores. Nonetheless, in all cases, N5 shows a negative correlation with self-efficacy: people with low immoderation levels tend to have higher DMSE scores.

Conscientiousness is the personality factor that is significantly correlated with the highest number of domains: three out of four (ACE, AIE, and TCE). Specifically, ACE is the domain with the largest correlation coefficient ($r(102) = 0.419$, $p = 0.000$), followed by AIE ($r(102) = 0.305$, $p = 0.001$) and TCE ($r(102) = 0.268$, $p = 0.003$). All the correlation coefficients are positive; hence, the conscientiousness level varies in the same direction as the ACE, AIE, and TCE scores. In addition, ACE has the highest correlation coefficient, implying a closer association with conscientiousness.

Neuroticism is significantly correlated with two out of four domains (ACE and TCE), with negative correlation coefficients. In other words, ACE and TCE scores change in the opposite direction to the neuroticism score.

We want to caution our readers again that a significant correlation does not imply a cause-effect relationship; it merely shows a tendency for two variables' scores to grow in the same rhythm.

This chapter also presented results related to regression analysis that assessed the possibility of using personality factors to explain the four DMSE domains' variation.

Conscientiousness was selected in two out of three regression models that we ran (ACE and TCE), consistently obtaining positive coefficients. The results of the models suggest that high conscientiousness levels potentially contribute to higher decision-making efficacy scores.

In addition, neuroticism was selected in two of the three regression models (ACE and TCE); in both cases, neuroticism's coefficient is negative.

Agreeableness is present in the SIE and TCE regression models, in both cases with negative coefficients. Therefore, higher agreeableness levels might signal lower SIE and TCE scores. Finally, openness is present in only one regression model (SIE), with a positive coefficient.

Extroversion was not selected in any regression models (ACE, SIE, and TCE), although assertiveness (E3) is the personality facet statistically correlated with all DMSE domains. Therefore, while E3 alone is an important personality characteristic, the overall factor (i.e., extraversion) does not sufficiently contribute to explaining the variation in the DMSE domains.

The cross-validation approach demonstrates that the accuracy of all three predicted models is satisfactory, although the ACE model's predictive power is much higher than the other two.

However, a paired T-Test between absolute residuals of predicted and mean model showed that, for all three models, there is no advantage in using the prediction model instead of the mean model because the difference between them is not statistically significant. Therefore, further investigation is needed, using a larger dataset, and also perhaps by gathering data from a more diverse population within Brazil, and worldwide.

Finally, the study of the moderating effects of age, experience, education level, and role examined if these variables can change the strength and/or direction of the relationships between DMSE domains and personality factors. We could not check some of the moderating effects;¹⁸ for the ones we did, none was found to be significant in this study.

These results indicate that, contrary to our expectations that some demographic characteristics would have a moderating effect, the variables that we investigated do not moderate the relationship between personality and DMSE.

¹⁸ i.e., the models that contain AIE and role, SIE and age, and SIE and education level.

7.6 Summary of the chapter

This chapter presented the results and discussion related to the analysis of the relationship between DMSE domains and personality. The study was conducted and presented with regard to the four DMSE domains (ACE, AIE, TSE, and SIE). In each section, the correlation, prediction, and moderation results were presented, followed by a discussion of the findings.

8 Discussion and limitations

This chapter discusses the findings and limitations of this Ph.D. research, which investigates the relationship between personality and decision-making. The following section discusses the results, and Section 8.2 presents their limitations.

8.1 Discussion

This investigation proposes to fill the gap in the lack of studies in software engineering that investigate the relationship between personality and decision-making. Therefore, the main research question is: “*What is the relationship between decision-making and personality?*” This question was answered by considering two different perspectives, each related to one research phase.

The **discovery phase** searched for published papers that investigate the abovementioned relationship (RQ SLR 1), and the **investigation phase** collected data to investigate the relationship between decision-making style and personality (RQ SRV 1), as well as between decision-making self-efficacy and personality (RQ SRV 2). Table 88 summarizes the main findings of this investigation. The definition of each research question and its details are presented in Chapter 2.

Table 88 shows the three research questions that help to answer the main research question of this investigation. The first one (RQ SLR 1) relates to the discovery phase, and the remaining two (RQ SRV 1 and 2) were answered by the investigation phase.

As Table 88 shows, **RQ-SLR1** was detailed into four objectives. The literature review suggests that the relationship between decision-making and personality has been investigated mainly in the management field. Many personality aspects (28) have been investigated using eight different personality instruments.

Concerning decision-making aspects, we identified 30 different aspects, which have been classified in a taxonomy proposed herein. The taxonomy is composed of three classes: decision-making, decision-maker, and decision-making process.

Table 88. Main findings of this research.

| Research question | Research question breakdown | Results summary |
|---|--|-----------------|
| RQ-SLR1 What is the relationship between decision-making and personality? (Chapter 3) | <p>Personality aspects: 28 different personality aspects, measured using eight instruments</p> <p>Decision-making aspects: 30 different personality aspects, classified into three classes.</p> <p>Relationships: 75 relationships</p> <p>Moderators and mediators: Two moderators and two mediators</p> | |
| RQ-SRV1 What is the relationship between decision-making style and personality? (Chapter 6) | <p>DMS Correlation: One personality factor (A) and six personality facets. Max. correlation coefficient = 0.332</p> <p>Regression Explanation: Agreeableness explains 4.2% of DMS variation</p> <p>Accuracy: Satisfactory, however similar accuracy of the median model.</p> <p>Moderation: Role moderates the relationship. When the role is technical or mixed, the effect is increased</p> | |
| RQ-SRV2 What is the relationship between decision-making self-efficacy and personality? (Chapter 7) | <p>ACE Correlation: Two personality factors (C and N) and 18 personality facets. Max. correlation coefficient = 0.480</p> <p>Regression Explanation: Conscientiousness explains 30.6% of the ACE variation</p> <p>Accuracy: Satisfactory, however similar accuracy of the median model.</p> <p>Moderation: Age, experience, education level, and role do not moderate the relationship</p> <p>Correlation: One personality factor (C) and nine personality facets. Max. correlation coefficient = 0.305</p> <p>Regression Explanation: No model was selected</p> <p>Accuracy: -</p> <p>Moderation: -</p> | |
| SIE | <p>Correlation: Three personality facets (A5, E3, N5). Max. correlation coefficient = 0.250</p> <p>Regression Explanation: Conscientiousness and openness explain 5.5% of SIE variation</p> <p>Accuracy: Satisfactory, however similar accuracy of the median model.</p> <p>Moderation: Age, experience, education level, and role do not moderate the relationship</p> | |
| TCE | <p>Correlation: Two personality factors (C and N) and nine personality facets. Max. correlation coefficient = 0.335</p> <p>Regression Explanation: Agreeableness, conscientiousness, and neuroticism explain 13.5% of TCE variation</p> <p>Accuracy: Satisfactory, however similar accuracy of the median model.</p> <p>Moderation: Age, experience, education level, and role do not moderate the relationship</p> | |

We identified a large number of relationships between personality and decision-making aspects: 75 in total. Most of the studies use the experiment or survey method to analyze the relationships. However, the number of mediators and moderators of the relationships mentioned above is low (two each).

The link between decision-making style and personality, and between decision-making self-efficacy domains and personality, were investigated in **RQ-SRV1** and **RQ-SRV2**, respectively. We conducted survey research and analyzed the data using three different approaches. The correlation approach verified if any personality variable is related to the survey decision-making variables (DMS and DMSE domains). The multiple linear regression with backward elimination of variables examined if personality variables can explain the variation in decision-making variables. The accuracy of the estimated models was checked using a cross-validation technique.

Finally, we employed hierarchical regression to inspect the moderating effects of age, education level, experience, and role on the relationships between decision-making and personality variables.

The number of relationships identified in the literature review (**RQ-SLR1**, **Table 51**) is compared with the number of statistically significant correlations identified in the survey research (**RQ-SRV1** and **RQ-SRV2**) in Table 89. Observe that the total number of relationships in the SLR shown in Table 89 does not add up to 75, because we could not map all the personality aspects identified in the SLR to the five personality factors (see Section 3.2 for details related to the mapping process).

Table 89. Number of relationships between decision-making variables and personality factors identified in the systematic literature review and the survey.

| Personality Factor | Relationships identified in the SLR | | Significant correlations from the survey | |
|--------------------|-------------------------------------|--------|--|--------|
| | # | % | # | % |
| Agreeableness | 10 | 22.7% | 1 | 12.5% |
| Conscientiousness | 10 | 22.7% | 3 | 37.5% |
| Extraversion | 4 | 9.1% | 0 | 0.0% |
| Neuroticism | 9 | 20.5% | 3 | 37.5% |
| Openness | 11 | 25.0% | 1 | 12.5% |
| Total | 44 | 100.0% | 8 | 100.0% |

By comparing the SLR and survey results, we can see that openness is the personality factor with the greatest number of relationships in the SLR. However,

considering the survey results, conscientiousness and neuroticism are the factors that appear most frequently in the survey results (see Table 89). The observed difference could indicate the importance of conscientiousness and neuroticism in software engineering decisions compared to those made in a management context. Following the same logic, agreeableness has exactly the same importance, and openness is more important in management than software engineering context.

About extraversion, SLR and survey results show that this personality factor is the less relevant of all five. This difference in the results is contradictory if we compare them with the survey results from the personality facets' perspective. Assertiveness (E3) is a facet of extraversion, and it is the one with the highest number of significant correlation with the decision-making variables investigated (four; see Table 90). Assertiveness is also the facet with the highest correlation coefficient.

Interestingly, extraversion *as a factor* is not significantly correlated with any decision-making variables. However, one of its facets has the largest number of significant correlations. The correlation coefficients (r) are all positive and vary from 0.316 to 0.200, which does not indicate a strong correlation between E3 and the decision-making variables (i.e., $r < 0.7$).

Three conscientiousness (self-efficacy, C1; self-discipline, C5; and cautiousness, C6) and one neuroticism facet (immoderation, N5) are significantly correlated with three distinct decision-making variables (Table 90). The correlation coefficients are positive for all the facets of conscientiousness; however, the relationship is not strong, seeing as they range between 0.184 and 0.480 ($r < 0.7$). Immoderation (N5) has negative correlation coefficients in all cases, and the numbers vary between 0.328 and 0.181. None of the cases is the correlation strong ($r > 0.7$); in fact, none of the significant correlations identified in the survey has a coefficient higher than 0.7. This result shows that, despite some low-level similarities, the decision-making and personality variables are different and contribute diverse information about the survey population.

Another interesting result is that A3 (altruism) and O6 (liberalism) have positive and negative correlation coefficients, respectively, depending on the decision-making variable. The coefficients of A3 and O6 are positive for the DMS relationship and negative for the TCE one; however, as noted earlier, all the correlation coefficients are lower than 0.7 (i.e., not strong correlations). These results show that A3 and O6 can behave differently when compared with some decision-making variables.

Table 90. Number of significant correlations between decision-making variables and personality facets – survey research.

| Agreeableness Facets | | | | Neuroticism Facets | | | |
|----------------------|---------------------------|---|-------|--------------------|---------------------------|---|-------|
| Facets | # significant correlation | | Total | Facets | # significant correlation | | Total |
| | + | - | | | + | - | |
| A1 | 2 | 0 | 2 | N1 | 1 | 0 | 1 |
| A2 | 1 | 0 | 1 | N2 | 0 | 1 | 1 |
| A3 | 1 | 1 | 2 | N3 | 0 | 2 | 2 |
| A4 | 1 | 0 | 1 | N4 | 0 | 2 | 2 |
| A5 | 0 | 2 | 2 | N5 | 0 | 3 | 3 |
| A6 | 0 | 1 | 1 | N6 | 0 | 2 | 2 |

| Conscientiousness Facets | | | | Openness Facets | | | |
|--------------------------|---------------------------|---|-------|-----------------|---------------------------|---|-------|
| Facets | # significant correlation | | Total | Facets | # significant correlation | | Total |
| | + | - | | | + | - | |
| C1 | 3 | 0 | 3 | O1 | 0 | 0 | 0 |
| C2 | 0 | 0 | 0 | O2 | 1 | 0 | 1 |
| C3 | 2 | 0 | 2 | O3 | 1 | 0 | 1 |
| C4 | 2 | 0 | 2 | O4 | 1 | 0 | 0 |
| C5 | 3 | 0 | 3 | O5 | 0 | 0 | 0 |
| C6 | 3 | 0 | 3 | O6 | 1 | 1 | 2 |

| Extraversion Facets | | | |
|---------------------|---------------------------|---|-------|
| Facets | # significant correlation | | Total |
| | + | - | |
| E1 | 1 | 0 | 1 |
| E2 | 0 | 0 | 0 |
| E3 | 4 | 0 | 4 |
| E4 | 0 | 0 | 0 |
| E5 | 0 | 1 | 1 |
| E6 | 1 | 0 | 1 |

Table 91 shows the results of the regression models generated in the analysis of the survey data. We considered only the personality factors in the regression analysis, because the factors aggregate the facets, and because we did not have the sample size necessary to include all the personality facets in the regression. Considering that we have 30 personality facets, the sample size should be at least equal to 300 (details in Section 2.3.7).

The multiple linear regression identified four different models. Agreeableness was selected in three of them (see Table 91), which indicates the importance of this

personality trait in decision-making. This same personality trait can have a positive or a negative coefficient depending on the DV.

Table 91. Personality factors present in the regression models – survey research.

| Personality factor | Presence in the regression models with coefficient | | Total |
|-----------------------|--|---|-------|
| | + | - | |
| Agreeableness (A) | 1 | 2 | 3 |
| Conscientiousness (C) | 2 | 0 | 2 |
| Extraversion (E) | 0 | 0 | 0 |
| Neuroticism (N) | 0 | 2 | 2 |
| Openness (O) | 1 | 0 | 1 |

Agreeableness has a positive coefficient in the model that explains the variation of the DMS variable, and negative ones in the SIE and TCE models. These results indicate that high agreeableness levels contribute to a more participative decision-making style and lower social influence efficacy.

The best explanation rate (Adj. R^2) was found in the ACE regression model. The factors identified (C and N) explain 30.6% of the ACE variation. On the other hand, DMS has the worst explanation power: agreeableness (the only personality factor identified) explains only 4.2% of the DMS variation. Table 92 summarizes the prediction power and accuracy of the four regression models generated in the survey research.

Table 92. Models Accuracy Measures – survey research.

| Model | | | MMRE | | MdMRE | | Pred(25) | | MAR | | Score |
|-------|-----------|-------|-------|-------|-------|-------|----------|-------|-------|-------|--------|
| ID | Adj R^2 | | Min | Max | Min | Max | Min | Max | Min | Max | range |
| DMS | Predicted | 0.042 | 11.7% | 30.4% | 7.8% | 21.0% | 63.6% | 100% | 20.65 | 37.87 | 30–300 |
| | Mean | - | 9.9% | 27.7% | 6.6% | 21.5% | 60.0% | 85.7% | 16.40 | 42.47 | |
| ACE | Predicted | 0.306 | 8.8% | 21.8% | 5.8% | 14.3% | 63.6% | 100% | 6.74 | 12.25 | 0–100 |
| | Mean | - | 8.0% | 19.7% | 5.3% | 21.3% | 72.7% | 100% | 5.67 | 12.22 | |
| SIE | Predicted | 0.055 | 17.4% | 52.1% | 11.3% | 32.0% | 40.0% | 90.0% | 9.62 | 19.05 | 0–100 |
| | Mean | | 17.8% | 47.6% | 10.5% | 30.9% | 40.0% | 80.0% | 9.80 | 17.40 | |
| TzCE | Predicted | 0.135 | 8.2% | 14.5% | 4.6% | 12.8% | 50.0% | 90.9% | 6.73 | 12.92 | 0–100 |
| | Mean | - | 9.5% | 17.0% | 4.8% | 20.7% | 50.0% | 90.9% | 7.40 | 15.40 | |

Accuracy is an important issue in assessing how useful the models are. Therefore, we conducted cross-validation and calculated four different accuracy measures for each model, and we compared them with the median model. All the measures aim

to estimate the difference between the value predicted by the regression equation and the value we collected in the survey (the error).

Table 92 shows that while DMS, SIE, and TCE models have a low prediction power, their accuracy is satisfactory. ACE has a better prediction power and satisfactory accuracy. However, compared to the median models, the prediction models do not differ widely. Therefore, we executed a paired T-Test comparing the absolute residuals of predicted and mean models. We concluded that there is no statistical difference between them in any of the models.

The result points that there is no advantage to use the prediction models instead of the mean model. Thus, further investigation is needed, using a larger dataset, and also perhaps by gathering data from a more diverse population within Brazil, and worldwide.

Moderating effects were investigated in the literature review (**RQ-SLR1**) and the survey (**RQ-SRV1** and **RQ-SRV2**). The literature review identified studies that report the moderating effect of problem structure and a similar degree of diversity in a relationship between decision-making and personality. The moderating effects of role on the relationship between DMS and agreeableness is one of the survey research results.

Board-member interaction and top management psychology empowerment were identified in the literature review as mediators of the relationship between decision-making and personality. The survey research did not investigate mediating effects.

8.2 Threats to validity

A discussion on research validity is important because it addresses the results' *goodness* and *soundness* (Given, 2008, p. 938); in other words, it assesses how close to the real world are the conclusions we made (Maxwell, 2012). The research documented herein contains some threats to the validity; however, they should be analyzed with respect to the research methodology adopted.

The **discovery phase** was conducted using an SLR. We developed an SLR protocol, which was extensively discussed and approved by the researchers who participated in this phase. The protocol was developed from the best-related practices in software engineering. Therefore, we believe that much potential bias was reduced. However, we believe two biases related to this phase are important to highlight; they are described below. A complete description of biases in the SLR can be found in Section 3.3 of this document.

Although we adopted guidelines to identify the list of databases, define and validate the search string, and compliment the search with snowballing, some relevant studies might not have been included in the SLR.

In terms of data extraction, we defined and approved a form. Furthermore, the extraction phase was validated by two experienced researchers. However, some mistakes may have been made during the extraction (see Section 3.3 for details).

For the **discovery phase**, we adopted a survey methodology. The *construct validity* refers to the measurements and, applying to the survey study presented herein if the instrument employed actually measures what it is intended to measure (Wright, Kim, & Perry, 2010). In this context, the personality, decision-making style, and decision-making self-efficacy questionnaires have been used and tested before; however, they were written originally in English. Because our survey population is composed of Brazilians, we translated the questionnaires to Brazilian Portuguese. These translations were reviewed twice, first during the survey pilot and then by a third-party person. However, maybe we introduced some errors during the translation process, which might impact the measurement.

Regarding the *external validity*, there are some threats. The first one is related to the survey population and its geographic distribution. All the survey population is Brazilians despite some of the participants work in other countries. Another coverage problem is related to the fact that most of the survey population executes technical roles.

The sample size used to conduct the analysis is not large as the questionnaire took between 2 and 5 hours to be answered. These characteristics can impact the generalization power of the survey results and future work gathering data from participants located in other countries and having a mix of different roles.

Another threat is related to the dependent variables, which are all bounded. In other words, their values fall in a known range (Bottai, Cai, & McKeown, 2010; Lesaffre, Rizopoulos, & Tsonaka, 2007). The decision-making style has a theoretical range between 30 and 300, and decision-making self-efficacy variables range from 0 to 100. Although we have tried different transformations to deal with the dataset problems, none of them solved the multivariate regression assumption problems. Therefore, we decided to run the multiple linear regressions without transforming them, and some of the estimated values were outside the range. This might impact the accuracy measures, and it is important to investigate this issue as future work.

Finally, among the threats to the *internal validity* of survey research mentioned by Fink (2012), the only threat we found is related to participants' selection. All the

participants were the first author's acquaintances; in other words, we used a non-probabilistic convenience sample. The sampling method implies that not all members of the aimed population had an equal chance to participate in this study, and it can have an impact on the randomization. We applied snowballing to expand the survey population and, therefore, to deal with this potential threat. However, this might impact the internal validity of the research results.

9 Conclusions

This investigation contributes to an understanding of the relationship between decision-making and personality. We defined a research process with two core phases: discovery and investigation. During the discovery phase, we executed an SLR to search for and analyze published studies on the relationship between decision-making and personality. Section 2.2 presents the SLR protocol, and Chapter 3 the results we obtained by executing this protocol.

The investigation phase was carried out through a survey of 102 software-engineering professionals. Section 2.3 details the survey design, Chapter 4 presents the descriptive statistics of the collected data, Chapter 5 describes the data analysis approaches we employed, and Chapters 6 and 7 present and discuss the survey results.

The research contributions of this research suggest that, although the link between decision-making and personality has not been discussed in the software-engineering context, this relationship exists, and personality characteristics influence the decision-making process and output.

The following section summarizes the research contributions. Sections 9.2 and 9.3 discuss the research relevance, and Section 9.4 describes the research directions based on the findings and limitations of this work.

9.1 Summary of contributions

This investigation has five main contributions related to one or more research questions, as shown in Table 9.3.

The contributions C1 and C2 relate to the discovery phase of this investigation. Contributions C3 and C5 pertain to both the discovery and investigation phases, and contribution C4 is connected only to the investigation phase.

Table 93. List of research contributions.

| ID | Description of Contributions | Related RQ |
|----|---|---|
| C1 | List of personality aspects and respective instruments | RQ-SLR 1.1 |
| C2 | List of decision-making aspects | RQ-SLR 1.1 |
| C3 | Characterization of the relationship between decision-making and personality | RQ-SLR 1.3, RQ-SRV 1 and 2, objective 1 |
| C4 | Personality variables that explain the variation on decision-making variables: regression models and their accuracy | RQ-SRV 1 and 2, objective 2 |
| C5 | Factors that interfere with the relationship between decision-making and personality | RQ-SLR 1.4, RQ-SRV 1 and 2, objective 3 |

C1 – List of personality aspects and respective instruments

The SLR results include a list of 28 personality aspects that were investigated as being relevant to decision-making. We used eight different instruments to measure these personality aspects. This contribution applies to researchers who want to study only personality and/or the relationship between personality and other factors. This list can help to define the relevant personality aspects to be investigated and the instruments to be employed.

C2 – List of decision-making aspects

The SLR synthesized 30 different decision-making aspects that were investigated in relation to personality. They were grouped into three different classes: decision-making, decision-maker, and decision-making process. This contribution applies to researchers who wish to investigate only decisions and/or the relationship between personality and other factors. This list can help to define the relevant decision-making aspects to be investigated.

C3 – Characterization of the relationship between decision-making and personality

In this investigation, the SLR identified 75 relationships between personality and decision-making aspects, presented according to the personality instrument used to collect data. In the investigation phase, the survey identified six statistically significant correlations between the investigated decision-making aspects and

personality *factors*, as well as 45 significant correlations between the investigated decision-making aspects and personality *facets*. These results can be used by researchers and practitioners who want to identify factors that can influence decision-making.

C4 – Personality variables that explain the variation in decision-making variables: regression models and their accuracy

The investigation phase resulted in four regression models, in which the DVs were the decision-making variables investigated and the IVs the personality factors. The Adjusted R² values of the models vary from 0.042 to 0.306. In other words, for some models, personality factors explain a significant percentage of the variation in decision-making variables; for others, this percentage is negligible. Furthermore, despite the models' accuracy is satisfactory (MMRE values vary from 7.8% to 53.4%), the values are similar to the mean models. Therefore, further investigation is needed, using a larger dataset, and also perhaps by gathering data from a more diverse population within Brazil, and worldwide. However, researchers can use these results to further investigate the causal relationship represented in the regression models. Industry professionals can also use this contribution to improve the decisions they make.

C5 – Factors that interfere with the relationship between decision-making and personality

The SLR identified two moderators and two mediators, and the survey identified one moderator for the relationship between decision-making and personality. These results are important to research and industry personnel who wish to identify factors influencing the relationship between personality and decision-making.

9.2 Relevance to academia

The contributions of this Ph.D. thesis can be used by other researchers who want to investigate either personality, or decision-making, or the relationship between both.

The list of personality aspects and their instruments can be used to define the aspect to be investigated, based on criteria such as the most investigated one, the least investigated one, the most important one, the one with the most identified

relationships. This list can also be used to select the personality instrument to be employed in the research. Similarly, the list of decision-making aspects can be used to identify which aspect will be investigated, considering some researcher's criteria.

The list of relationships between decision-making and personality aspects is provided as one of the SLR results, and the correlation results of the survey investigation can be used to identify the most relevant relationships. Researchers can develop criteria to select one relationship, such as the one with the largest number of identified relationships or the one with the greatest correlation coefficient (or the lowest, depending on the research goals).

Both lists mentioned in the previous paragraphs, as well as the regression models, can be used to justify the choice of the decision and personality aspects to be investigated, because these results mean that they are somehow relevant. They can also be used to build some additional research hypotheses.

Another use of the regression models is to define more focused research. This Ph.D. research provided evidence of the explanation power of certain personality factors in some decision-making aspects, and based on these results, it is possible to design a more robust research study that focuses on a more specific aspect or factor. For example, researchers may wish to design an experiment to confirm the causal relationship between ACE and conscientiousness and/or neuroticism (the model with the highest Adj. R^2).

Finally, the list of mediators and moderators can help researchers to identify factors that influence the relationship between personality and decision-making. This list and the list of personality aspects can be used to identify factors that influence decision-making.

9.3 Relevance to the industry

From the industry point of view, the results can be used to improve decision-making in organizations. The list of personality aspects (C1), list of relationships (C3), regression models (C4), and identified mediators and moderators (C5) can be used to define factors that may interfere with organizational decision-making. These factors can be assessed and prioritized, enabling organizations to work on the most critical factors.

For example, many authors highlight the importance of collaborative decision-making in producing accurate and complete architecture-related decisions (Capilla et al., 2020; Gaubatz et al., 2015). Therefore, the DMS regression model could be

used to select the team members that would result in the most participative decision-making style.

The list of decision-making aspects (an SLR result) can also be used to define the focus of decision-making improvement. The aspects can be assessed and prioritized, and the organization can then focus on improving the most relevant decision-making aspects.

9.4 Future research

There are many possibilities of research extending from this study. With regard to the **discovery phase**, the SLR should be updated after some time, because new relevant studies may be published in the future.

Regarding the **investigating phase**, it may be interesting to collect more data to identify more statistically significant correlations and predictors. Furthermore, with more datapoints, we can investigate the possibility of predicting the decision-making variables using personality facets instead of factors. This type of analysis would provide a more detailed snapshot of the relationship between decision-making and personality.

Another important future work is to check the regression models' accuracy. The models presented as a result of this thesis should be validated, for example, in some software development teams.

An interesting avenue of future research is to investigate more variables that may moderate and mediate the relationship between decision-making and personality. Perhaps, analyze different human factors, other than personality, that may also impact decision-making.

The cause-effect relationship related to the regression models presented here can also be further investigated, with consideration for other research designs (e.g., experiments) and data analysis approaches. Furthermore, the regression models could be explored for data from people of different countries rather than only Brazilians.

This research employed a **questionnaire for measuring decision-making style** designed by Vroom and Yetton (1973). This questionnaire comprises 30 decision-making problems collected by companies from different segments (such as the chemical and energy industries). An interesting, related work is to update the set of problems with situations that software engineers may actually face during the execution of their tasks.

Finally, perhaps the most important future work related to this research is the development of techniques to help managers who should lead specific decision-making, considering the candidates' personality profiles.

List of references

- Abatecola, G., Mandarelli, G., & Poggese, S. (2013). The personality factor: How top management teams make decisions. A literature review. *Journal of Management & Governance*, 17(4), 1073–1100. <https://doi.org/10.1007/s10997-011-9189-y>
- Albayrak, Ö., Kurtoglu, H., & Biçakçı, M. (2009). Incomplete Software Requirements and Assumptions Made by Software Engineers. 2009 16th Asia-Pacific Software Engineering Conference, 333–339. <https://doi.org/10.1109/APSEC.2009.39>
- Arisholm, E., Gallis, H., Dyba, T., & Sjöberg, D. I. K. (2007). Evaluating Pair Programming with Respect to System Complexity and Programmer Expertise. *IEEE Transactions on Software Engineering*, 33(2), 65–86. <https://doi.org/10.1109/TSE.2007.17>
- Babyak, M. A. (2004). What You See May Not Be What You Get: A Brief, Nontechnical Introduction to Overfitting in Regression-Type Models. *Psychosomatic Medicine*, 66(3), 411–421.
- Banker, R. D., & Slaughter, S. A. (2000). The Moderating Effects of Structure on Volatility and Complexity in Software Enhancement. *Information Systems Research*, 11(3), 219–240. <https://doi.org/10.1287/isre.11.3.219.12209>
- Baron, R., & Kenny, D. (1986). The Moderator-Mediator Variable Distinction in Social Psychological Research: Conceptual, Strategic, and Statistical Considerations. *Journal of Personality and Social Psychology*, 51(6), 1173–1182.
- Barroso, A., Madureira, J. S., Soares, M. S., & Nascimento, R. P. C. (2017). Influence of Human Personality in Software Engineering—A Systematic Literature Review. *Proceedings of the 19th International Conference on Enterprise Information Systems*, 3, 53–62. Porto, Portugal: SciTePress. <https://doi.org/10.5220/0006292000530062>
- Basili, V., Trendowicz, A., Kowalczyk, M., Heidrich, J., Seaman, C., Münch, J., & Rombach, D. (2014). *Aligning Organizations Through Measurement: The GQM+ Strategies Approach*. Switzerland: Springer Publishing Company, Inc.
- Bergner, R. M. (2020). What is personality? Two myths and a definition. *New Ideas in Psychology*, 57, 100759. <https://doi.org/10.1016/j.newideapsych.2019.100759>
- Blair, J., Czaja, R. F., & Blair, E. (2014). *Designing Surveys: A Guide to Decisions and Procedures (Third edition)*. Los Angeles: SAGE Publications, Inc.
- Boddy, D. (2008). *Management: An Introduction (4th ed.)*. Harlow: Pearson.
- Booth, A., Sutton, A., & Papaioannou, D. (2016). *Systematic Approaches to a Successful Literature Review (2nd ed.)*. Los Angeles: SAGE Publications Ltd.
- Bottai, M., Cai, B., & McKeown, R. E. (2010). Logistic quantile regression for bounded outcomes. *Statistics in Medicine*, 29(2), 309–317. <https://doi.org/10.1002/sim.3781>
- Briggs, C., & Little, P. (2007). Impacts of Organizational Culture and Personality Traits on Decision - making in Technical Organizations. *Systems Engineering*, 11(1), 15 - 26. <https://doi.org/10.1002/sys.20083>
- Burge, J. E., Carroll, J. M., McCall, R., & Mistrik, I. (2008). Decision-Making in Software Engineering. In *Rationale-Based Software Engineering* (pp. 67–76). Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-540-77583-6_5
- Burger, J. M. (2010). *Personality (8th ed.)*. Belmont, CA: Cengage Learning.

- Butcher, J. N. (2009). *Oxford Handbook of Personality Assessment*. Oxford: Oxford University Press. <https://doi.org/10.1093/oxfordhb/9780195366877.001.0001>
- Calefato, F., Iaffaldano, G., Lanubile, F., & Vasilescu, B. (2018). On developers' personality in large-scale distributed projects: The case of the apache ecosystem. 2018 IEEE/ACM 13th International Conference on Global Software Engineering (ICGSE), 87–96. IEEE.
- Capilla, R., Zimmermann, O., Carrillo, C., & Astudillo, H. (2020). Teaching Students Software Architecture Decision Making. In A. Jansen, I. Malavolta, H. Muccini, I. Ozkaya, & O. Zimmermann (Eds.), *Software Architecture* (pp. 231–246). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-58923-3_16
- Carver, C. S., & Scheier, M. F. (2012). *Perspectives on Personality* (7th ed.). Boston: Pearson.
- Casson, R. J., & Farmer, L. D. (2014). Understanding and checking the assumptions of linear regression: A primer for medical researchers. *Clinical & Experimental Ophthalmology*, 42(6), 590–596.
- Cervone, D., & Pervin, L. A. (2013). *Personality: Theory and Research* (12th ed.). Hoboken, NJ: Wiley.
- Charette, R. N. (2005). Why software fails [software failure]. *IEEE Spectrum*, 42(9), 42–49.
- Coelho, J., & Valente, M. T. (2017). Why modern open source projects fail. *Proceedings of the 2017 11th Joint Meeting on Foundations of Software Engineering*, 186–196. New York, NY, USA: Association for Computing Machinery. <https://doi.org/10.1145/3106237.3106246>
- Cohen, L., Manion, L., & Morrison, K. (2007). *Research Methods in Education* (6th ed.). London: Routledge.
- Colomo-Palacios, R., Casado-Lumbreras, C., Soto-Acosta, P., & García-Crespo, Á. (2013). Decisions in software development projects management. An exploratory study. *Behaviour & Information Technology*, 32(11), 1077–1085. <https://doi.org/10.1080/0144929X.2011.630414>
- Corr, P. J., & Matthews, G. (2009). *The Cambridge Handbook of Personality Psychology*. New York: Cambridge University Press.
- Costa, P., & McCrae, R. (2000). Revised NEO personality inventory interpretive report. Lutz, FL: Psychological Assessment Resources.
- Coyle, S., Conboy, K., & Acton, T. (2013, April 1). Group Process Losses in Agile Software Development Decision Making [Article]. Retrieved November 12, 2020, from International Journal of Intelligent Information Technologies (IJIT) website: www.igi-global.com/article/content/77873
- Cruz, S., da Silva, F. Q. B., & Capretz, L. F. (2015). Forty years of research on personality in software engineering: A mapping study. *Computers in Human Behavior*, 46, 94–113. <https://doi.org/10.1016/j.chb.2014.12.008>
- Cruzes, D. S., & Dyba, T. (2011). Recommended Steps for Thematic Synthesis in Software Engineering. 2011 International Symposium on Empirical Software Engineering and Measurement, 275–284. <https://doi.org/10.1109/ESEM.2011.36>

- Cunha, J. A. O. G., Moura, H. P., & Vasconcellos, F. J. S. (2016). Decision-making in Software Project Management: A Systematic Literature Review. *Procedia Computer Science*, 100, 947–954. <https://doi.org/10.1016/j.procs.2016.09.255>
- Dawson, J. F. (2014). Moderation in Management Research: What, Why, When, and How. *Journal of Business and Psychology*, 29(1), 1–19. <https://doi.org/10.1007/s10869-013-9308-7>
- Dieste, O., Grimón, A., Juristo, N., & Saxena, H. (2011). Quantitative Determination of the Relationship between Internal Validity and Bias in Software Engineering Experiments: Consequences for Systematic Literature Reviews. 2011 International Symposium on Empirical Software Engineering and Measurement, 285–294. <https://doi.org/10.1109/ESEM.2011.37>
- Drury-Grogan, M. L., & O'dwyer, O. (2013). An investigation of the decision-making process in agile teams. *International Journal of Information Technology & Decision Making*, 12(06), 1097–1120. <https://doi.org/10.1142/S0219622013400105>
- Dybå, T. (2003). Factors of software process improvement success in small and large organizations: An empirical study in the scandinavian context. Proceedings of the 9th European Software Engineering Conference Held Jointly with 11th ACM SIGSOFT International Symposium on Foundations of Software Engineering, 148–157. Helsinki, Finland: Association for Computing Machinery. <https://doi.org/10.1145/940071.940092>
- Dybå, T., & Dingsøyr, T. (2008). Empirical studies of agile software development: A systematic review. *Information and Software Technology*, 50(9), 833–859. <https://doi.org/10.1016/j.infsof.2008.01.006>
- Erjavec, J., Khan, N. Z., & Trkman, P. (2016). The impact of personality traits and domain knowledge on decision-making—A behavioral experiment. *Research-in-Progress Papers*. Retrieved from https://aisel.aisnet.org/ecis2016_rip/38/
- Feist, J., & Feist, G. (2008). *Theories of Personality* (7th ed.). Boston: McGraw-Hill Humanities/Social Sciences/Languages.
- Feldt, R., Torkar, R., Angelis, L., & Samuelsson, M. (2008). Towards individualized software engineering: Empirical studies should collect psychometrics. Proceedings of the 2008 International Workshop on Cooperative and Human Aspects of Software Engineering, 49–52. New York, NY, USA: Association for Computing Machinery. <https://doi.org/10.1145/1370114.1370127>
- Fenton, N., & Bieman, J. (2014). *Software Metrics: A Rigorous and Practical Approach*, Third Edition. Boca Raton, FL: CRC Press.
- Field, A. P. (2009). *Discovering statistics using SPSS:(and sex and drugs and rock'n'roll)*. London, UK: Sage Publications.
- Fink, A. (2013). *How to Conduct Surveys: A Step-by-Step Guide* (5th ed.). Thousand Oaks, LA: SAGE Publications.
- Fitzgerald, S. P. (2002). *Decision making*. Oxford UK: Capstone Publishing.
- Fulop, L., & Linstead, S. (1999). *Management: A Critical Text*. South Yarra: Macmillan.

- Furnham, A., Moutafi, J., & Crump, J. (2003). The relationship between the revised NEO-Personality Inventory and the Myers-Briggs Type Indicator. *Social Behavior and Personality*, 31(6), 577-584-584. <https://doi.org/10.2224/sbp.2003.31.6.577>
- Gaubatz, P., Lytra, I., & Zdun, U. (2015). Automatic enforcement of constraints in real-time collaborative architectural decision making. *Journal of Systems and Software*, 103, 128-149. <https://doi.org/10.1016/j.jss.2015.01.056>
- Ghasemi, A., & Zahediasl, S. (2012). Normality Tests for Statistical Analysis: A Guide for Non-Statisticians. *International Journal of Endocrinology and Metabolism*, 10(2), 486-489. <https://doi.org/10.5812/ijem.3505>
- Given, L. M. (Ed.). (2008). *The SAGE Encyclopedia of Qualitative Research Methods* (1st ed.). Los Angeles, CA: SAGE Publications, Inc.
- Glube, R. (1978). *Leadership decision making: An empirical test of the vroom and yetton model* (Doctoral dissertation, Cranfield Institute of Technology. School of Management). Cranfield Institute of Technology. School of Management. Retrieved from <https://dspace.lib.cranfield.ac.uk/handle/1826/10268>
- Goldberg, L. R. (1992). The development of markers for the Big-Five factor structure. *Psychological Assessment*, 4(1), 26.
- Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2009). *Multivariate Data Analysis* (7th ed.). Harlow: Pearson Education Limited.
- Halim, Z., Atif, M., Rashid, A., & Edwin, C. A. (2017). Profiling players using real-world datasets: Clustering the data and correlating the results with the big-five personality traits. *IEEE Transactions on Affective Computing*.
- Hannay, J. E., Arisholm, E., Engvik, H., & Sjoberg, D. I. K. (2010). Effects of Personality on Pair Programming. *IEEE Transactions on Software Engineering*, 36(1), 61-80. <https://doi.org/10.1109/TSE.2009.41>
- Hayes, A. F. (2017). *Introduction to Mediation, Moderation, and Conditional Process Analysis, Second Edition: A Regression-Based Approach* (2nd ed.). New York: The Guilford Press.
- Hayes, A. F., & Montoya, A. K. (2017). A Tutorial on Testing, Visualizing, and Probing an Interaction Involving a Multicategorical Variable in Linear Regression Analysis. *Communication Methods and Measures*, 11(1), 1-30. <https://doi.org/10.1080/19312458.2016.1271116>
- Hayes, A. F., & Preacher, K. J. (2014). Statistical mediation analysis with a multicategorical independent variable. *British Journal of Mathematical and Statistical Psychology*, 67(3), 451-470. <https://doi.org/10.1111/bmsp.12028>
- Hogan, R., Johnson, J. A., & Briggs, S. R. (1997). *Handbook of Personality Psychology*. San Diego: Elsevier.
- IBM Knowledge Center. (2014). ANOVA and Tests of Linearity. Retrieved March 20, 2020, from ANOVA and Tests of Linearity website: www.ibm.com/support/knowledgecenter/sslvm_b_23.0.0/spss/tutorials/means_anovatests.html

- Ivarsson, M., & Gorschek, T. (2011). A method for evaluating rigor and industrial relevance of technology evaluations. *Empirical Software Engineering*, 16(3), 365–395. <https://doi.org/10.1007/s10664-010-9146-4>
- Jia, J., Zhang, P., & Capretz, L. F. (2016). Environmental Factors Influencing Individual Decision-Making Behavior in Software Projects: A Systematic Literature Review. 2016 IEEE/ACM Cooperative and Human Aspects of Software Engineering (CHASE), 86–92. <https://doi.org/10.1109/CHASE.2016.026>
- John, O. P., Robins, R. W., & Pervin, L. A. (Eds.). (2010). *Handbook of Personality, Third Edition: Theory and Research (Third edition)*. New York: The Guilford Press.
- Johnson, J. A. (2014). Measuring thirty facets of the Five Factor Model with a 120-item public domain inventory: Development of the IPIP-NEO-120. *Journal of Research in Personality*, 51, 78–89.
- Johnson, J. A. (n.d.). Descriptions Used in IPIP-NEO Narrative Report. Retrieved February 7, 2020, from <http://www.personal.psu.edu/faculty/j/5/j5j/IPIPNEOdescriptions.html>
- Jose, P. E. (2013). *Doing Statistical Mediation and Moderation (1st ed.)*. New York: The Guilford Press.
- Kanij, T., Merkel, R., & Grundy, J. (2015). An empirical investigation of personality traits of software testers. *Proceedings of the Eighth International Workshop on Cooperative and Human Aspects of Software Engineering*, 1–7. Piscataway, NJ: IEEE Press.
- Kasunic, M. (2005). *Designing an effective survey*. Carnegie-Mellon University. Pittsburgh PA: Software Engineering Institute.
- Kauer, D., Waldeck, T. C. P. zu, & Schäffer, U. (2007). Effects of top management team characteristics on strategic decision making: Shifting attention to team member personalities and mediating processes. *Management Decision*, 45(6), 942–967. <https://doi.org/10.1108/002517407110762017>
- Kitchenham, B., Budgen, D., & Brereton, P. (2015). *Evidence-Based Software Engineering and Systematic Reviews (1st ed.)*. Boca Raton, FL: CRC Press.
- Kitchenham, B., Pickard, L. M., MacDonell, S. G., & Shepperd, M. J. (2001). What accuracy statistics really measure. *IEE Proceedings - Software*, 148(3), 81–85. <https://doi.org/10.1049/ip-sen:20010506>
- Koontz, H., & Weihrich, H. (2012). *Essentials Of Management: An International and Leadership Perspective (9th ed.)*. New Delhi: Mc Graw Hill India.
- Landau, S., & Everitt, B. S. (2003). *A Handbook of Statistical Analyses Using SPSS (1st edition)*. Boca Raton: Chapman and Hall/CRC.
- Lepine, J. A., Hollenbeck, J. R., Ilgen, D. R., & Hedlund, J. (1997). Effects of Individual Differences on the Performance of Hierarchical Decision-making Teams: Much More Than g. *Journal of Applied Psychology*, 82(5), 803–811.
- Lesaffre, E., Rizopoulos, D., & Tsonaka, R. (2007). The logistic transform for bounded outcome scores. *Biostatistics*, 8(1), 72–85. <https://doi.org/10.1093/biostatistics/kxj034>
- Levy, J. J. (2007). Personality Tests. In *Encyclopedia of Measurement and Statistics*. 2455 Teller Road, Thousand Oaks California 91320 United States of America: Sage Publications, Inc. <https://doi.org/10.4135/9781412952644.n346>

- Malavolta, I., Muccini, H., & V., S. R. (2014). Enhancing Architecture Design Decisions Evolution with Group Decision Making Principles. In I. Majzik & M. Vieira (Eds.), *Software Engineering for Resilient Systems* (pp. 9–23). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-12241-0_2
- Marczyk, G. R., DeMatteo, D., & Festinger, D. (2005). *Essentials of Research Design and Methodology* (1 edition). Hoboken, N.J: Wiley.
- Matthews, G. (2008). Personality and information processing: A cognitive-adaptive theory. *Handbook of Personality Theory and Assessment*, 1, 56–79.
- Maxwell, J. A. (2012). *Qualitative Research Design: An Interactive Approach* (3rd ed.). Thousand Oaks: SAGE Publications.
- McAvoy, J., & Butler, T. (2009). The role of project management in ineffective decision making within Agile software development projects. *European Journal of Information Systems*, 18(4), 372–383. <https://doi.org/10.1057/ejis.2009.22>
- Medina, A., & Francis, A. J. (2015). What Are the Characteristics that Software Development Project Team Members Associate with a Good Project Manager? *Project Management Journal*, 46(5), 81–93. <https://doi.org/10.1002/pmj.21530>
- Mendes, E., Di Martino, S., Ferrucci, F., & Gravino, C. (2007). Effort estimation: How valuable is it for a web company to use a cross-company data set, compared to using its own single-company data set? *Proceedings of the 16th International Conference on World Wide Web*, 963–972. Association for Computing Machinery. <https://doi.org/10.1145/1242572.1242702>
- Mendes, E., Felizardo, K., Wohlin, C., & Kalinowski, M. (2019). Search Strategy to Update Systematic Literature Reviews in Software Engineering. 2019 45th Euromicro Conference on Software Engineering and Advanced Applications (SEAA), 355–362. <https://doi.org/10.1109/SEAA.2019.00061>
- Mendes, F. (2018). The Relationship between Personality and Value-Based Decision-Making. 2018 IEEE/ACM 40th International Conference on Software Engineering: Companion (ICSE-Companion), 460–461.
- Mendes, F., Mendes, E., & Salleh, N. (2019). The relationship between personality and decision-making: A Systematic literature review. *Information and Software Technology*, 111, 50–71. <https://doi.org/10.1016/j.infsof.2019.03.010>
- Mendes, F., Mendes, E., Salleh, N., & Oivo, M. (2021). Insights on the relationship between decision-making style and personality in software engineering. *Information and Software Technology*, 136, 106586. <https://doi.org/10.1016/j.infsof.2021.106586>
- Moe, N. B., Aurum, A., & Dybå, T. (2012). Challenges of shared decision-making: A multiple case study of agile software development. *Information and Software Technology*, 54(8), 853–865. <https://doi.org/10.1016/j.infsof.2011.11.006>
- Myburgh, W., Watson, M. B., & Foxcroft, C. D. (2015). Development and validation of a managerial decision making self-efficacy questionnaire. *SA Journal of Industrial Psychology*, 41(1), 01–15.

- Petersen, K., & Wohlin, C. (2009). Context in Industrial Software Engineering Research. Proceedings of the 2009 3rd International Symposium on Empirical Software Engineering and Measurement, 401–404. Washington, DC, USA: IEEE Computer Society. <https://doi.org/10.1109/ESEM.2009.5316010>
- Power, K., & Wirfs-Brock, R. (2019). An Exploratory Study of Naturalistic Decision Making in Complex Software Architecture Environments. In T. Bures, L. Duchien, & P. Inverardi (Eds.), *Software Architecture* (pp. 55–70). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-29983-5_4
- Rose, J., Pedersen, K., Hosbond, J. H., & Kræmmergaard, P. (2007). Management competences, not tools and techniques: A grounded examination of software project management at WM-data. *Information and Software Technology*, 49(6), 605–624. <https://doi.org/10.1016/j.infsof.2007.02.005>
- Salleh, N., Mendes, E., Grundy, J., & Burch, G. S. J. (2009). An empirical study of the effects of personality in pair programming using the five-factor model. Proceedings of the 2009 3rd International Symposium on Empirical Software Engineering and Measurement, 214–225. IEEE Computer Society.
- Schultz, D. P., & Schultz, S. E. (2016). *Theories of Personality*. Boston, MA: Cengage Learning.
- Schwaber, K., & Sutherland, J. (2017). *The Scrum Guide. The Definitive Guide to Scrum: The Rules of the Game*. Retrieved from <https://scrumguides.org/>
- Shepperd, M., & MacDonell, S. (2012). Evaluating prediction systems in software project estimation. *Information and Software Technology*, 54(8), 820–827. <https://doi.org/10.1016/j.infsof.2011.12.008>
- Shoaib, L., Nadeem, A., & Akbar, A. (2009). An empirical evaluation of the influence of human personality on exploratory software testing. 2009 IEEE 13th International Multitopic Conference, 1–6. <https://doi.org/10.1109/INMIC.2009.5383088>
- Sulayman, M., & Mendes, E. (2010). Software and Web Process Improvement – Predicting SPI Success for Small and Medium Companies. In T. Kim, H.-K. Kim, M. K. Khan, A. Kiumi, W. Fang, & D. Ślęzak (Eds.), *Advances in Software Engineering* (pp. 120–129). Berlin, Heidelberg: Springer. https://doi.org/10.1007/978-3-642-17578-7_13
- Teller, J., Unger, B. N., Kock, A., & Gemünden, H. G. (2012). Formalization of project portfolio management: The moderating role of project portfolio complexity. *International Journal of Project Management*, 30(5), 596–607. <https://doi.org/10.1016/j.ijproman.2012.01.020>
- Tsiga, Z. D., Emes, M., & Smith, A. (2016). Attitudes to risk management in space projects. *Journal of Modern Project Management*, 4(1), 41–51.
- Ürü, F. O., Çaliskan, S. C., Atan, Ö., & Aksu, M. (2011). How Much Entrepreneurial Characteristics Matter in Strategic Decision-Making? *Procedia - Social and Behavioral Sciences*, 24, 538–562. <https://doi.org/10.1016/j.sbspro.2011.09.112>
- Vroom, V. H., & Jago, A. G. (1974). Decision making as a social process: Normative and descriptive models of leader behavior. *Decision Sciences*, 5(4), 743–769.
- Vroom, V. H., & Jago, A. G. (1988). *The new leadership: Managing participation in organizations*. Englewood Cliffs, N.J: Prentice-Hall, Inc.

- Vroom, V. H., & Yetton, P. W. (1973). *Leadership and decision-making*. Pittsburgh, PA: University of Pittsburgh Press. <https://doi.org/10.2307/j.ctt6wrc8r>
- Weiner, I. B., & Greene, R. L. (2008). *Handbook of Personality Assessment*. Hoboken, N.J: John Wiley & Sons.
- Williams, C. (2016). *MGMT* (9th ed.). Boston, MA: Cengage Learning.
- Wohlin, C., & Aurum, A. (2015). Towards a decision-making structure for selecting a research design in empirical software engineering. *Empirical Software Engineering*, 20(6), 1427–1455. <https://doi.org/10.1007/s10664-014-9319-7>
- Wohlin, C., Runeson, P., Höst, M., Ohlsson, M. C., Regnell, B., & Wesslén, A. (2012). *Experimentation in Software Engineering*. Springer Science & Business Media.
- Wright, H. K., Kim, M., & Perry, D. E. (2010). Validity concerns in software engineering research. *Proceedings of the FSE/SDP Workshop on Future of Software Engineering Research*, 411–414. New York, NY, USA: Association for Computing Machinery. <https://doi.org/10.1145/1882362.1882446>
- Zhang, H., Babar, M. A., & Tell, P. (2011). Identifying relevant studies in software engineering. *Information and Software Technology*, 53(6), 625–637. <https://doi.org/10.1016/j.infsof.2010.12.010>

Appendix 1 - Invitation for survey participation

Hello <Name_of_the_person>,

I am a Ph.D. candidate at the University of Oulu (Finland). The main goal of my Ph.D. research is to investigate the relationship between personality and decision-making, considering the Software Engineering context.

In this stage of my research, I will execute a survey, and, because of this, I am searching for people that work in software development projects and perform one of the following group of roles:

1. **Business-related professionals:** People who know about the business and contribute to the project as sources of requirements or any other business knowledge required to perform the software development.
2. **Management-related professionals:** people that perform any task related to software development management.
3. **Technical-related professionals:** people that perform any task necessary to develop the software directly, such as requirement engineers, software architects, software coders, and testers.

The main problem is because the questionnaire takes too much time to be answered (about 4 hours) and I can not decrease the time to answer it. Because of this, I've contacted people individually, asking if he/she can participate in my survey and/or provide me some people names that could participate in my survey. The survey will be answered during four-session with a duration of one hour each. When the participant finishes one session, I will send the material related to the next session.

Do you work in a software development project performing one of the groups of roles I've described before? If so, may you answer my questionnaire? Is it possible that you provide me some names of people you know that could answer my questionnaire?

If you accept my invitation, please, let me know which of the three groups of roles you are. I will send you the material for the first session in July.

Furthermore, if you decide to provide me some names to participate in this survey, please talk to the person before giving me her/his information and check if the person is really committed to answering my questionnaire. I am sure that your personal invitation will change her/his mind about participating or not in this survey.

Appendix 2 Normality

We employed the Shapiro-Wilk test to compare the variables in the interval scale with the normal distribution. The null hypothesis of the test is that *the sample is normally distributed*, and if the test is statistically significant ($p < 0.05$), then the distribution is non-normal (Ghasemi & Zahediasl, 2012). The variables not normally distributed are marked with an asterisk in the table.

Table 1. Shapiro-Wilk normality test results for all interval variables

| Variables | Shapiro-Wilk | | | | |
|--------------------------|-------------------------------------|-------|-------|-------|--------|
| | Statistic | df | Sig. | | |
| Decision-Making Style | DMS | 0.993 | 63 | 0.979 | |
| Decision-Making | Affect Control Efficacy | ACE | 0.978 | 63 | 0.321 |
| Self-Efficacy | Analytical and Inferential Efficacy | AIE | 0.962 | 63 | 0.047 |
| | Social Influence Efficacy | SIE | 0.977 | 63 | 0.285 |
| | Thought Control Efficacy | TCE | 0.979 | 63 | 0.371 |
| Personality Factors | Agreeableness* | A | 0.919 | 63 | 0.001* |
| | Conscientiousness | C | 0.971 | 63 | 0.137 |
| | Extraversion | E | 0.976 | 63 | 0.261 |
| | Neuroticism | N | 0.986 | 63 | 0.675 |
| | Openness | O | 0.985 | 63 | 0.614 |
| Agreeableness Facets | Trust* | A1 | 0.959 | 63 | 0.033* |
| | Morality* | A2 | 0.815 | 63 | 0.000* |
| | Altruism* | A3 | 0.946 | 63 | 0.008* |
| | Cooperation | A4 | 0.896 | 63 | 0.000* |
| | Modesty | A5 | 0.983 | 63 | 0.541 |
| | Sympathy* | A6 | 0.961 | 63 | 0.045* |
| Conscientiousness Facets | Self-Efficacy* | C1 | 0.943 | 63 | 0.006* |
| | Orderliness* | C2 | 0.900 | 63 | 0.000* |
| | Dutifulness* | C3 | 0.943 | 63 | 0.006* |
| | Achievement-Striving* | C4 | 0.955 | 63 | 0.021* |
| | Self-Discipline | C5 | 0.962 | 63 | 0.051 |
| | Cautiousness* | C6 | 0.955 | 63 | 0.021* |
| Extraversion Facets | Friendliness | E1 | 0.980 | 63 | 0.390 |
| | Gregariousness* | E2 | 0.942 | 63 | 0.005* |
| | Assertiveness* | E3 | 0.957 | 63 | 0.026* |
| | Activity Level | E4 | 0.980 | 63 | 0.385 |
| | Excitement-Seeking* | E5 | 0.958 | 63 | 0.033* |
| | Cheerfulness | E6 | 0.963 | 63 | 0.055 |

| Variables | | Shapiro-Wilk | | | |
|--------------------|--------------------|--------------|-------|------|--------|
| | | Statistic | df | Sig. | |
| Neuroticism Facets | Anxiety | N1 | 0.965 | 63 | 0.069 |
| | Anger* | N2 | 0.952 | 63 | 0.016* |
| | Depression* | N3 | 0.950 | 63 | 0.012* |
| | Self-Consciousness | N4 | 0.980 | 63 | 0.403 |
| | Immoderation* | N5 | 0.931 | 63 | 0.002* |
| | Vulnerability | N6 | 0.976 | 63 | 0.251 |
| Openness Facets | Imagination | O1 | 0.969 | 63 | 0.106 |
| | Artistic Interests | O2 | 0.972 | 63 | 0.165 |
| | Emotionality | O3 | 0.972 | 63 | 0.154 |
| | Adventurousness | O4 | 0.971 | 63 | 0.148 |
| | Intellect | O5 | 0.971 | 63 | 0.144 |
| | Liberalism | O6 | 0.969 | 63 | 0.115 |

Appendix 3 Linearity

We verified the linearity of the relationship between the dependent and independent variables by applying an ANOVA test, the deviation from linearity. If the test returns statistically significant ($p < 0.05$), then there is a non-linear relationship between the tested variables (IBM Knowledge Center, 2014).

Table 1 shows the result of the test related to the decision-making style. Note that the non-linear relationships are marked with an asterisk.

Table 1. ANOVA deviation from linearity between decision-making style, personality factors, and moderators.

| Independent Variable | Sum of Squares | df | Mean Square | F | Sig. |
|----------------------|----------------|----|-------------|-------------|--------|
| Agreeableness | 32 162 428 | 30 | 1 072 081 | 0.499 | 0.970 |
| Conscientiousness | 53 778 623 | 30 | 1 792 621 | 1.101 | 0.395 |
| Extraversion | 43 012 778 | 30 | 1 433 759 | 0.735 | 0.799 |
| Neuroticism* | 79 652 736 | 35 | 2 275 792 | 2.360 | 0.013* |
| Openness | 40 044 336 | 28 | 1 430 155 | 0.802 | 0.723 |
| Age | 1 017 | 3 | 339 | 0,189710047 | 0.902 |
| Educational Level | 1 218 | 2 | 609 | 0,347149393 | 0.708 |
| Experience | 2 952 | 4 | 738 | 0,418488446 | 0.794 |
| Role | 360 | 2 | 180 | 0,101708562 | 0.903 |

Table 2 shows the result of the deviation from the linearity test related to the decision-making self-efficacy domains. Note that the non-linear relationships are marked with an asterisk.

Table 2. ANOVA deviation from linearity between decision-making self-efficacy domains, personality factors, and moderators.

| Dependent Variable | Independent Variable | Sum of Squares | df | Mean Square | F | Sig. |
|---|----------------------|----------------|----|-------------|-------|--------|
| Affect Control Efficacy (ACE) | Agreeableness* | 7342.273 | 38 | 193.218 | 1.633 | 0.042* |
| | Conscientiousness | 4908.623 | 39 | 125.862 | 1.074 | 0.395 |
| | Extraversion | 4216.808 | 40 | 105.420 | 0.621 | 0.944 |
| | Neuroticism | 4659.674 | 44 | 105.902 | 0.807 | 0.769 |
| | Openness | 6744.780 | 39 | 172.943 | 1.322 | 0.161 |
| | Age | 11.860 | 3 | 3.953 | 0.030 | 0.993 |
| | Educational level* | 1108.868 | 2 | 554.434 | 3.995 | 0.021* |
| | Experience | 266.708 | 4 | 66.677 | 0.466 | 0.760 |
| Analytical and Inferential Efficacy (AIE) | Role | 203.583 | 2 | 101.791 | 0.697 | 0.501 |
| | Agreeableness | 6450.269 | 38 | 169.744 | 1.458 | 0.092 |
| | Conscientiousness* | 6633.838 | 39 | 170.098 | 1.744 | 0.025* |
| | Extraversion | 5568.265 | 40 | 139.207 | 1.032 | 0.449 |
| | Neuroticism | 6032.206 | 44 | 137.096 | 1.011 | 0.480 |
| | Openness | 5855.448 | 39 | 150.140 | 1.197 | 0.260 |
| | Age | 209.495 | 3 | 69.832 | 0.530 | 0.663 |
| | Educational level | 46.940 | 2 | 23.470 | 0.169 | 0.845 |
| Social Influence Efficacy (SIE) | Experience | 122.783 | 4 | 30.696 | 0.222 | 0.925 |
| | Role | 705.380 | 2 | 352.690 | 2.668 | 0.074 |
| | Agreeableness | 7850.332 | 38 | 206.588 | 0.549 | 0.975 |
| | Conscientiousness | 12536.930 | 39 | 321.460 | 1.006 | 0.484 |
| | Extraversion | 11442.015 | 40 | 286.050 | 0.834 | 0.727 |
| | Neuroticism | 16968.960 | 44 | 385.658 | 1.449 | 0.095 |
| | Openness | 11252.363 | 39 | 288.522 | 0.879 | 0.663 |
| | Age | 1514.557 | 3 | 504.852 | 1.659 | 0.181 |
| Thought Control Efficacy (TCE) | Educational level* | 1931.619 | 2 | 965.810 | 3.170 | 0.046* |
| | Experience | 703.442 | 4 | 175.860 | 0.555 | 0.696 |
| | Role | 1388.498 | 2 | 694.249 | 2.219 | 0.114 |
| | Agreeableness | 7727.461 | 38 | 203.354 | 0.869 | 0.675 |
| | Conscientiousness | 5108.524 | 39 | 130.988 | 0.503 | 0.988 |
| | Extraversion | 7727.316 | 40 | 193.183 | 0.776 | 0.801 |
| | Neuroticism | 9608.698 | 44 | 218.380 | 1.033 | 0.451 |
| | Openness | 6815.154 | 39 | 174.748 | 0.672 | 0.907 |
| Thought Control Efficacy (TCE) | Age | 259.227 | 3 | 86.409 | 0.394 | 0.758 |
| | Educational level | 556.374 | 2 | 278.187 | 1.278 | 0.283 |
| | Experience | 126.293 | 4 | 31.573 | 0.142 | 0.966 |
| | Role | 175.486 | 2 | 87.743 | 0.385 | 0.682 |

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