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The Relationship between Personality, Numeracy Abilities and Managerial Decision-Making

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Abstract

The study investigates how personality and numeracy abilities predict performance across three facets of decision-making competence (DMC) among managers. It addresses a timely and important topic at the intersection of individual differences and managerial decision-making. The analysis is based on data collected from 80 managers enrolled in Executive EMBA programs at the Wroclaw University of Economics and Business. Participants completed validated research tools, including the Polish Ten-Item Personality Inventory (TIPI-PL), the Berlin Numeracy Test (BNT), and three subscales of the Adult Decision-Making Competence (ADMC) framework: Applying Decision Rules (DR), Consistency in Risk Perception (RP), and Resistance to Sunk Costs (SC). The research utilized correlation analyses to assess the relationships between personality traits, numeracy abilities, and decision-making competence. Moderation analyses examined whether numeracy abilities moderated the effect of personality on decision-making competence. I found significant positive correlations between numeracy abilities and all three facets of decision-making competence, with the strongest effect observed for resistance to sunk costs. In contrast, personality showed little predictive power, with only openness to experience demonstrating a modest correlation with decision-making competence. Moderation analyses revealed that numeracy abilities significantly moderated the relationship between extraversion and applying decision rules and also moderated the relationship between agreeableness and consistency in risk perception. Other interactions were marginal or non-significant. Although a relatively small sample size limits the findings' generalizability, the analysis offers meaningful insights into the relationship between numeracy, personality, and managerial decision-making competence. The results highlight the relevance of numeracy in managerial decision-making and its potential role in managerial development.

Keywords: personality, numeracy abilities, managerial decision-making, applying decision rules, consistency in risk perception, resistance to sunk cost, moderation.

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Introduction

The study aimed to explore the relationship between personality, numeracy abilities, and managerial decision-making. The research sought not only to clarify how these variables are interrelated but also to provide a deeper understanding of their interaction within a managerial context.

Definitions of Key Variables

Personality

The literature commonly defines personality as a stable pattern of thoughts, emotions, and behaviors that distinguish individuals from one another across contexts and over time. Although definitions vary, most of them emphasize two key components: uniqueness and consistency in behavior. According to Zimbardo and Gerrig (2012), personality is "a multifaceted set of psychological traits that shape a person's characteristic pattern of behavior which is stable in different situations over the flow of time." Similarly, Horwood *et al.* (2020) define personality as "someone's usual pattern of behavior, feelings, and thoughts," highlighting its cross-temporal stability. He clarifies that the term "usual" refers to how someone typically behaves across times and situations. Burger (2011) adds that personality reflects "consistent behavior patterns and intrapersonal processes originating within the individual," pointing to the internal mechanisms and observable behavioral regularities. Larsen and Buss (2008) further describe personality as "the set of psychological traits and mechanisms within the individual that are organized and relatively enduring and that influence his or her interactions with, and adaptations to, the intrapsychic, physical, and social environments." This definition underscores the interaction between internal personality structures and external demands, including those found in the workplace. In psychological and organizational research, scholars most commonly assess personality by means of the Big Five Model, introduced by Goldberg (1990). This model categorizes personality into five personality dimensions, known also as personality traits, that is, Extraversion, Agreeableness, Conscientiousness, Emotional Stability, and Openness to Experience. Extraversion refers to the tendency to seek stimulation and enjoy the company of others. Individuals high in extraversion are typically more energetic and sociable, while those low in extraversion are more introverted and reserved. Agreeableness reflects interpersonal warmth, empathy, and cooperativeness. People characterized by high level of agreeableness are cooperative and sympathetic. Conversely, those low in agreeableness tend to be more skeptical or aggressive. Conscientiousness involves being organized, self-disciplined, and reliable. It contrasts with tendencies towards carelessness, negligence, and unreliability. Emotional Stability is the extent to which an individual is calm and resilient in the face of negative emotions. While those high in emotional stability are emotionally resilient and collected, those with its low level may exhibit increased emotional reactivity and instability. Openness to Experience describes intellectual curiosity, creativity, and openness to new ideas. Individuals high in openness are imaginative and exploratory, while those low in openness are more resistant to change and may prefer routine and tradition. The NEO Personality Inventory–Revised (NEO-PI-R) by Costa and McCrae (1992) is a widely used tool

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for assessing the Big Five dimensions of personality: Extraversion, Agreeableness, Conscientiousness, Neuroticism (the opposite of Emotional Stability), and Openness to Experience. However, due to its length and complexity, researchers developed other, more concise research tools for research contexts requiring efficient administration. In the present study, I assessed personality using the Polish adaptation of the Ten-Item Personality Inventory (TIPI-PL). Originally, Gosling *et al.* (2003) developed TIPI as a brief, psychometrically validated research tool to measure the Big Five personality dimensions where time constraints are a concern. The TIPI-PL version validated by Sorokowska *et al*. (2014) has demonstrated acceptable internal consistency and construct validity in Polish samples. I selected it for this study due to its brevity, cultural relevance, and suitability for use in managerial professionals.

Numeracy abilities

Numeracy abilities are not a single psychological construct. Scholars commonly define the term as the cognitive ability to comprehend, interpret, and use numerical and probabilistic information in everyday reasoning and decision-making (Cokely *et al*., 2012). The literature often discusses this construct under other names, such as "numeracy skills," "numeracy," or "mathematical skills." The notion comprises multiple, interrelated yet distinct components (Sobkow *et al.*, 2020). A key distinction within this domain is between objective statistical numeracy and subjective numeracy. Objective statistical numeracy, which is the focus of the present study, refers to a person's actual ability to understand and apply numerical concepts such as ratios, percentages, probabilities, and basic statistics (Weller *et al*., 2013; Cokely *et al*., 2012). In contrast, subjective numeracy reflects an individual's perception of their numeracy (Fagerlin *et al*., 2007). Gal *et al*. (2005) underscore that numeracy involves not only computational proficiency but also the ability to compare magnitudes, interpret ratios, and apply basic statistical reasoning. This broader conceptualization is particularly crucial in areas where numeracy enables informed decision-making under risk (Peters, 2012; Tiede *et al*., 2022). As Cokely *et al.* (2012) argue, numeracy is strongly linked to risk literacy, defined as the ability to make informed decisions in the face of uncertainty. This finding is especially evident in applied settings such as health and finance, where numeracy facilitates better comprehension of probabilities and risk (Schwartz *et al*., 1997; Reyna *et al*., 2009; Garcia-Retamero *et al*., 2019). In the present study, I measured numeracy by means of the Berlin Numeracy Test (BNT). It is a validated tool developed to measure objective statistical numeracy in educated populations (Cokely *et al*., 2012). The BNT has demonstrated predictive validity in assessing decision-making competence.

Decision-making competence

Decision-making competence (DMC) is the ability to make decisions that are consistent, normatively acceptable, and resistant to cognitive bias. Early theories of human decision-making, such as Rational Choice Theory, viewed decisions as the outcome of logical, cognitive processing aimed at maximizing utility (Simon, 1955; Becker, 1993). However, these models have been challenged by psychological approaches, such as Prospect Theory, which emphasize how decisions under risk and uncertainty are influenced by subjective value perception, heuristics, and framing effect (Kahneman & Tversky, 1979). To empirically assess DMC, I relied on the Adult Decision-Making Competence (ADMC) framework by Bruine de Bruin *et al.*

(2007). It reflects the degree to which people apply logical rules, evaluate risks accurately, and avoid decision-making errors across diverse domains (Bruine de Bruin *et al*., 2007). ADMC is a psychometric tool designed to assess decision-making competence across a range of cognitive tasks. It includes seven subscales capturing a broad range of cognitive processes associated with competent decision-making. These include: applying decision rules, consistency in risk perception, resistance to sunk costs, recognizing social norms, under/overconfidence, and resistance to framing. In their research, Bruine de Bruin *et al*. (2007) demonstrated that ADMC scores are significantly correlated with real-world decision outcomes, including financial decision quality and avoidance of risky behavior, supporting the predictive validity of the tool. Moreover, ADMC performance is distinct from traditional cognitive ability measures, highlighting its utility in applied and organizational settings. For the study purpose, I selected three scales of ADMC based on their relevance to managerial decision-making. Applying Decision Rules (DR) is the ability to apply specific decision-making rules when faced with multiple options. It assesses how effectively an individual can follow predefined decision-making criteria to select the most appropriate option from a set of available options. Consistency in Risk Perception (RP) measures how well individuals understand probability rules and maintain consistency in risk assessment. Resistance to Sunk Costs (SC) refers to the ability to disregard past investments of time, money, or effort (sunk-cost fallacy) when making future-oriented decisions. Prior studies have shown that performance on the three chosen scales correlates with decision quality in both experimental and applied domains (Del Missier *et al*., 2012; Weller *et al*., 2015). According to Parker and Fischhoff (2005), individuals with higher DMC tend to exhibit greater consistency, better probabilistic reasoning, and more accurate evaluations of expected outcomes.

Theories Explaining the Relationships Between Variables and Hypotheses

We may understand the relationship between personality traits, numeracy abilities, and decision-making competence (DMC) by means of cognitive and dispositional psychological theories. These perspectives may provide a theoretical foundation to explain why individuals differ in how effectively they make decisions in complex, uncertain, or high-stakes environments.

Personality and Decision-Making Competence

The relationship between personality and decision-making competence can be conceptualized by means of Trait Activation Theory (Tett & Burnett, 2003). According to this concept, personality traits are not always expressed, but are activated by specific situations that are pertinent to those traits. In the area of decision-making, when a given situation activates traits, it can influence behavior and job performance. In this way, certain personality traits, such as openness to experience and conscientiousness, may facilitate thoughtful decision processes. For instance, people with a higher level of openness to experience can be more cognitively flexible and willing to explore multiple alternatives, which might enhance performance on tasks involving uncertainty or novelty (McCrae & Costa, 1997). On the other hand, conscientious individuals may be more thorough and rule-consistent, especially in structured tasks

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such as applying decision rules (Judge & Zapata, 2015). Barrick and Mount (1991) showed that all personality traits were related to task performance, and three of them, namely emotional stability, openness to experience, and agreeableness, explained 28% of the variance in participants' management performance. Other meta-analyses suggest that the effect of personality on decision-making is limited or context-dependent (Appelt *et al*., 2011; Weller *et al*., 2015). It might stem from the fact that personality shapes preferences and motivational orientations rather than determines actual cognitive performance. For instance, in the face of stress, neuroticism may predispose individuals to decision avoidance or delayed action under stress. However, contextual and cognitive factors may influence this effect. Moreover, previous studies have connected personality dimensions, such as agreeableness and extraversion, to interpersonal aspects of decision-making. However, their ability to predict decision-making competence, such as captured in the ADMC framework, may be limited unless moderated by cognitive abilities, such as memory, as proposed by Del Missier *et al.* (2013). Consequently, although personality provides a dispositional foundation, its relationship with DMC seems to be neither consistent nor deterministic.

Numeracy Abilities and Decision-Making Competence

The relationship between numeracy abilities and decision-making competence is strongly supported by several cognitive processing theories. Fuzzy-Trace Theory (Reyna & Brainerd, 1995) argues that individuals encode information in memory using two types of mental representations: verbatim (precise, literal) and gist (fuzzy, qualitative, and meaning-based). Verbatim processing refers to surface-level detail, while gist processing reflects the meaning of a decision context. Individuals high in numeracy possess cognitive resources to understand numerical aspects of a decision (e.g., risk, probability), which enables them to extract the gist of a given problem. They are also more likely to rely on gist-type representations, which are generally more adaptive in complex and uncertain situations (Sobkow *et al*., 2020). Skilled Decision Theory (Cokely *et al*., 2018) emphasizes that highly numerate individuals function like experts when making decisions under risk or uncertainty. Instead of relying solely on algorithmic rules, they make use of well-organized knowledge stored in long-term memory, such as personal values, prior experiences, or learned patterns. This kind of expert-like reasoning helps them overcome cognitive limitations (e.g., working memory constraints) and better manage the complexity of real-life decision-making. Last but not least, the Multiple Numeric Competencies theory by Peters and Bjälkebring (2015) underscores that numeracy is a multidimensional construct. Among its components, objective statistical numeracy plays a particularly central role in decision-making. Individuals high in this ability are more likely to make normatively accurate decisions, adapt their strategies to the importance of a given task, and process numerical information more precisely. They are also less prone to cognitive biases and are more consistent in their evaluation of risks and outcomes. A substantial amount of research over the last years has shown that statistical numeracy is also one of the strongest indicators of superior decision-making in various areas, including healthcare and finance (Cokely *et al.*, 2018; Garcia-Retamero *et al*., 2019; Skagerlund *et al*., 2022). Moreover, scholars also found that it enhances performance in financial planning, forecasting, evidence evaluation, and high-stakes decision-making in applied contexts, such as managerial settings (Peters, 2012). Moreover, Jasper *et al*. (2012) found that numeracy is a key predictor of adap-

tive risky decision-making, thus supporting the link between numeracy abilities and decision-making. Numeracy abilities are not only essential for interpreting complex data but also for resisting cognitive biases such as the sunk cost fallacy. Unlike personality, numeracy is a trainable skill; this partially justifies its treatment as a "causal lever" in organizational practice (e.g., selection, training). In fact, empirical research has demonstrated that efforts to improve objective statistical numeracy lead to measurable improvements in multiple domains. For example, training programs have been shown to improve comprehension, risk literacy, and decision-making (García Retamero & Cokely, 2013; Sobkow *et al*., 2019). Specifically, Galesic and García Retamero (2011) found that individuals low in numeracy were more willing to avoid shared decision-making, highlighting the potential for numeracy interventions to meaningfully improve decision behavior. Therefore, while personality may shape an individual's decision-making style, numeracy can provide the cognitive infrastructure required to execute those decisions competently.

Numeracy abilities moderate the relationship between personality and decision-making

I assumed that numeracy acts as a moderator, influencing the strength of the relationship between personality and decision-making. We may find the theoretical framework for this assumption in cognitive–dispositional interaction models, which propose that cognitive abilities can interact with personality to shape behavior (Stanovich, 2009; Toplak *et al*., 2011). According to Stanovich (2009), rational thinking is not only determined by intelligence, but also by thinking dispositions (e.g., reflection, open-mindedness) and mindware, acquired cognitive tools such as statistical and logical reasoning skills. His model suggests that individuals with stronger cognitive abilities may be better equipped to override intuitive or impulsive tendencies, thereby weakening the influence of personality on decision-making (Stanovich & West, 2000). This rationale aligns with compensatory models, where cognitive abilities can interact with dispositional traits depending on task demands. For instance, extraverted individuals may be more likely to use fast, heuristic decision-making, but those high in numeracy might correct for these tendencies through more analytical processing (Del Missier *et al*., 2012). Support for this view also comes from Cognitive Load Theory, which posits that complex decisions deplete cognitive resources (Sweller, 1988). Under such loads, individuals tend to rely on fast, automatic, and intuitive processing (System 1), unless they have sufficient capacity to engage in slow and deliberative reasoning (System 2) (Kahneman 2011). In this way, numeracy might act as a resilience factor, helping individuals maintain analytical rigor even in cognitively demanding situations. Empirical research further supports the role of numeracy in mitigating heuristic biases and enhancing decision quality under pressure (Peters, 2012; Cokely *et al*., 2012). Accordingly, in the present study, I positioned numeracy not as a mediator (i.e., transmitting the effect of personality) but as a moderator, a variable that influences the relationship between personality and decision-making competence.

Hypotheses

Based on the theoretical framework discussing the relationship between the investigated variables, I formulated the following hypotheses:

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H1: Higher numeracy scores positively correlate with better performance in applying decision rules (DR).
H2: Higher numeracy scores positively correlate with greater consistency in risk perception (RP).
H3: Higher numeracy scores positively correlate with greater resistance to sunk costs (SC).
H4: There is a correlation between personality and the three scales of DMC (DR, RP, SC).
H5: Numeracy abilities moderate the relationship between personality and DMC.

Method

Participants

The research included 80 managers enrolled in an Executive MBA program at Wroclaw University of Economics and Business. As part of the program's entry requirements, all participants held at least a university-level degree and had several years of professional managerial experience. The participants represented a wide array of managerial roles across sectors such as human resources, manufacturing, and sales. Participation was voluntary, confidential, and anonymous. I obtained informed consent from all participants before the start of the study. I instructed the participants not to use a calculator while solving the tasks. I conducted the study in Polish.

Procedure

I conducted the study in cooperation with Executive MBA Office at Wroclaw University of Economics and Business in 08.2024. The MBA Office sent the invitations to participate by email to a database of over 400 current students and alumni. I collected the data via an online survey platform (Qualtrics). The study followed a fixed order of administration and did not employ randomization. Participants could complete the survey at their own pace; there were no time constraints. The survey took approximately 25 minutes to complete.

Materials

I measured personality using the Polish version of the Ten Item Personality Inventory (TIPI-PL) (Sorokowska *et al*., 2014). This research tool consists of 10 items that assess the Big Five personality dimensions: Extraversion, Agreeableness, Conscientiousness, Emotional Stability (opposite of Neuroticism), and Openness to Experience. Each personality dimension is evaluated with two items rated on a 7-point Likert scale (1 = strongly disagree to 7 = strongly agree). The scores for these two items, related to a given personality trait, are averaged to obtain the final score for a personality dimension.

I assessed numeracy using the Berlin Numeracy Test (BNT) by Cokely *et al*. (2012). The present study employed the computerized 4-item version of the BNT, which consists of four open-ended, probability-based tasks. Depending on the score, the test classifies participants into five groups (on a scale of 0–4) based on the number of correctly solved tasks. Scores ranged from 0 to 4, with higher scores indicating higher numeracy.

I measured decision-making competence (DMC) using three subscales from the Adult Decision-Making Competence (ADMC) framework by Bruine de Bruin *et al*. (2007). The selected subscales were Applying Decision Rules (DR), Consistency in Risk Perception (RP), and

Resistance to Sunk Costs (SC). The Polish-language versions were provided by Prof. Jakub Traczyk (SWPS University), who had previously adapted them for use in Polish research contexts (Sobkow, 2025). Before beginning the DMC tasks, all participants received standardized instructions, along with examples of completed tasks, to ensure proper understanding and completion. I computed separate scores for each subscale. Higher scores indicated better decision-making competence.

Results

Participants' characteristics

I asked the participants about their gender, age, place of residence, and the size of the team they managed. I analyzed the data from 80 participants (n = 80). Participants ranged in age from 32 to 52 years (M = 40.1, SD = 4.97). The gender distribution was predominantly male, with 73.75% (n = 59), while females constituted 26.25% (n = 21). In terms of residence, the majority of respondents (67.50%, n = 54) reported living in cities with populations exceeding 500,000 inhabitants. As far as the managed team size is concerned, 41.25% of participants (n = 33) reported that their team consisted of less than five members. I calculated descriptive statistics for all investigated variables, i.e., personality (TIPI-PL), numeracy (BNT), and decision-making competence (ADMC: DR, RP, SC). I compared the gathered results with published reference data to provide a context for interpreting participants' performance. As summarized in Table 1, the mean scores for all personality traits, apart from openness to experience, were higher when compared to reference scores reported by Sorokowska *et al*. (2014). Participants also demonstrated a higher score on the BNT compared to reference data from Sobkow *et al*. (2025). The scores on the three selected ADMC subscales were also higher in comparison with the reference data reported by Bruine de Bruin *et al*. (2007).

TABLE 1. TIPI-PL, BNT and ADMC scores compared to reference data

Category	Current study		Reference data	
	M	*SD*	*M*	*SD*
TIPI-PL score (personality)				
Extraversion	5.74	1.14	4.56	1.48
Agreeableness	5.67	0.94	5.26	1.12
Conscientiousness	5.96	1.13	5.47	1.13
Emotional Stability	5.37	1.30	4.85	1.45
Openness to Experience	5.30	1.26	5.43	1.06
BNT score (numeracy)	2.31	1.24	1.79	1.14
ADMC score (decision-making competence)				
Applying Decision Rules (DR)	0.74	0.23	0.44	0.24
Consistency in Risk Perception (RP)	0.81	0.11	0.70	0.16
Resistance to Sunk Costs (SC)	4.75	0.74	4.40	0.77

Note: *M* = mean; *SD* = standard deviation; DR = Applying Decision Rules; RP = Consistency in Risk Perception; SC = Resistance to Sunk Costs; BNT = Berlin Numeracy Test; TIPI-PL = Polish version of the Ten Item Personality Inventory.

Source: own elaboration.

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Relationship between Personality and Decision-Making Competence

To examine the relationship between personality and decision-making competence, I computed Spearman's rank correlations. Given that the majority of variables did not meet the assumption of normality (as assessed via the Shapiro-Wilk test), I employed a non-parametric method. Table 2 presents the correlation results. Overall, the correlations between personality and DMC were generally weak and non-significant, with two notable exceptions. Openness to experience positively correlated with applying decision rules (r_S = .225, p = .045) and with resistance to sunk costs (r_S = .381, p < .001). These correlations indicate that a higher level of openness to experience was linked to better application of decision rules and a greater ability to resist to sunk-costs. In contrast, other personality dimensions did not exhibit statistically significant correlations with any of the three DMC facets. Correlations coefficients for these traits ranged from r_S = –.055 to r_S = .183, with all associated p-values exceeding the .05 threshold.

TABLE 2. Correlation Table: Personality and Decision-Making Competence

Category	DR		RP		SC	
	r_S	p	r_S	p	r_S	p
TIPI-PL score (personality)						
Extraversion	0.051	0.651	-0.055	0.627	0.135	0.232
Agreeableness	0.183	0.105	0.130	0.252	0.152	0.179
Conscientiousness	0.055	0.630	-0.027	0.810	0.153	0.176
Emotional Stability	0.110	0.332	-0.034	0.767	0.117	0.303
Openness to Experience	0.225*	0.045	0.026	0.817	0.381*	< .001

Note: r_s = Spearman rank correlation coefficient; p-value indicates significance level; DR = Applying Decision Rules; RP = Consistency in Risk Perception; SC = Resistance to Sunk Costs; TIPI-PL = Polish version of the Ten Item Personality Inventory.

Source: own elaboration.

Relationship between Numeracy and Decision-Making Competence

As shown in Table 3, numeracy abilities positively correlated with all three facets of DMC. The correlation between BNT scores and applying decision rules was moderate and statistically significant, r_S = .367, p < .001, indicating that participants with higher numeracy levels were more likely to apply decision rules accurately. I observed a weaker, yet statistically significant, positive correlation between BNT and Consistency in Risk Perception, r_S = .247, p = .027. This suggests that participants with higher numeracy abilities also demonstrated more consistent risk judgments, although the effect size was small. The strongest correlation emerged between numeracy and resistance to sunk costs, with a coefficient of r_S = .573, p < .001, reflecting a moderately strong and statistically significant association.

TABLE 3. Correlation Table: Numeracy and Decision-Making Competence

Category	DR		RP		SC	
	r_S	p	r_S	p	r_S	p
BNT score (numeracy)	0.367	p < .001*	0.247	p = 0.027*	0.573	p < .001*

Note: r_s = Spearman rank correlation coefficient; p-value indicates significance level; DR = Applying Decision Rules; RP = Consistency in Risk Perception; SC = Resistance to Sunk Costs; BNT = Berlin Numeracy Test.

Source: own elaboration.

Numeracy abilities moderate the relationship between personality and decision-making competence

To examine whether numeracy moderates the relationship between personality traits and decision-making competence (DMC), I conducted a series of multiple linear regression analyses. Each model tested one of the three DMC dimensions Applying Decision Rules (DR), Consistency in Risk Perception (RP), and Resistance to Sunk Costs (SC), as the dependent variable. The predictor variables included the five personality traits: Extraversion, Agreeableness, Conscientiousness, Emotional Stability, and Openness to Experience, numeracy abilities (measured by the Berlin Numeracy Test), and their corresponding interaction terms (e.g., BNT x Extraversion). For each regression model, I calculated both R^2 and adjusted R^2 to assess the proportion of variance in the DMC outcome explained by the predictors, accounting for the number of predictors in the model.

The overall regression model predicting DR was statistically significant, $F(11, 68) = 2.52$, $p = .009$, accounting for approximately 25% of the variance in DR scores ($R^2 = .246$, adjusted $R^2 = .148$). Among the predictors, extraversion and openness to experience showed statistically significant main effects ($p = .010$ and $p = .009$, respectively. I observed one significant interaction effect (BNT*Extraversion): numeracy (BNT) moderated the relationship between extraversion and DR ($\beta = 1.63$, $t(68) = 2.43$, $p = .018$). No other interaction terms reached statistical significance. Table 4 presents the detailed data for this regression model.

TABLE 4. Regression Model: Moderating effect of numeracy on each personality trait and DR

Model		*B*	*SE*	*β*	*t*	*p*
M_0	(Intercept)	0.735	0.025		28.921	< .001
M_1	(Intercept)	1.419	0.359		3.956	< .001
	Extraversion	-0.116	0.044	-0.582	-2.651	0.010*
	Agreeableness	-0.038	0.057	-0.157	-0.673	0.503
	Conscientiousness	-0.089	0.046	-0.443	-1.953	0.055
	Emotional stability	-0.007	0.047	-0.039	-0.146	0.884
	Openness to Experience	0.105	0.039	0.583	2.672	0.009*
	BNT	-0.281	0.169	-1.533	-1.666	0.100
	BNT*Extraversion	0.047	0.019	1.629	2.429	0.018*
	BNT*Agreeableness	0.022	0.023	0.760	0.942	0.349
	BNT*Conscientiousness	0.030	0.023	1.121	1.311	0.194
	BNT*Emotional stability	-0.007	0.020	-0.245	-0.331	0.742
	BNT*Openness to Experience	-0.032	0.017	-1.094	-1.872	0.065

Note: *B* = Unstandardized coefficient; *β* = Standardized coefficient; *SE* = Standard Error; *t*-value indicates statistical significance; *p*-value indicates significance level; BNT = Berlin Numeracy Test.

Source: own elaboration.

The regression model predicting consistency in risk perception (RP) was statistically significant, $F(11, 68) = 1.41$, $p = .042$, explaining approximately 16% of the variance in RP scores ($R^2 = .156$, adjusted $R^2 = .045$). None of the main effects of personality traits or numeracy (BNT)

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reached statistical significance. I identified a significant interaction effect between numeracy and agreeableness (BNT*Agreeableness): $\beta = 2.21$, $SE = 0.012$, $t = 2.57$, $p = .012$, indicating that the effect of agreeableness on RP varied depending on numeracy level.Table 5 reports full regression coefficients for this model.

TABLE 5. Regression Model: Moderating effect of numeracy on each personality trait and RP

Model		*B*	*SE*	*β*	*t*	*p*
M_0	(Intercept)	0.810	0.012		66.347	< .001
M_1	(Intercept)	1.125	0.183		6.147	< .001
	Extraversion	-0.021	0.022	-0.220	-0.945	0.348
	Agreeableness	-0.043	0.029	-0.373	-1.503	0.138
	Conscientiousness	0.004	0.023	0.046	0.192	0.848
	Emotional stability	-0.038	0.024	-0.445	-1.573	0.120
	Openness to Experience	0.026	0.020	0.302	1.304	0.197
	BNT	-0.034	0.086	-0.380	-0.389	0.698
	BNT*Extraversion	6.818×10-4	0.010	0.049	0.069	0.945
	BNT*Agreeableness	0.030	0.012	2.205	2.574	0.012*
	BNT*Conscientiousness	-0.015	0.012	-1.143	-1.258	0.213
	BNT*Emotional stability	0.013	0.010	0.961	1.224	0.225
	BNT*Openness to Experience	-0.016	0.009	-1.179	-1.900	0.062

Note: *B* = Unstandardized coefficient; *β* = Standardized coefficient; *SE* = Standard Error; *t*-value indicates statistical significance; *p*-value indicates significance level; BNT = Berlin Numeracy Test.

Source: own elaboration.

The regression model predicting resistance to sunk cost bias (SC) was not statistically significant, $F(11, 68) = 1.35$, $p = .218$, accounting for approximately 18% of the variance ($R^2 = .180$, adjusted $R^2 = .047$). None of the main effects of personality traits or numeracy (BNT) reached statistical significance. Furthermore, I did not observe any significant interaction terms between numeracy and the personality traits, indicating that numeracy did not moderate the relationship between personality and resistance to sunk cost bias. Table 6 presents full regression coefficients for this model.

TABLE 6. Regression Model: Moderating effect of numeracy on each personality trait and SC

Model		*B*	*SE*	*β*	*t*	*p*
M_0	(Intercept)	4.746	0.083		57.368	< .001
M_1	(Intercept)	3.836	1.074		3.572	< .001
	Extraversion	-0.075	0.131	-0.115	-0.571	0.570
	Agreeableness	0.155	0.170	0.196	0.913	0.364
	Conscientiousness	-0.116	0.137	-0.177	-0.847	0.400
	Emotional stability	-0.126	0.140	-0.220	-0.901	0.371
	Openness to Experience	0.192	0.118	0.326	1.624	0.109
	BNT	0.210	0.506	0.352	0.416	0.679

BNT*Extraversion	0.053	0.058	0.562	0.911	0.365
BNT*Agreeableness	-0.100	0.069	-1.074	-1.448	0.152
BNT*Conscientiousness	0.070	0.068	0.812	1.032	0.306
BNT*Emotional stability	0.010	0.060	0.115	0.170	0.866
BNT*Openness to Experience	-0.013	0.051	-0.141	-0.263	0.793

Note: *B* = Unstandardized coefficient; *β* = Standardized coefficient; *SE* = Standard Error; *t*-value indicates statistical significance; *p*-value indicates significance level; BNT = Berlin Numeracy Test.

Source: own elaboration.

In summary, Table 7 presents the results of the regression models examining the moderating effect of numeracy on the relationship between personality and decision-making competence.

TABLE 7. Summary of Regression Analyses Examining the Moderating Role of Numeracy on the Relationship Between Personality and Decision-Making Competence (DR, RP, SC)

Dependent Variable	*Significant interaction*	R^2	*adjusted* R^2
Applying Decision Rules (DR)	BNT*Extraversion (β = 1.63, *SE* = 0.019, *t*(68) = 2.43, *p* = .018)	0.246	0.148
Consistency in Risk Perception (RP)	BNT*Agreeableness (β = 2.21, *SE* = 0.012, *t*(68) = 2.57, *p* = .012)	0.156	0.045
Resistance to Sunk Costs (SC)	None	0.180	0.047

Note: R^2 = indicates how well a statistical model explains the variability in a dependent variable using independent variables; adjusted R^2= accounts for the number of independent variables in a regression model; *B* = Unstandardized coefficient; *β* = Standardized coefficient; *SE* = Standard Error; *t*-value indicates statistical significance; *p*-value indicates significance level; BNT = Berlin Numeracy Test

Source: own elaboration.

Discussion

This study investigated how numeracy and personality predict decision-making competence (DMC) among managers, focusing on three dimensions Adult Decision-Making Competence framework, i.e., applying decision rules (DR), consistency in risk perception (RP), and resistance to sunk costs (SC). I formulated five hypotheses based on the theoretical and empirical literature guiding this research.

Presentation of Results for Each Hypothesis

Hypotheses 1–3 predicted that higher numeracy abilities would correlate with higher decision-making competence on each of the three ADMC subscales. The results supported these hypotheses. I observed significant positive correlations between numeracy (measured by BNT) and decision-making competence (DR, RP, and SC). This suggests that individuals with higher numeracy abilities are better equipped to apply decision rules, evaluate risks consistently, and resist sunk costs. These findings align with prior research linking numeracy to risk numeracy, rational decision-making, and resistance to bias (Cokely *et al*., 2012; Peters, 2012). Hypothesis 4 postulated that personality correlates with DMC dimensions.

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The correlation analysis results demonstrated partial support for this hypothesis. Among the Big Five personality dimensions, openness to experience showed a statistically significant correlation with both DR and SC. Other traits, such as extraversion, agreeableness, conscientiousness, and emotional stability showed non-significant correlations across DMC outcomes. These findings are consistent with earlier meta-analyses, implying that personality traits, while influential in certain behavioral domains, tend to show modest or context-dependent correlations with decision competence (Appelt *et al*., 2011; Weller *et al*., 2015). Hypothesis 5 stated that numeracy abilities moderate the relationship between personality and DMC. This hypothesis was also partially supported. I found significant interaction effects between numeracy and extraversion on DR. I observed a second significant correlation between numeracy and agreeableness on RP. These findings suggest that numeracy can amplify or buffer the influence of personality on decision-making competence, supporting cognitive-dispositional interaction models (Stanovich, 2009). Although numeracy significantly moderated the relationship between extraversion and DR and between agreeableness and RP, I did not observe any moderation effects for resistance to sunk costs (SC). These results suggest that the moderating role of numeracy may be task-specific or limited to particular personality–decision-making pairings, influencing decision-making facets that rely more heavily on structured, analytical reasoning. In contrast, decisions involving sunk costs may be shaped by contextual or emotional factors beyond numerical reasoning, which could explain the absence of significant interaction effects.

In contrast, I did not observe any moderation effects for SC, and the model did not reach statistical significance, indicating that the moderating role of numeracy may be task-specific or limited to particular personality-decision-making pairings.

Research Limitations

Several factors may have affected the validity and reliability of the present study. The most important challenge was the insufficient sample size (N = 80), which may have limited the statistical power, particularly in the moderation analyses involving multiple predictors. The relatively small number of participants increases the likelihood of Type II errors, potentially obscuring weaker but theoretically meaningful interaction effects that might emerge in larger samples. In turn, this limitation restricts the generalizability of the findings. Second, the specific characteristics of the sample group may have influenced the observed results. Compared to the reference group (Bruine de Bruin *et al*., 2007; Sobkow *et al*., 2025), participants possessed above-average numeracy abilities and decision-making competence. Similarly, the group showed elevated scores in Extraversion, Conscientiousness, Agreeableness, and Emotional Stability (Sorokowska *et al*., 2014). While this is consistent with the high educational and professional profile of Executive MBA students, it may also reflect a non-representative, high-performing managerial group with above-average cognitive and analytical skills. This limits the extent to which one may generalize the findings to broader or less specialized groups. Finally, I measured variables using self-report inventories and scenario-based tasks, which may be subject to social desirability bias or misinterpretation. While the sample consisted of working managers, all tasks were completed in an artificial online environment. Real-world decision-making often occurs under conditions of stress or uncertainty, which the study's design may not have fully captured.

Implications for Practice

Notwithstanding the research limitations, the findings offer a number of practical implications. Given the positive correlations between numeracy and all three DMC subscales, organizations may consider including tools such as the Berlin Numeracy Test (BNT) in the recruitment and development of managerial staff. The BNT can serve as a proxy for risk literacy and statistical reasoning, both of which are necessary for structured decision-making. Since numeracy is a cognitive skill that can be enhanced, targeted interventions like training in probabilistic reasoning, visual aids, or evidence-based forecasting may strengthen decision-making. Previous studies (Garcia-Retamero & Cokely, 2013; Peters & Bjälkebring, 2015; Sobkow *et al*., 2020) supported the effectiveness of such programs in improving numeracy and boosting the quality of decision-making in applied contexts. Openness to experience positively correlated with DR and SC, while the majority of personality traits did not have a significant correlation with DMC outcomes. This suggests that personality assessments may offer supplementary insight in identifying traits supporting decision-making, particularly in dynamic or uncertain environments. Nonetheless, considering the weak effect sizes, such tests should complement rather than replace cognitive tests like BNT.

General Conclusion

This study contributes to our better understanding of how cognitive (numeracy) and dispositional (personality) factors interact to shape managerial decision-making. It underscores the crucial role of numeracy in predicting structured, consistent, and biased-free decisions, while also pointing to the context-dependent role of personality traits. These findings support efforts to integrate cognitive training into managerial development and imply that a better understanding of individual-cognitive personality profiles may lead to more effective managerial practices.

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