**Success Factors of European Research and Innovation Projects**

**Abstract**

The success of research and innovation projects in the EU largely depends on the quality of proposals submitted for funding. Given the low success rates of EU research and innovation funding, this paper explores the subtle differences between funded and unfunded high-quality proposals, focusing on Horizon 2020 collaborative proposals. This study addresses two main research questions: (1) What makes a project proposal strong? (2) What distinguishes good proposals that are funded from those that are not? Using Qualitative Comparative Analysis and Hamming Distance Analysis of a sample of 30 Evaluation Summary Reports (15 pairs, one of which was funded and the other was an unfunded but highly rated proposal from the same call), various factors influencing funding decisions were identified in different stages of the analysis. The general finding is that successful funding outcomes depend on a layered interplay of several conditions, where the absence of critical elements can be as detrimental as their presence can be favourable. Furthermore, the analysis shows that financing failure is the result of different, often complex, pathways involving the absence of important conditions. The findings highlight the variability and complexity of the evaluation process and emphasise that success is rarely due to a single factor, but rather a combination of interdependent conditions.

**Keywords**

Horizon 2020, EU research funding, proposal evaluation, Qualitative Comparative Analysis (QCA), Hamming distance analysis, funding success factors, research project selection, collaborative proposals

# 1. Introduction

The research policy of the European Union (EU) aims to promote excellence and competitiveness in research and innovation, drive economic growth and societal development and tackle major global challenges such as climate change, health and digital transformation. EU research policy is implemented through a variety of programmes and initiatives, including the EU Framework Programmes (FPs) for research and innovation. The eighth FP from 2014 to 2020 was called Horizon 2020 (H2020) and had a budget of around €80 billion (European Commission [EC] 2020; Flash 2018; Valsecchi 2019). FPs provide funding for research projects and promote collaboration between researchers and organisations, but not necessarily only in Europe. This collaboration is expected to help create the European Research Area (ERA), a unified and borderless research environment and strengthen the overall research capacity and innovation potential of Europe (ERArea 2021). Additionally, participation in grant applications also has benefits at the level of individual researchers, as they improve both the quantity and quality of their publications and expand their collaborative networks with co-applicants (Ayoubi et al. 2019; Tóth 2024).

The success rate of research and innovation projects in the EU is generally low, typically ranging from 5% to 20%, depending on the funding programme and call. For H2020, the average success rate was 11.6%, a significant decrease from 18.5% in the 7th FP, reflecting the increasing oversubscription and leaving many high-quality proposals unfunded (EU Framework … 2017).

As competition for limited funds increases, both funders and researchers are critically evaluating the grant review process as a decision-making mechanism (Forsberg et al. 2022; Langfeldt 2022). This process, however, is not without its challenges, as it is influenced by both objective criteria and subjective factors that can introduce bias and inconsistency. Research highlights the role of evaluators' experience and expertise (Abdoul et al. 2012a; Geuna & Muscio 2009), personal preferences (Santos et al. 2024), and emotional dimensions (Brunet & Müller 2024) in shaping these decisions. Additionally, peer reviewers do not consistently apply the same evaluation criteria (Hug 2024). Despite these insights, the academic peer review process remains under-theorized, with most studies focusing on identifying biases rather than developing comprehensive theoretical frameworks to explain or mitigate these issues (Hug 2022). This theoretical gap limits our understanding of the complex interplay between objective and subjective factors, contributing to inconsistencies in evaluation outcomes. Consequently, variability in criteria and subjective interpretations often leads to a lack of consensus among reviewers, particularly in the humanities, resulting in low inter-rater reliability (Hug & Ochsner 2022; Pina et al. 2015).

Although significant insights into the selection process have been gained, there are still some research gaps that need to be filled. One of these gaps is understanding the subtle differences between two good proposals with only minor differences in quality, especially considering that many outstanding proposals (scoring 14 and higher) are not funded. It is relatively easy to distinguish between good and bad proposals (Boyack & Klavans 2018), but differenting within a pool of good proposals is much more difficult, as stated by Melin & Danell (2006), in the case of individual postdoctoral grants. Analyzing proposals that scored high but were not funded and comparing them with proposals that were funded allows us to understand what is crucial for a proposal to be approved. Previous studies have shown that the grant application review process is not unbiased (Abdoul et al 2012b). **In this context, the issue of fairness and correctness in the selection process has become increasingly important (**Feliciani et al. 2024), as it not only affects which proposals are funded, but also raises broader concerns about the fairness and integrity of evaluation systems.

The objective of this paper is to comprehensively identify the factors and set of logic that reviewers explicitly or implicitly refer to when making a statement about the worth of H2020 proposals. The following two research questions were answered.

1. What are factors make a project proposal strong?
2. What is the subtle difference between good proposals that are approved and good proposals which are not approved?

The results of this research are significant, as they offer valuable insights for both applicants and funding bodies. By understanding the criteria used by reviewers, applicants can enhance their proposals, while funding bodies can refine their evaluation processes to promote fairness and efficiency, ultimately leading to more innovative and impactful research projects.

We believe that this research is necessary, as the EU FPs have reached a certain level of maturity but are constantly evolving in response to the changing needs and developments of EU research and innovation policy and its implementation. Despite being one of the largest funding programmes, the evaluation process and criteria of EU FPs are still under-researched. This becomes clear in this and the next chapter, as very few studies specifically address the intricacies of EU FPs.

# **2. Background**

**2.1. Theory: Theory of change and the project funding process**

The theoretical framework that guides our research is the **Theory of Change (ToC)**, a comprehensive framework to evaluate social change initiative (Bonell et al. 2020; Breuer et al. 2018; Gilissen et al. 2018). By mapping out the pathways to outcomes, it clarifies the logic behind the strategy of a program or initiative (Figure 1).

By applying ToC, we can evaluate the effectiveness of grant evaluation processes and decision-making mechanisms. Sandin & Benner (2022) argue that evaluations need to take a systems perspective, but warn of the complexities of aligning evaluations conducted at different levels. Gallo et al. (2023) suggest integrating rankings with traditional evaluation methods to improve the accuracy of assessments. Similarly, Buljan et al. (2023) explore the removal of numerical scores and find that it does not significantly affect the quality of reviews, while Qussini et al. (2023) examine blinding models. Shaw (2023) takes a step further by proposing a lottery as an alternative or complement to traditional peer review. Philipps (2021) notes that many researchers are open to alternative approaches and point to a growing recognition of the need for reform for a more equitable distribution of research funding. These interventions exemplify targeted changes aimed at improving the review process and leading to more accurate, fair and equitable funding decisions and higher trust in the process.

Non-Funded

Evaluation

EU Call for Proposals

Outcomes

Funded

Figure 1: *Logical Process for EU Proposals’ selection*

The **EU project funding process**, whichoffers a variety of funding opportunities for research and innovation initiatives, begins with **calls for proposals** which are set out in work programmes. Under H2020, three pillars were identified: excellent science, industrial leadership, and societal challenges with some cross-cutting themes, two of which are operated on the basis of public calls: Science with and for society and Spreading excellence and widening participation. The pillar concerning societal challenges is comprised of six parts: 1) Health, demographic change, and well-being; 2) Food security, sustainable agriculture and forestry, marine and maritime and inland water research, and the bioeconomy; 3) Secure, clean, and efficient energy; 4) Smart, green, and integrated transport; 5) Climate action, environment, resource efficiency, and raw materials; and 6) Europe in a changing world–inclusive, innovative, and reflective societies.

There are three main types of projects under H2020: Research and Innovation Actions (RIAs), which focus on developing new knowledge; Innovation Actions (IAs), which emphasize implementing and commercializing existing solutions; and Coordination and Support Actions (CSAs), which support networking and dissemination activities among stakeholders.

The official call for proposals is published on the EU's official website as well as on other relevant platforms. The publication includes all necessary information and instructions for potential applicants, such as the deadline for submitting proposals, eligibility criteria, and evaluation processes.

After proposals for the respective calls have been submitted, the **evaluation** begins. Independent experts follow the established evaluation criteria (EC 2020). The independent experts score the proposals based on three criteria: excellence, impact, quality, and efficiency of implementation (McCarthy 2017), with each criterion scoring a maximum of 5, resulting in a maximum total score of 15 for each proposal. The numerical score is accompanied by narrative feedback for each proposal in terms of its strengths and weaknesses. The feedback, known as the Evaluation Summary Report (ESR), provides detailed strengths and weaknesses of the three criteria used in the evaluation of the eligibility of the proposal to be funded.

The **outcome** of the evaluation is the decision on whether the proposal will be funded. The EU has set a threshold score of 10 as the minimum score for a proposal to be considered for funding, provided that funds are available. The higher the score, the greater the chance that a proposal is funded. Proposals are steadily improving in quality, so it is not unusual for recent projects to achieve a score 14.5 and 15. However, due to the high number of applicants, it is not uncommon that even the most excellent proposals (scoring 14 or more) are not funded.

## **2.2. Factors of a strong project proposal**

Whether or not an application is approved often depends on its compliance with the evaluation criteria and the overall quality of the application. It makes it difficult to conduct studies on evaluation criteria because of discipline-specific criteria, limited data availability, varying criteria across countries and funders, and because some criteria can be vague and context-dependent (Hug & Aeschbach 2020; Johnson & Hermanowicz 2017, Lamont & Guetzkow 2016; Langfeldt et al. 2019).

The H2020 uses umbrella criteria: scientific and technological excellence, impact, quality, and efficiency of implementation, and the potential to achieve policy objectives (EC 2021a; Guide for … 2019). While this may seem simple, reality is far more complex and nuanced as the mentioned criteria are complex and contain a range of subcriteria. Hug & Aeschbach (2020) highlight the importance of academic relevance, originality, and extra-academic relevance in the evaluation criteria for EU-based research programs, which include coherence, justification, rigor, appropriateness, completeness, and quality.

The literature emphasizes the importance of three fundamental elements in every application: content, form and structure, and relevance. In terms of content, a strong proposal begins with a clear description of the research contribution and its significance, supported by a thorough rationale and clearly-defined problem statement (Annersten & Wredling 2006; Berndtsson et al. 2002). A detailed methodology is essential (Ofir et al. 2016), as is a justifiable budget (Sternberg et al. 2017), clearly formulated objectives and aims (Gabbi & Sauer 2019), and consideration of ethical issues (Joyce 2002). Evidence of the latest knowledge in the field and a clear dissemination plan that emphasizes transdisciplinary and interdisciplinary approaches are also vital (Padmadewi et al. 2023). The proposal should convincingly highlight the researcher's competence, and demonstrate their expertise and the relevance of their previous work (Locke et al. 2013). The organization of the proposal is equally critical in terms of form and structure. It should include a coherent and effective action plan for each objective, a convincing work plan, and a high-quality project design (Joyce 2002; Molfese et al. 2002; Van Ekelenburg 2020). **Social relations between the consortium partners and their cohesion can determine the quality and the success of the proposal (Balland et al. 2019; Wanzenböck et al. 2020).** Finally, in terms of relevance, Lauronen (2020) stress that the proposal should demonstrate the potential societal impact and be in line with the EU's research and innovation priorities. Chams et al. (2023) have broadened the scope by emphasizing the need to assess the research impact in terms of societal contributions, particularly sustainability. Besides sustainability, the evaluation process increasingly considers factors such as inclusive economic growth (Ajdarpašić & Qorraj 2019).

Research quality is the backbone of science. Although it may seem simple at first glance, it is a complex and multi-layered concept that differs significantly depending on the context, stakeholder perspective and discipline (Langfeldt et al. 2020). These differences exist not only between disciplines but also within disciplines, reflecting the various ways in which the scholarly community understands and evaluates research quality (Andersen 2013; Hug et al. 2013; Laudel 2024; Margherita et al. 2022; Mårtensson et al. 2016; Ochsner et al. 2013; ). This complexity is reflected in the evaluation of research proposals, where different perspectives influence how proposals are evaluated. The criteria for what constitutes high-quality research— be it methodological rigour, originality or societal impact — highlight the need for an evaluation approach that can take these diverse viewpoints into account. The use of the term ‘excellence’ to describe research performance, which encompasses dimensions such as the quality, impact and efficiency, adds to this complexity (Leyser 2020). In the context of EU funding, Wanzenböck et al. (2020) interpret excellence as a combination of reputation and research capabilities, which further illustrate the varying interpretations of research quality in different settings.

Additional insights into the criteria are provided by examining the outcomes of the process and analysing which individuals, institutions and countries are more successful than others. These factors are interesting for our study as they provide a contextual understanding of the criteria. Bornmann et al. (2020) find - for individual projects – a statistically significant correlation between selection decisions and scientific achievements of the applicants, which are expressed in the number of publications and citation impact. Additionally, Mocanu et al. (2024) identify international visibility as a key factor for success. Institutional factors such as previous participation, reputation, strong research capabilities (Ajdarpasic & Qorraj 2019; Enger & Castellacci 2016; Lepori et al. 2015) and overall excellence Wanzenböck et al. (2020) increase the likelihood of receiving EU funding. Research capability itself is complex and in some ways ambiguous; Piro et al. (2020) understand it as a combination of excellence and a range of applications. It is relevant to the institutional and national level. National characteristics include the capacity for impactful research (De Jong & Muhonen 2020) and strong national and international research networks (Ukrainski et al. 2018).

# **3. Methodology**

The empirical part was conducted in three phases: 1) identification and collection of relevant project proposals and their associated ESRs, 2) thematic analysis of these ESRs to uncover the factors (conditions) that influence the outcome, and 3) performance of Qualitative comparative analysis (QCA) and Hamming distance analysis.

**3.1 Identifying and collecting relevant projects and ESRs**

We focused on collaborative proposals from H2020, encompassing various project types such as RIAs, IAs, and CSAs, which involve multiple partners across different countries. The standardized application and evaluation processes within Horizon 2020 ensure uniformity in the collected data, making it easier to conduct comparative analyses. Using a single program limits the variables related to differences in evaluation criteria and processes that might occur across different funding programs.

Our initial sample comprised 16 proposals that we (as an institution) were directly involved in (either as coordinator or partner), which scored 12 or higher, but were not granted funding. A score of 12 was chosen, as it represents the lowest score received by a funded proposal within the institution’s experience with Horizon 2020. From a theoretical standpoint, setting the cutoff at 12 (i.e., 20% above the threshold) allows the examination of high-quality proposals that demonstrate the potential for funding, but were ultimately unsuccessful.

For each unfunded proposal in our initial sample, we identified all winning proposals from the same call, using the CORDIS database (<https://cordis.europa.eu/>). We then initiated a systematic process to acquire the ESRs for these funded proposals. We first contacted coordinators through the CORDIS website, using a communication template outlining the study and explaining our research objectives and ethical considerations. We limited our outreach to two projects per call, if there were more than two winners. If we received no response or our request was declined, we expanded our outreach to all granted projects for that specific call (ranging from 3 to 10 projects). Finally, if we still did not receive a response, we utilized project websites to find direct contact information for the coordinators. In total, 67 coordinators/managers were contacted. The data collection process was conducted between May 23 and June 16, 2022. We prioritized data protection and anonymity by assigning unique codes to each project proposal before the analysis. We received 19 ESRs, of which 15 (including one in-house) were used for our analysis. Finally, our pool was comprised of 30 ESRs: 15 funded proposals and 15 unfunded proposals from the same call.

**3.2 Identifying conditions through thematic analysis and coding them**

A thematic analysis was conducted by meticulously scrutinizing the ESRs, which followed a strict pattern, making the examination of one ESR indicative of the structure and content present in others. This approach allowed the identification of recurring themes and more precise conditions (Table 1) that influence funding outcomes. As recommended by Greckhamer et al. (2018), the selection of conditions expected to explain the outcomes was guided by our theoretical framework and knowledge.

Table 1: Conditions Considered in the Evaluation of ESRs

|  |  |  |
| --- | --- | --- |
| No ID | ID used in analysis | CONDITION |
|  |  | High clarity of overall and specific objectives |
| 1 | A | Explicit coverage of identified topic |
| 2 | B | Effective engagement of all stakeholders |
| 3 | C | Use of credible methodology |
| 4 | D | Presence of innovative potentials |
| 5 | E | Effective communication of project activities among all stakeholders |
| 6 | F | Meeting expected impacts |
| 7 | G | Identification of effective dissemination approaches |
| 8 | H | Effective data management |
| 9 | I | Effective sustainability measures |
| 10 | J | Efficient management (effective schedule and allocation of tasks) |
| 11 | K | Appropriate allocation of resources |
| 12 | L | Risk assessment and mitigation strategies identified |
| 13 | M | High Complementarity of research team |

In the second step, all ESRs were systematically coded under 14 conditions. This process involved careful reading of each ESR and using a standardized coding sheet to maintain consistency across all ESRs. The table was elaborated upon, including the last column (outcome). One for funded proposals and 0 for unfunded proposals. We used a binary coding system to indicate the presence (1) or absence (0) of each condition (Bianchi et al. 2018; Verweij & Trell 2019).

It is worth noting that condition 1 (high clarity of overall and specific objectives) was present in all cases, regardless of the outcome. To prevent this from skewing our analysis, we exclude this condition from our final set of variables.

Table 2: Table with coded values.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **case** | **A** | **B** | **C** | **D** | **E** | **F** | **G** | **H** | **I** | **J** | **K** | **L** | **M** | **Y** |
| case 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | **1** |
| case 2 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | **1** |
| case 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | **1** |
| case 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | **1** |
| case 5 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | **1** |
| case 6 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | **1** |
| case 7 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | **1** |
| case 8 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | **1** |
| case 10 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | **1** |
| case 11 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | **1** |
| case 12 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | **1** |
| case 13 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | **1** |
| case 14 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | **1** |
| case 15 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | **1** |
| case 16 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | **1** |
| case 1-NON | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | **0** |
| case 2-NON | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | **0** |
| case 3-NON | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | **0** |
| case 4-NON | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | **0** |
| case 5-NON | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | **0** |
| case 6-NON | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | **0** |
| case 7-NON | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | **0** |
| case 8-NON | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | **0** |
| case 10-NON | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | **0** |
| case 11-NON | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | **0** |
| case 12-NON | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | **0** |
| case 13-NON | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | **0** |
| case14-NON | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | **0** |
| case 15-NON | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | **0** |
| case 16-NON | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | **0** |

* 1. **Analyses**

To achieve our research objectives, we employed Qualitative Comparative Analysis (QCA) and Hamming distance analysis. **QCA** is an ideal method for examining complex causal relationships in small-to medium-sized datasets, as it allows the identification of multiple pathways to a particular outcome by considering the combination of different conditions. **Hamming Distance analysis**, on the other hand, is a powerful tool for measuring the dissimilarity between binary or categorical datasets, making it suitable for detecting subtle variations in patterns across different cases or conditions, particularly when comparing configurations in QCA results.

* + 1. **Qualitative Comparative Analysis (QCA)**

QCA is an asymmetric data analysis method that integrates the logical rigor of qualitative analysis with the empirical intensity of quantitative strategies (De Block & Vis 2019; Pappas & Woodside 2021). This method is particularly suited for evaluating the presence or absence of factors influencing a specific outcome (Fainshmidt et al. 2020; Greckhamer et al. 2018) as it operates on the principle that different combinations of conditions can lead to the same outcome, and the absence of an outcome may be caused by different conditions than its presence (Greckhamer et al. 2018).

We employed a crisp-set QCA, in which both the causal conditions and the outcome are binary. This approach was chosen over fuzzy-set QCA because of the nature of our data and the research questions. As Parente & Federo (2019) note, crisp-set QCA is particularly useful when dealing with clearly defined dichotomous variables, which aligns well with our study's focus on the presence or absence of specific conditions in proposal evaluations.

The QCA process involved the following steps:

**Truth Table Construction**: We constructed a truth table based on Table 2, using the specialized QCA software fsQCA. A truth table is used to list all possible combinations of causal conditions and their associated outcomes. In our case, the truth table displays all logically possible combinations of the 13 conditions (2^13 = 8,192 rows) and their associated outcomes. Each row represents a unique configuration of conditions, and we recorded the number of empirical matches for each configuration. Configurations without empirical matching (did not appear in our data) were marked as logical remainders and were excluded from the table (Table 3).

We employed **minimization** which refers to the process of simplifying complex combinations of causal conditions in a truth table by identifying and reducing redundant conditions. This is completed using Boolean algebra by applying the Quine-McCluskey algorithm to identify the parsimonious and intermediate combinations of conditions leading to each outcome (funded and not funded). **Complex solution** is because of 13 conditions (see the limitation in the Discussion section). It includes all logically possible combinations of conditions that explain the outcome (in combinations, the \* symbol represents AND, whereas ~ represents NOT). This solution retains all the condition combinations that meet the minimum consistency threshold, often resulting in a complex interpretation. A **Parsimonious solution** simplifies the complex solution by removing as many conditions as possible, while still adequately explaining the outcome. This solution focuses on the core conditions that are both necessary and sufficient for all cases (Pappas & Woodside 2021). Finally, an **Intermediate Solution** is a balance between a complex and parsimonious solution. It includes some, but not all, logical remainders (unobserved combinations of conditions that are theoretically possible) chosen based on theoretical or substantive reasons. We performed this step in three variations: two for positive outcomes (funded proposals), once for present conditions and once for absent conditions, and the third for negative outcomes (unfunded proposals) with absent conditions, as QCA is of asymmetric nature (Schneider & Wagemann 2012).

The other key elements of QCA are prime implicants, necessary and sufficient conditions, and concepts of coverage and consistency. Prime implicants are the simplest combination of conditions that can result in positive outcomes. These are key components in constructing parsimonious and intermediate solutions. A prime implicant chart helps identify these combinations by showing which conditions are essential for producing the outcome in a simplified form. A **necessary condition** (or a combination of conditions) refers to a condition that is required to be present for the outcome to occur. In other words, whenever an outcome occurs, the condition is always present. However, on its own, a necessary condition may not be sufficient to cause an outcome. A **sufficient condition** (or a combination of conditions) is a condition whose presence guarantees the occurrence of the outcome; however, it may not be the only pathway leading to the outcome. According to general practice in QCA, we set consistency thresholds for necessity > 0.9 and sufficiency 0.75 (Ragin 2008)

Examining which conditions or combinations of conditions were necessary or sufficient for the outcome involved calculating the consistency and coverage scores for each condition and combination. **Consistency and coverage analysis** quantify how consistently and comprehensively each condition contributes to successful funding outcomes. **Consistency of conditions** measures the reliability of a condition leading to an outcome; that is, how often cases with the condition exhibit the outcome? A consistency of 1 or 100% for a certain condition means that every case with that condition exhibits the outcome every time. **Coverage** is fragmented into coverage of conditions and coverage of solutions. The former measures the proportion of cases in which the condition leads to the outcome, relative to all cases in which the outcome occurs. A high coverage means that the condition explains a large portion of the instances of the outcome. **Coverage of solutions r**efers to the extent to which the outcome is explained by the solution. It is further divided into two types. **Raw coverage** indicates the proportion of all cases (or instances) that are covered by a particular combination of conditions. For instance, 0.133333 for a certain combination indicates that this specific condition combination covers approximately 13.33% of all cases analyzed. This helps to understand the empirical importance or relevance of each condition in explaining the outcome. **Unique coverage** represents the proportion of cases that are uniquely covered by this particular combination of conditions, and not by any other combination. A unique coverage of zero for a certain combination suggests that all cases explained by this combination can also be explained by other combinations. This shows the extent to which a condition combination exclusively contributes to the explanation of the outcome.

We performed calculations separately for outcome 1 (funded?) and the presence of condition conditions, outcome 0 (not funded?), and the absence of conditions. The first variant focuses only on factors that must be present to achieve the desired outcome (in our case, funding), excluding the impact of their absence on the outcome. The second focuses on conditions that, when not present, lead to the failure or non-occurrence of an outcome (in our case, not funding).

Throughout this process, we adhered to the best practices in the QCA, as outlined by Rihoux & Ragin (2009), ensuring transparency and replicability in our analysis. This rigorous approach allowed us to systematically uncover the complex combinations of factors that distinguish funded and unfunded high-quality research proposals in the EU context.

**3.3.2 Hamming distance analysis**

We developed a 13-bit string (the outcome column was ignored) for each proposal based on the data in Table 1 and performed Hamming distance analysis. This analysis measures the difference between two strings of equal length. The Hamming distance between the two strings is defined as the number of positions (elements) at which the corresponding symbols in the strings are different. In other words, this is the minimum number of substitutions required to change one string into another. We calculated the Hamming distance for each pair of cases, that is, for the ESR of granted and non-granted proposals. These differences could include both positive attributes present in funded proposals and absent in non-funded proposals as well as negative attributes present in non-funded proposals but absent in funded ones. This provides a comprehensive view of how proposals differ overall. Furthermore, we identified elements with a value of 1 in funded cases and 0 in non-funded cases, that is, dropped bits. This specifically highlights the elements present in successful proposals, but absent in unsuccessful ones. These could be interpreted as key factors or strengths that contribute to the success of a proposal.

# Results and discussion

This chapter presents the findings of the analysis of ESRs from both funded and unfunded proposals under the Horizon 2020 program. Using a combination of thematic analysis, QCA, and Hamming distance analysis, we explore the complex interplay of conditions that influence funding outcomes, reflections, and limitations.

4.1 Results

The truth table was compiled from the binary codes and all possible combinations of conditions. Table 3 contains only the combinations that appear in our empirical data (logical reminders are excluded). Each row in the table represents a unique combination of conditions (see Table 1 for what stands for A, B, etc.) and shows (column Y) whether this combination is associated with the outcome y=1 (funded) or outcome y=0 (non-funded). Paths to outcome y=1 are numerous and almost all of them are unique, as only one combination appears twice.

Table 3: Truth table

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| A | B | C | D | E | F | G | H | I | J | K | L | M | Y | Num-ber | raw consist. |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 2 | 1 |
| 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 |
| 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 |
| 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 |
| 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 |
| 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 |
| 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 |
| 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 |
| 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |

**Consistency and coverage analysis** show how consistently and comprehensively each condition contributes to successful funding outcomes (see Table 4). Conditions with the highest consistency, such as condition C (credible methodology) (76.47% consistency, 86.67% coverage) and condition J (efficient management) (63.16% consistency, 80.00% coverage as highly predictive of funding success), corroborate the findings of Hug and Aeschbach (2020), who emphasized the importance of academic relevance and the coherence of the proposal. On the other hand, conditions with the highest coverage, such as H (effective data management) (57.69% consistency, 100% coverage) and condition F (meeting expected impacts) (60.87% consistency, 93.33% coverage), despite not being as consistent, echo the conclusions of Johnson & Hermanowicz (2017), who pointed out that a well-justified alignment with societal challenges and robust data handling are critical in securing funding. Conversely, the conditions with the lowest coverage, namely I (effective sustainability measures) (53.85% consistency, 46.67% coverage) and K (appropriate allocation of resources) (50.00% consistency, 60.00% coverage), indicate a lower priority in the funding decision, reflecting their sporadic impact on successful outcomes.

Table 4: Consistency and coverage scores for each condition

|  |  |  |
| --- | --- | --- |
| **Condition** | **Consistency** | **Coverage** |
| A | 50.00% | 80.00% |
| B | 52.00% | 86.67% |
| C | 76.47% | 86.67% |
| D | 54.55% | 80.00% |
| E | 50.00% | 86.67% |
| F | 60.87% | 93.33% |
| G | 56.00% | 93.33% |
| H | 57.69% | 100.00% |
| I | 53.85% | 46.67% |
| J | 63.16% | 80.00% |
| K | 50.00% | 60.00% |
| L | 52.17% | 80.00% |
| M | 54.55% | 80.00% |

The Parsimonious Solutions (Table 5), with the simplest and most direct combinations of conditions that consistently lead to funding (outcome Y=1, present conditions), offer insights into the core factors that enhance a proposal's likelihood of success. Complementing this, the intermediate solutions (Table 6) bring more complexity and detail by incorporating additional logical remainders based on their theoretical relevance, thus providing a nuanced view of the conditions that foster successful funding. The presence of negated conditions (~) implies asymmetric causality; ie. the absence of certain factors is as important as the presence of others. In the context of our study, this is not the case, but it suggests that even the absence of certain conditions can lead to a positive outcome. Raw coverage determines the necessity. This means that whenever these combinations occur, the outcome is present. The threshold is > 0.9, which means that none of the combinations have coverage values that are high. In our case, the values vary from 0.133333 to 0.6 (C\*E\*H\*L). B\*E\*F\*G\*H\*M had the second-highest raw coverage (0.533333). Higher coverage suggests a more important or common path to success. They appeared in 12 (73.33%) cases with positive outcomes. These two combinations include credible methodology, stakeholder engagement, effective dissemination, effective communication, meeting expected impacts, data management, appropriate allocation of resources, and risk assessment. As shown in Table 6, the combinations had lower coverage values. Combination A\*C\*D\*F\*G\*H\*J\*~K\*L\*M (raw coverage of 26.67% and unique coverage of 13.33%). It shows an example of how a broad set of conditions can effectively contribute to securing funding in the Horizon 2020 programme. This combination encompasses nearly all evaluated factors, ranging from stakeholder engagement (B), credible methodology (C), and innovative potential (E) to effective data management (H) and risk assessment (J). The 26.67% raw coverage indicates that approximately one-fourth of the successful proposals include this extensive set of conditions. The unique coverage of 13.33% further indicates that this particular combination of conditions, although not the most common, uniquely contributes to successful outcomes in a significant subset of cases.

The unique coverage in Tables 5 and 7 was zero, indicating a significant overlap between the combinations. No single combination explains any of the cases. Tables 5–8 contain solutions that have a consistency of 1 (perfect consistency), meaning that whenever these combinations occur, the outcome is present.

Table 5: Parsimonious solutions for funding success (consistency 1, outcome y=1, conditions present)

|  |  |  |  |
| --- | --- | --- | --- |
| **Combinations of conditions** | **Raw coverage** | **Unigue coverage** | **cases** |
| ~A\*F\*~I | 0.133333 | 0 | 1, 14 |
| ~A\*H\*~I | 0.133333 | 0 | 1, 14 |
| ~A\*~I\*L | 0.133333 | 0 | 1, 14 |
| ~B\*C\*J | 0.133333 | 0 | 5, 6 |
| ~B\*D\*J | 0.133333 | 0 | 5, 6 |
| ~B\*G\*J | 0.133333 | 0 | 5, 6 |
| ~A\*F\*K | 0.133333 | 0 | 1, 14 |
| C\*~K\*L | 0.4 | 0 | 4, 5, 8, 10, 13, 15 |
| ~A\*F\*M | 0.133333 | 0 | 1, 14 |
| C\*I\*J | 0.4 | 0 | 6, 7, 10, 11, 15, 16 |
| B\*C\*H\*I | 0.4 | 0 | 7, 10, 11, 13, 15, 16 |
| C\*E\*H\*L | 0.6 | 0 | 1, 2, 3, 4, 7, 8, 10, 13, 15 |
| E\*F\*H\*J\*K | 0.333333 | 0 | 2, 7, 11, 12, 14 |
| E\*F\*H\*J\*M | 0.4 | 0 | 4, 8, 11, 12, 14, 15 |
| E\*F\*H\*~I\*J\*L | 0.266667 | 0 | 2, 4, 8, 14 |
| B\*E\*F\*G\*H\*K | 0.4 | 0 | 1, 2, 3, 7, 11, 12 |
| A\*E\*G\*H\*J\*K | 0.333333 | 0 | 2, 6, 7, 11, 12 |
| B\*E\*F\*G\*H\*M | 0.533333 | 0 | 1, 3, 4, 8, 11, 12, 13, 15 |
| A\*E\*G\*H\*J\*M | 0.4 | 0 | 4, 6, 8, 11, 12, 15 |

Table 6: Intermediate solutions for funding success (consistency 1, outcome y=1, conditions present)

|  |  |  |  |
| --- | --- | --- | --- |
| **Combinations of conditions** | **Raw coverage** | **Unigue coverage** | **cases** |
| B\*E\*F\*H\*J\*K\*L\*M | 0.0666667 | 0.0666667 | 14 |
| A\*C\*D\*F\*G\*H\*J\*~K\*L\*M | 0.266667 | 0.133333 | 4, 5, 8, 15 |
| A\*~B\*C\*D\*F\*G\*H\*J\*L\*M | 0.0666667 | 0 | 5 |
| B\*C\*D\*E\*F\*G\*H\*I\*J\*L | 0.2 | 0.0666667 | 7, 10, 15 |
| A\*B\*C\*E\*F\*G\*H\*J\*K\*L | 0.133333 | 0.0666667 | 2, 7 |
| A\*B\*D\*E\*F\*G\*H\*J\*K\*M | 0.0666667 | 0.0666667 | 12 |
| A\*C\*D\*E\*G\*H\*I\*J\*K\*M | 0.0666667 | 0.0666667 | 6 |
| A\*C\*D\*F\*G\*H\*I\*J\*L\*M | 0.133333 | 0.0666667 | 15, 16 |
| B\*C\*D\*E\*F\*G\*H\*K\*L\*M | 0.133333 | 0.133333 | 1, 3 |
| A\*B\*C\*E\*F\*G\*H\*I\*J\*K\*M | 0.0666667 | 0.0666667 | 11 |
| A\*B\*C\*D\*E\*F\*G\*H\*I\*L\*M | 0.133333 | 0.0666667 | 13, 15 |

Conversely, Tables 7 and 8 focus on the configurations linked to unfunded proposals, corresponding to the outcome Y=0, where certain conditions are absent. Table 7’s parsimonious solutions emphasize the minimal sets of absent conditions frequently found in unfunded proposals, offering a broad view of common weaknesses. By contrast, Table 8’s intermediate solutions provide a more detailed exploration by including additional combinations of absent conditions, delivering insights into the specific factors that might contribute to a proposal’s failure to secure funding. This comprehensive approach enhances the understanding of both positive and negative influences on funding outcomes, shedding light on the critical deficiencies in unfunded H2020 proposals. For instance, in Table 7, the combination A\*~C\*L, which covers 46.67% of the cases, reveals that nearly half of the unfunded proposals suffer from unclear objectives, lack of credible methodology, and insufficient resource allocation—fundamental flaws that must be addressed in future submissions. Extending the analysis, Table 8 presents conditions such as *~*C\*~H\*~I*,* with 20% raw coverage, pointing out significant shortcomings in methodology, data management, and information handling.

Table 7: Parsimonious solutions for funding failure (consistency 1, outcome y=0, conditions absent)

The condition combinations predominantly involve negations (i.e., absence of conditions).

|  |  |  |  |
| --- | --- | --- | --- |
| **Combinations of conditions** | **Raw coverage** | **Unique coverage** | **Cases** |
| ~H | 0.266667 | 0 | 5-NON, 6-NON, 13-NON, 16-NON |
| ~J\*~L | 0.2 | 0 | 5-NON, 7-NON, 10-NON |
| ~D\*~J | 0.2 | 0 | 4-NON, 5-NON, 6-NON |
| ~C\*~K | 0.333333 | 0 | 1-NON, 2-NON, 4-NON, 10-NON, 13-NON |
| ~C\*~J | 0.4 | 0 | 4-NON, 5-NON, 10-NON, 12-NON, 13-NON, 14-NON |
| ~C\*~F | 0.4 | 0 | 2-NON, 4-NON, 5-NON, 10-NON, 11-NON, 15-NON |
| ~C\*I | 0.266667 | 0 | 1-NON, 10-NON, 11-NON, 15-NON |
| A\*~K\*~M | 0.2 | 0 | 2-NON, 8-NON, 10-NON |
| ~A\*~C\*G | 0.2 | 0 | 1-NON, 5-NON, 11-NON |
| I\*~J\*K | 0.133333 | 0 | 6-NON, 7-NON |
| A\*~C\*L | 0.466667 | 0 | 2-NON, 4-NON, 12-NON, 13-NON, 14-NON, 15-NON, 16-NON |
| ~C\*D\*L | 0.4 | 0 | 1-NON, 11-NON, 12-NON, 13-NON, 14-NON, 16-NON |
| ~C\*G\*L | 0.333333 | 0 | 1-NON, 4-NON, 11-NON, 13-NON, 16-NON |
| C\*D\*F\*~L | 0.133333 | 0 | 7-NON, 8-NON |
| A\*~D\*L\*M | 0.2 | 0 | 4-NON, 6-NON, 15-NON |
| D\*~I\*J\*K\*L | 0.133333 | 0 | 3-NON, 16-NON |
| E\*I\*K\*L\*M | 0.2 | 0 | 6-NON, 11-NON, 15-NON |
| A\*~I\*J\*K\*L\*M | 0.133333 | 0 | 3-NON, 16-NON |
| G\*~I\*J\*K\*L\*M | 0.133333 | 0 | 3-NON, 16-NON |

Table 8: Intermediate solutions for funding failure (consistency 1, outcome y=0, conditions absent)

|  |  |  |  |
| --- | --- | --- | --- |
| **Combinations of conditions** | **Raw coverage** | **Unigue coverage** | **Cases** |
| ~D\*~H\*~J | 0.133333 | 0.0666667 | 5-NON, 6-NON |
| ~C\*~H\*~I | 0.2 | 0.133333 | 5-NON, 13-NON, 16-NON |
| ~B\*~J\*~L | 0.0666667 | 0.0666667 | 7-NON |
| ~A\*~C\*~F | 0.133333 | 0.0666667 | 5-NON, 11-NON |
| ~C\*~G\*~I\*~J | 0.133333 | 0.133333 | 12-NON, 14-NON |
| ~A\*~C\*~K\*~M | 0.0666667 | 0.0666667 | 1-NON |
| ~B\*~C\*~D\*~F\*~G | 0.0666667 | 0.0666667 | 15-NON |
| A\*~I\*~K\*~L\*~M | 0.0666667 | 0 | 8-NON |
| ~C\*~D\*~F\*~I\*~J\*~K | 0.0666667 | 0.0666667 | 4-NON |
| D\*F\*~I\*~K\*~L\*~M | 0.0666667 | 0 | 8-NON |
| D\*~E\*~I\*J\*K\*L | 0.0666667 | 0 | 3-NON |
| ~C\*~E\*~F\*~J\*~K\*~L\*~M | 0.0666667 | 0.0666667 | 10-NON |
| ~C\*~D\*~F\*~G\*~I\*~K\*~M | 0.0666667 | 0.0666667 | 2-NON |
| A\*~E\*~I\*J\*K\*L\*M | 0.0666667 | 0 | 3-NON |
| ~E\*G\*~I\*J\*K\*L\*M | 0.0666667 | 0 | 3-NON |

The Hamming distance analysis (Table 9) measures the dissimilarities between funded and unfunded proposals by comparing binary strings of conditions. This method quantifies the differences in terms of missing or additional elements in unsuccessful proposals compared to successful proposals, revealing specific areas that unfunded proposals typically lack.

Table 9: Hamming distance between two cases

|  |  |  |  |
| --- | --- | --- | --- |
| **Pair of cases** | **Hamming distance** | **All Differences (Hamming distance)\*** | **Present in X case and absent in X-NON case 1** |
| Case 1 vs Case 1-NON | 5 | A, C, I, K, M | C, K, M |
| Case 2 vs Case 2-NON | 6 | C, D, F, G, K, M | C, F, G, K, M |
| Case 3 vs Case 3-NON | 2 | E, K | K |
| Case 4 vs Case 4-NON | 6 | C, D, F, J, K, M | C, D, J, K, M |
| Case 5 vs Case 5-NON | 8 | A, B, C, D, E, F, H, K | C, D, F, H, K |
| Case 6 vs Case 6-NON | 4 | B, D, F, I, L | F, L |
| Case 7 vs Case 7-NON | 4 | B, I, J, L, M | B, J, L, M |
| Case 8 vs Case 8-NON | 2 | L, M | L, M |
| Case 10 vs Case 10-NON | 7 | A, C, E, F, I, J, M | C, E, F, M |
| Case 11 vs Case 11-NON | 4 | A, C, F, L, M | C, F, L, M |
| Case 12 vs Case 12-NON | 5 | C, G, I, J, L | C, I, J, L |
| Case 13 vs Case 13-NON | 5 | C, H, I, J, K | C, H, I, J, K |
| Case 14 vs Case 14-NON | 5 | A, C, F, I, J | C, F, I, J |
| Case 15 vs Case 15-NON | 8 | B, C, D, E, F, G, J, K | B, C, D, E, F, G, K |
| Case 16 vs Case 16-NON | 3 | C, H, I | C, H, I |

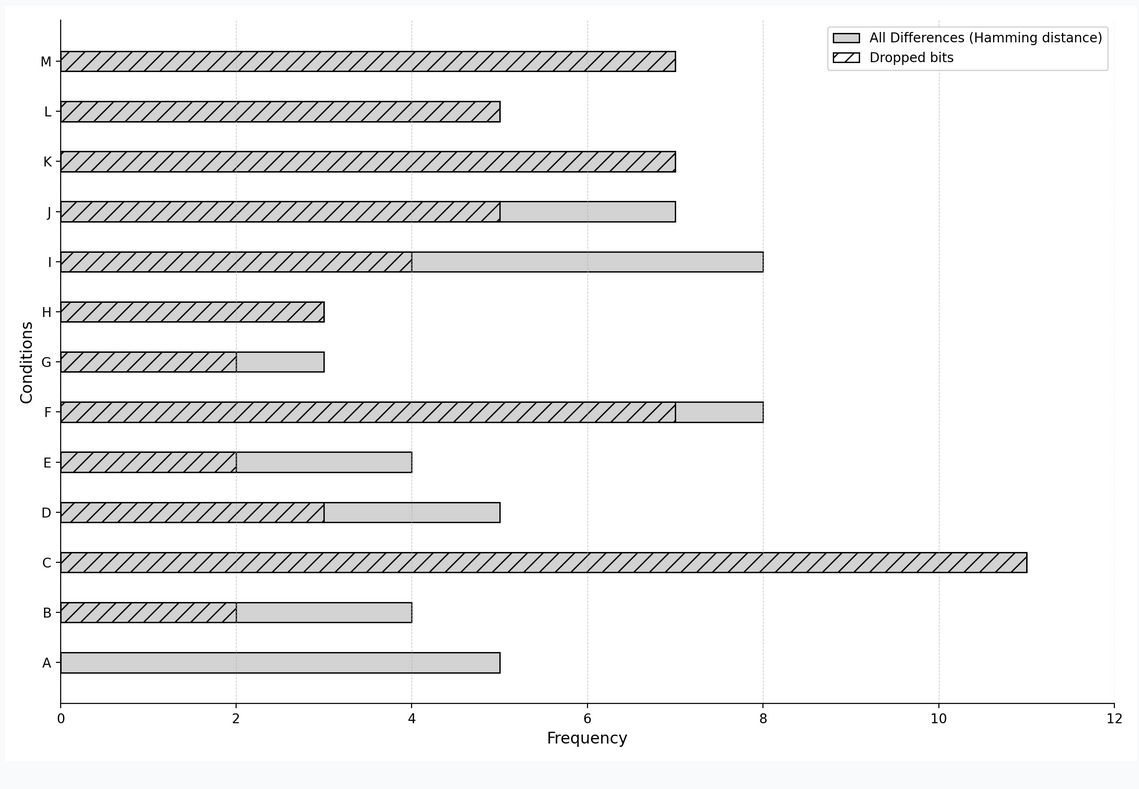
The Hamming distance analysis of the 15 proposal pairs revealed a range of differences between funded and unfunded proposals. The distances varied from 2 to 8. The mean distance was 4.93, with a median of five, which was also the mode. The variance of the distances was 3.64, with a standard deviation of 1.91. The frequency distribution showed that a distance of 5 was the most common, followed by distances of 4 (3 times), while distances of 2, 6, and 8 each occurred twice. Distances 3 and 7 were the least common, and each appeared only once. This distribution indicates that while there is a central tendency around the five differences, there is also considerable variation in how funded and unfunded proposals differ, suggesting a complex relationship between proposal characteristics and funding success.

Table 10: C**omparative analysis of Hamming distances between funded and unfunded proposals**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **All Differences (Hamming distance)\*** | | | **Present in X case and absent in X-NON case 1 (dropped bits)** | | |
| **Condition** | Frequency | % of all comparisons (15) | % of all differences (77) | Frequency | % of all comparisons (15) | % of all differences (58) |
| **A** | 5 | 33.33 | 6.49 | 0 | 0.00 | 0.00 |
| **B** | 4 | 26.67 | 5.19 | 2 | 13.33 | 3.45 |
| **C** | 11 | 73.33 | 14.29 | 11 | 73.33 | 18.97 |
| **D** | 5 | 33.33 | 6.49 | 3 | 20.00 | 5.17 |
| **E** | 4 | 26.67 | 5.19 | 2 | 13.33 | 3.45 |
| **F** | 8 | 53.33 | 10.39 | 7 | 46.67 | 12.07 |
| **G** | 3 | 20.00 | 3.90 | 2 | 13.33 | 3.45 |
| **H** | 3 | 20.00 | 3.90 | 3 | 20.00 | 5.17 |
| **I** | 8 | 53.33 | 10.39 | 4 | 26.67 | 6.90 |
| **J** | 7 | 46.67 | 9.09 | 5 | 33.33 | 8.62 |
| **K** | 7 | 46.67 | 9.09 | 7 | 46.67 | 12.07 |
| **L** | 5 | 33.33 | 6.49 | 5 | 33.33 | 8.62 |
| **M** | 7 | 46.67 | 9.09 | 7 | 46.67 | 12.07 |
| **15** | **77** |  |  | **58** | **15** |  |

Table 10 and Figure 1 highlight the conditions that differ and have an impact on funding decisions, with conditions C, F, and I showing strong discrepancies between funded and unfunded proposals. These differed in more than half of the comparisons. However, there is a distinction between the two. C is the condition that differs between non-funded and funded proposals. Dropped bits are conditions that are missing in the non-funded proposal. The highest frequencies are C, F, K, and M, that is,. credible methodology, expected impact, appropriate allocation of resources, and complementarity of the research team. H (effective data management) and G (effective dissemination), on the other hand, show how less variability and a lower frequency of general differentiation exist, but they function as dropped bits, indicating that while they are important, they do not distinguish between funded and unfunded proposals as significantly as the other conditions.

Figure 1: All differences vs. dropped bits.



### Limitations

A few limitations merit acknowledgement. First, s**implification through binary encoding:** The binary encoding method simplifies the complex characteristics of proposals, potentially overlooking subtle but critical differences in quality or presentation. This methodological choice, while necessary for quantitative analysis, may not fully capture the nuanced realities of the proposal evaluation. Second, 13 conditions (A through M), are a significant challenge for QCA, as they may obscure clear patterns or definitive conclusions about what consistently works or does not work in proposal success. It may also not be necessary to have an abundance of evaluation criteria (which generates an abundance of conditions), as Pina et al. (2021) found that reducing the evaluation criteria had little impact on the outcome of the peer review process. Third, are b**alanced outcomes**: with an even distribution of successful and unsuccessful outcomes, identifying consistent conditions or factors that invariably lead to funding can be challenging. This balance adds an additional layer of difficulty in distinguishing clear and actionable insights from data.

5. Conclusions

The distinction between a proposal being funded and one that cannot can be remarkably subtle, with minuscule differences often separating funded from unfunded proposals. This section delves into the intricate dynamics behind these outcomes, reflecting the complexity and nuanced interplay of conditions that influence funding decisions.

### Our analysis highlights that the causality behind successful funding is **layered** and involves multiple interdependent conditions that must align to create a favorable outcome. This **layered causality and the role of conditions** become evident, as The conditions with the highest coverage in our dataset did not include negated conditions, emphasizing that the absence of certain key elements can be as critical as their presence. This suggests that all essential conditions must be met or exceeded to enhance the chances of funding, aligning with the broader understanding that success is not determined by a single factor, but rather by the convergence of multiple elements. The finding that no single condition guarantees funding, but rather a combination of factors, supports Hug & Aeschbach’s (2020) conclusion that proposals are evaluated holistically with multiple criteria considered simultaneously. Moreover, the prominence of conditions such as credible methodology (C) and appropriate resource allocation (K) as key differentiators between funded and unfunded proposals challenges the emphasis placed on innovation and originality by Pier et al. (2018). In the context of Horizon 2020, our findings suggest that methodological rigor and resource management may be more critical than previously recognized.

Analysing the diverse pathways and reasons for funding failure is more nuanced and complex than analysing success. Failures often result from the absence of several key conditions that are not always immediately apparent or quantifiable. The conditions that lead to rejection are usually more diverse than those that lead to acceptance, as different combinations of missing elements influence the narrow segments of unsuccessful proposals. In accordance, Hren et al. (2022), found that weaknesses in proposals tended to influence evaluations more than strengths. The diversity of rejection factors spreads the analytical focus across different configurations, making it difficult to isolate the ultimate causes of failure. These results emphasise the multi-layered and multi-faceted nature of proposal evaluation, where different levels of criteria and subtle distinctions play a crucial role in both positive and negative funding decisions. The results of the Hamming distance show that while funded and unfunded proposals often differ in various ways, certain conditions consistently stand out. This analysis emphasises the idea that while innovation and feasibility are important, the lack of fundamental conditions, such as a clear methodology and effective resource management, can be equally detrimental to the success of a proposal.

The high **process variability** and uniqueness of the paths leading to successful funding suggest a more layered and flexible process than previously assumed. While earlier studies, such as those by Lamont & Guetzkow (2016) and Geuna & Muscio (2009), proposed a more standardized set of criteria, our findings indicate that the evaluation process can be context-dependent and adaptable. This is likely influenced by the broader and more diverse datasets used in this study, which capture a wider array of proposal types and research fields.

Several factors may explain **why our results differ slightly from previous studies**. First, the Horizon 2020 framework places a strong emphasis on addressing societal challenges and fostering innovation across various disciplines. This broader focus may lead to a wider interpretation of what constitutes a successful proposal, which could explain the diversity of the pathways observed in our study. Second, the methodological approach used in this study, including a comprehensive truth table and Hamming distance analysis, may reveal more nuanced differences between proposals than traditional qualitative methods. This approach allows for a more detailed examination of the specific combinations of conditions that contribute to success or failure, thus uncovering layers of complexity that might otherwise be overlooked. Finally, the evolution of funding criteria over time, with a growing emphasis on interdisciplinary research and societal impact, may have shifted the relative importance of certain factors. Earlier studies may not have captured these changing priorities, which could account for the differences in the findings.

Funding decisions within the H2020 framework highlight the multifaceted nature of research proposal evaluations. Our findings indicate that successful funding outcomes are rarely the result of a single decisive factor; rather, they stem from the layered interplay of multiple conditions. This supports the ToC, which underscores the need for a clear and coherent pathway that links inputs to the desired outcomes. Similarly, our analysis revealed that proposals must not only meet all explicit criteria, but also communicate their coherence and potential impact effectively. By adopting this holistic approach to proposal development and evaluation, as advocated by the ToC, applicants can enhance their chances of success and contribute to a more innovative and impactful European Research Area.

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