University of Pannonia

Doctoral School of Business and Management

Thesis summary

Project portfolio-based planning, scheduling, and risk analysis of European Union Framework Programs in light of success criteria

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1. Introduction

In my dissertation, I focused on EU framework programs because their expanding influence and increasing role in research and innovation activities, as well as their achievements, are undeniable both in Europe and globally. The funding policy of the EU demonstrates a consistent increase in allocated resources from one framework program to the next to support R&D&I activities in this direction. In Hungary, the relevance of this topic is also reflected in the fact that numerous Hungarian organizations apply for funding from the framework programs and participate in the projects announced within their scope.

When considering project portfolios and framework programs together, the timeliness and novelty of the topic become evident. Framework programs, like other large-scale (publicly funded) research initiatives, are typically not planned or managed as project portfolios, even though they, much like in a corporate environment, consist of a collection of projects aimed at achieving defined strategic—on a global scale for framework programs—objectives. The academic literature has not addressed framework programs from this perspective, and there is no developed methodological support for planning, scheduling, and risk analysis for projects organized into various project execution structures within these programs.

2. Research objectives and research questions

The primary objective of my dissertation is to develop a method that supports the planning, scheduling, and temporal risk analysis of European Union (EU) framework programs, all based on project portfolio foundations.

Given the methodological approach from a project portfolio perspective, I set out to map the project execution structures found within a project portfolio onto the framework programs. The purpose of this was to uncover the opportunities and risks associated with the structural features of EU framework programs. Considering these factors is important because applying methodological tools and evaluating the results can lead to the design of better structures for framework programs and other R&D&I programs, which, like the framework programs, were not previously planned or managed as project portfolios. As a result, such programs could more effectively meet the objectives of decision-makers and grant issuers.

Based on my research objectives, the research questions posed in my dissertation are as follows:

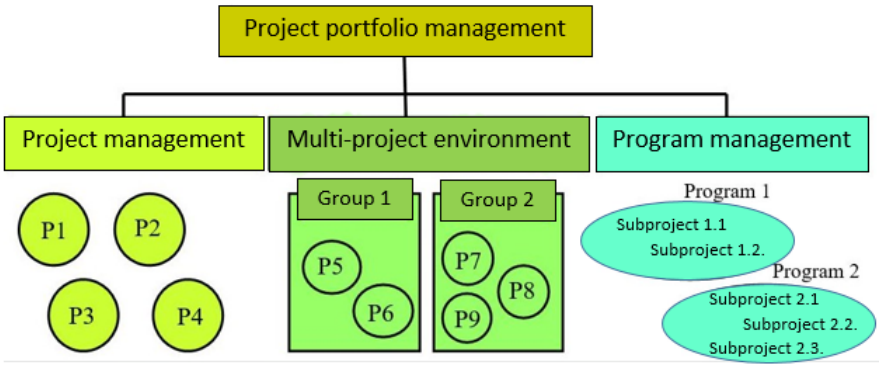
- **R.Q.1.** Is it possible to model the project execution structures of EU framework programs based on the available data about their projects?
- **R.Q.2.** Can the planning, scheduling, and risk analysis of EU framework programs be performed using matrix-based project planning techniques?
- **R.Q.3.** What are the risk implications of increasing the proportion of complex project execution structures within the Seventh Framework Program compared to single projects?

3. Literature review and research assumptions

In the following, I highlight the key findings from the literature that served as the basis for formulating my research hypotheses.

In a corporate environment, depending on how closely projects are connected—either through shared goals or common resources used for their implementation—projects can be classified as standalone projects, projects operating in a multi-project environment, programs, or project portfolios (Patanakul és Milosevic, 2009).

Figure 1 provides an illustrative representation of the distinctions between these categories, based on how closely the projects are interconnected. The project portfolio management encompasses all the projects undertaken within the company.



1. ábra. Project portfolio project connections (My own editing based on Patanakul és Milosevic, 2009

1. táblázat. Project characteristics taken into account for the design of project execution structures (My own editing)

	Single projects	**Projects in multi-project environment**	**Programs**
Feasibility	No dependencies on other projects	There is a resource dependency between projects (Fricke és Shenbar, 2000)	Feasibility of projects depends on each other (Görög, 1999)
Overlap in time	They are not dependent on each other	Projects overlap in time (Hans és tsai., 2007)	Following projects build on the previous projects (Hans és tsai., 2007); so overlap is much less frequent, or little between projects.
Content/logical relationship	There aren't any with other projects	Not among the projects	Since they share a common set of objectives (Patanakul és Milosevic, 2009), following projects build on the results of previous project.
Resource requirement	Bounded by limited resources, (Archibald, 2003; Görög, 1999) (Turner, 2009; Pfetzing és Rohde, 2001) but the completion is not depends on other projects.	Projects use the same resource pool (Yaghootkar és Gil, 2012) (Fricke és Shenbar, 2000)	Program management includes the prioritizing of resources (Turner, 2009)
Objectives	Achieve specific goals, aciclic nature (Görög, 1999; Szabó, 2012) cearly defined, independent objectives (Archibald, 2003; Hobbs, 2000) (Kerzner, 2009)	Projects within a group are generally not interdependent in terms of objectives, but are grouped at project manager level for efficiency and better management (Patanakul és Milosevic, 2009) Projects may have different objectives (Elonen és Artto, 2003)	Projects, running in a program are interdependent and have a common goal (PMI, 2013); goal-oriented projects that aim to achieve strategic objectives (Hans és tsai., 2007)
Responsible manager	A single project has one project manager (Hans és tsai., 2007) (Patanakul és Milosevic, 2009)	The same project manager lead them (Caniëls és Bakens, 2012). They require joint organisation (Cooper, Edgett és Kleinschmidt, 2000)	They require centrally coordinated management (Patanakul és Milosevic, 2009)

In Table 1, I have summarized the characteristics that, based on the available data from framework programs, I utilized in designing the project execution structures of the framework programs. Based on the characteristics identified in the literature and the available data on framework program projects, I formulated my first hypothesis:

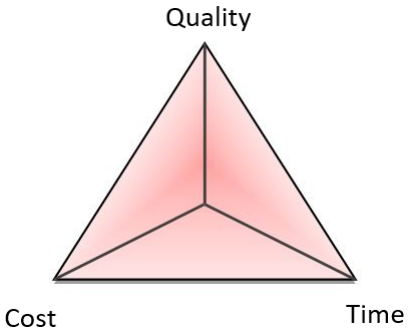
- **H.1.** Based on the literature characteristics of projects and programs forming the project portfolio and the available information on the framework program projects, it is possible to model single and complex project execution structures.

The first articles mentioning matrix representations of network-based project planning methods appeared in the 1960s, but the methodology specifically developed for project planning is associated with Steward, 1981b; Steward, 1981a. However, this method did not yet aim to handle project plans using a flexible project management approach. With advanced methods, it is now possible to represent the dependency relationships between two activities (Tang és tsai., 2010; Chen, Ling és Chen, 2003), prioritize activities, assess probabilities, and thus model various project plans (Kosztyán és Kiss, 2010). The PEM method allows not only for stochastic activity relationships but also for their execution to be stochastic (Kosztyán, Kiss és tsai., 2010). Extensions of the methods include multi-criteria matrix-based project planning, which can incorporate additional data, such as the cost and resource requirements of activities, into the project plan. Multilevel matrix planning procedures enable the modeling and management of projects, programs, and project portfolios running in multi-project environments (Kosztyán, 2013).

Overall, matrix-based project planning techniques unify traditional and flexible planning methods within a single system. This feature was important when selecting the project planning technique to be applied, as it offers the possibility to account for flexibility. The fundamental network-based project planning methodology requires fixed dependencies. However, there are more advanced methods, such as GERT, that do not mandate fixed dependencies, thus providing more decision-making options and outcomes. Still, even with these methods, it is necessary to predefine the structure, which is why they are insufficient for achieving my research objectives. With matrix methods, it is not necessarily required to predefine the relationships between activities (or projects), whether they will be executed sequentially or in parallel, or even if the realization of a specific activity (or project) is uncertain. For the selected framework programs, it is therefore essential to use this technique, as it is not possible to precisely determine in advance—only estimate—whether there is a substantive dependency between single projects or not.

- **H.2.** Using the matrix-based project planning technique, which is also applicable to corporate project portfolios, it is possible to plan, schedule, and utilize it for risk analysis in framework programs.

Figure 2 illustrates the time-cost-quality triangle, often referred to as the project triangle, which representatively demonstrates the constraints and interrelationships of projects. Its essence lies in the requirement that the project must be executed within a specified timeframe, within the given cost and resource limits, and at the expected quality. Any change in one of these elements affects the other two.



2. ábra. Time-Cost-Quality Triangle (Hobbs, 2000, p.9.)

Concepts closely related to project success are success factors and success criteria. According to Bredillet, 2008, **success factors** are influencing conditions that directly or indirectly contribute to the successful completion of projects. Cooke-Davies, 2002 defines **success criteria** as reference points that enable the measurement of project success. These are essentially target values whose achievement can be verified after project implementation.

In my dissertation, based on the available data from the Seventh Framework Program structured as a project portfolio, I considered the following dimensions of success in risk analysis:

- Average project success rate – I evaluate the feasibility of framework program projects based on classical success criteria.

- Project portfolio balance – My analyses focus on temporal risk, examining the benefits achievable at the framework program level at the expense of increased lead times.

Risk management is one of the fundamental research and practical areas of project portfolio management and is indispensable for the success of project portfolios (Hofman, Spalek és Grela, 2017; Sanchez és Robert, 2010; Teller és Kock, 2013).

2. táblázat. Correspondence of risks arising in project portfolio management in framework programs (My own editing)

Risk sources	Risk factors	Consequences
Project interactions	Resource sharing between projects (Bai és tsai., 2020) Dependencies between projects (Bai és tsai., 2020) (Ghasemi és tsai., 2018)	Meeting success criteria (PMI, 2017): - Total project time increase - Cost reduction - Publication performance increase

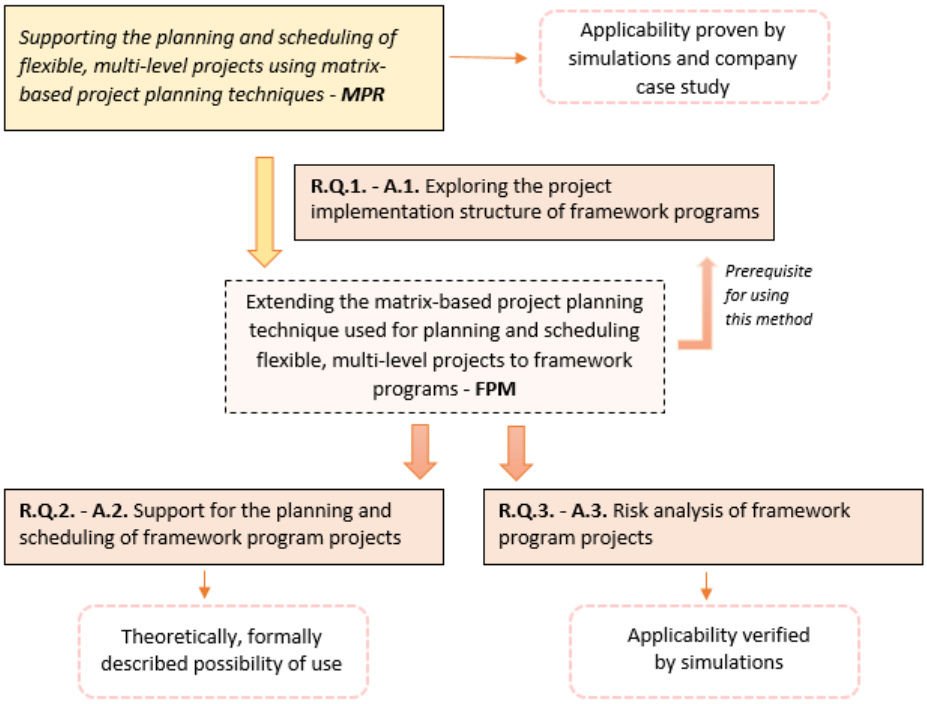
In Table 2, I identified how the definitions and components related to project portfolio risks appear in the analyses conducted on framework programs. This table also supports the conclusion of Wei és tsai., 2020 that interdependencies among projects can influence the outcomes achievable through project portfolio implementation. In the case of framework programs, this manifests in shared resource utilization or the logical and substantive interdependencies between projects. Applied to framework programs as R&D&Í project portfolios, this implies that:

- Projects interconnected within a program can lead to greater scientific outcomes, as the centrally coordinated management of project groups aligned with a shared goal is more likely to achieve strategic objectives (Ferns, 1991). However, they carry greater temporal risks compared to single projects, as delays in a predecessor project can result in delays in all subsequent projects when dependencies exist.

- If projects running in parallel have no shared goal but are managed by the same organization, resources must be distributed among the projects (multi-project environment). Resource sharing can result in relatively lower costs for each project compared to a single project; however, limited resources may lead to delays (Fricke és Shenbar, 2000).

In my dissertation, I focus on temporal risk analysis in framework programs, as meeting deadlines is a critical issue due to the constraints of the funding period (Tenhunen-Lunkka és Honkanen, 2024). Furthermore, both defined project execution structures impact the portfolio-level lead time, while changes in costs and outcomes can only be expected in the case of certain complex structures.

Based on the aforementioned definitions and characteristics from the literature related to project portfolio success and risks, I formulated hypotheses addressing my third research question:



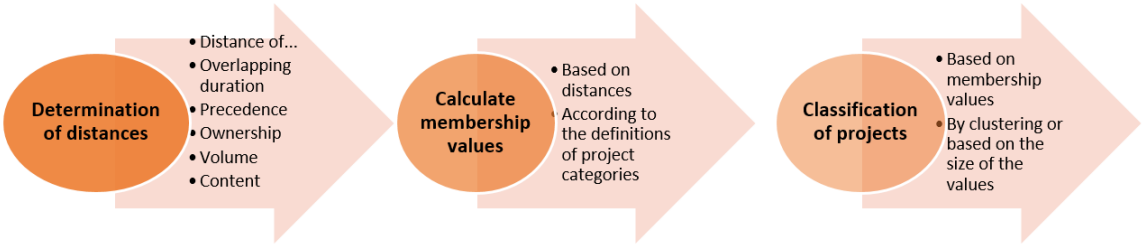
3. ábra. Correlations of the results in the dissertation (My own editing)

- **H.3.** Encouraging complex project execution structures within the Seventh Framework Program increases the extent of framework program risk sources, namely the emergence of project interactions, thereby altering the success criteria of the project portfolio.
  - **H.3.a.** Increasing the proportion of program structures raises project portfolio-level duration and achievable outcomes due to scope-related interdependencies between projects.
  - **H.3.b.** Increasing the proportion of multi-project structures raises project portfolio-level duration and reduces costs due to resource sharing.

4. Research Findings and Theses

Figure 3 illustrates the relationships between the research questions formulated in my dissertation and the the results obtained for these research objectives.

As the starting point for the methodological development of my dissertation, the matrix-based method I developed effectively models project portfolios managed using different project management approaches. The Multilevel Project Ranking (MPR) algorithm has been proven to identify optimal solutions that meet decision-makers' requirements. Applying this method highlighted that significantly more feasible solutions within constraints can be found for project portfolios using flexible



4. ábra. Steps for creating the project execution structure of the framework programs (My own editing)

project management approaches.

For the algorithm modeling, we selected a software development project. Improvements in planning were achieved by incorporating flexibility, while schedulability was enhanced by reducing total project times. However, in the case of the software development projects analyzed, the ability to reduce total project times was closely linked to leveraging flexibility. This is because, in such project environments, a high proportion of parallel activities is typically present. While the required time for the projects can still be reduced, opportunities for further parallelization are limited. Consequently, the method utilized the restructuring opportunities afforded by flexibility instead of relying heavily on additional parallelization.

In contrast, in project plans where parallel activities or projects are typically less common (e.g., research and development projects), the method has more scope to parallelize activities. This means that the time requirement could be further reduced without incurring additional costs or narrowing the scope of content. The MPR algorithm can efficiently leverage these opportunities and provide an optimal solution aligned with the objective functions.

In the context of the first research question of my dissertation, I addressed how the execution structure of a framework program's projects could be modeled. This step was necessary to answer my second and third research questions.

During the development of the first research question, I presented the project categorization described in our study (Kosztyán és tsai., 2022), using a database containing data from the Seventh Framework Program extracted from CORDIS.

We examined project interconnections based on project portfolio execution structures. The membership value of projects was estimated based on the specific characteristics of project portfolio element classifications. The results showed that the projects within the framework program could be classified according to the distances defined in the dissertation, considering the duration of overlap in time, project precedence, ownership, volume, and content (description). The membership values of projects — indicating the extent to which a framework program project exhibits

program or multi-project environmental characteristics — can be estimated using the distance matrices presented in the dissertation (see Figure 4).

These findings provide empirical evidence for classifying projects within the Seventh Framework Program's project portfolio, thereby structuring the framework program's projects into single project structures, multi-project structures, and program structures. The results indicate that more than half of the projects (13,555) in the Seventh Framework Program portfolio structure are single projects. It is noteworthy that the proportion of programs within the project execution structure of the Seventh Framework Program is remarkably low, comprising 106 programs and an additional 742 projects that are classified as both program components and projects within a multi-project environment. These observations shed light on the actual structure of the project portfolio derived from the European Union's Seventh Framework Program and the distribution of various projects within it.

Overall, it can be concluded — and validated through calculations on a real sample extracted from the projects of the Seventh Framework Program — that the project execution structure of a naturally formed project portfolio, without manual intervention, can be accurately mapped using the presented method, provided the necessary data is available. This approach is grounded in literature-based principles. Based on these findings, my first research thesis is as follows:

- **T.1.** By defining multi-project and program membership values based on characteristics derived from the literature, single project -, multi-project -, and program structures can be identified within the execution structures of framework programs modeled as project portfolios.

To answer the second research question of my dissertation, I demonstrated two potential applications of the framework-program-related Framework Precedence Matrix (FPM) algorithm:

- I addressed that, if the required data were available, the model could be used during the project selection phase of framework programs. This would enable not only risk analysis of the framework program projects but also support their planning and scheduling.

- I showcased the model's applicability in project portfolio-level risk analysis of framework program projects. Simulations were conducted for the risk analysis of the Seventh Framework Program, intended to address my dissertation's third research question.

3. táblázat. Comparison of projects running as part of a project portfolio and projects of framework programs (My own editing)

	Project portfolio environment	**Framework programme**
Unit	Activity	Project
Connection	Dependency relation between activities	Possible logical connection between projects
Structures	- Single project structure - Multi-project structure - Program structure	- Single project structure - Multi-project structure - Program structure

During the research conducted to develop the FPM algorithm, I explored the differences between projects operating in everyday project portfolio environments and those within framework programs. I presented the distinctions and similarities between a traditional project portfolio and a framework program's matrix representation, defined the units of analysis, and explained how connections between projects in framework programs and activities in project portfolios could be interpreted (see Table 3).

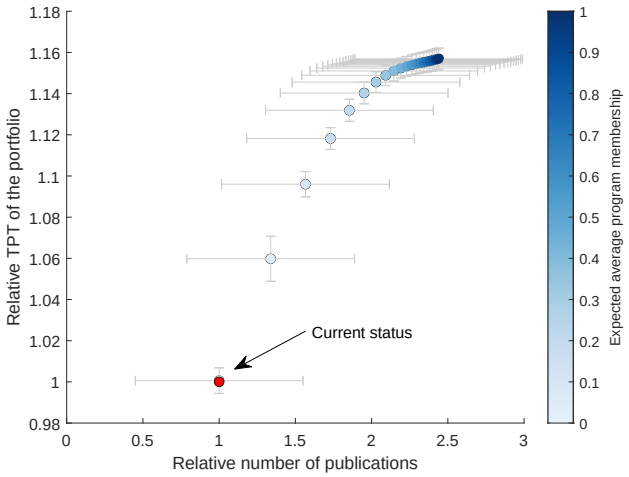
Additionally, I discussed how different defined project execution structures could be represented in matrices, how the total project time within these structures could be calculated, and how their expected values and risks could be determined.

Based on the formal description of the developed FPM algorithm and the simulations conducted for risk analysis, I formulated the second research thesis of my dissertation:

- **T.2.** The Framework Precedence Matrix (FPM) algorithm, developed as an extension of the Multilevel Project Ranking (MPR) algorithm, enables the planning and scheduling of framework programs structured as project portfolios and can be utilized to support risk analysis.

It is important to emphasize that I validated the applicability of the method for planning and scheduling through simulations and real-world corporate project portfolios by running the MPR algorithm. This validation was necessary as the required data for the Seventh Framework Program projects was not available for these analyses.

To address my third research question, simulations were conducted to examine the sensitivity of costs (risks of delays and relative project costs) and publications to changes in the distribution of projects running in multi-project environments and programs within a project portfolio derived from Seventh Framework Program projects.



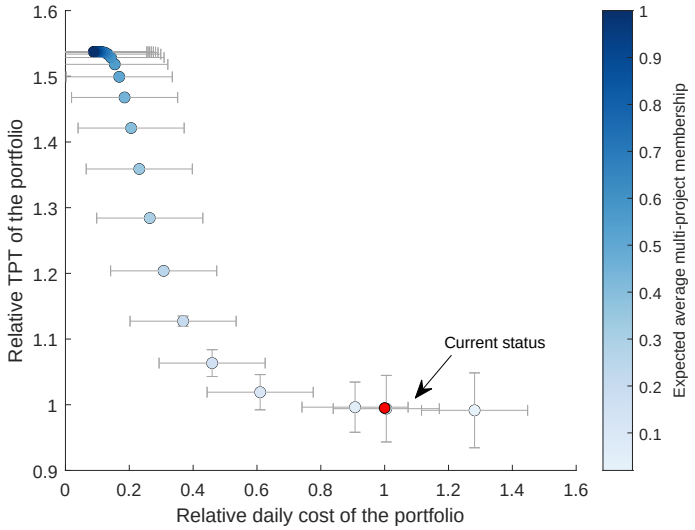
5. ábra. The effect of increasing the program membership value on the number of publications and the TPT of the project portfolio (My own editing)

The results indicate that programs are more sensitive to outputs (i.e., the number of publications) than to the duration of the project portfolio. For example, increasing the expected average program membership value from nearly zero to 0.5 roughly doubles the number of publications, while the total project portfolio duration increases by only 1.15 times (see Figure 5). Specifically, due to the 7-year constraint of the framework programs and the average duration of 1.5 years for projects within these programs, only 3–5 projects can be launched within a program. Consequently, the impact of delays is much smaller compared to the increase in the number of publications.

This finding carries significant policy implications, as favoring programs over single projects can result in a substantial increase in the number of publications (performance), while the overall portfolio duration at the framework program level increases only marginally.

- **T.3.a.** Increasing the proportion of program structures within the project execution structure of the Seventh Framework Program results in a smaller increase in project portfolio duration compared to the significant improvement in publication performance achieved through this restructuring.

For projects operating within a multi-project environment, it can be concluded that in the case of the Seventh Framework Program, projects executed in a multi-project structure are more sensitive to relative daily costs than to portfolio duration, up to an expected average multi-project membership value of approximately 0.3. Beyond the 0.3 threshold, projects within a multi-project structure become more sensitive to portfolio duration than to relative daily costs.



6. ábra. The effect of increasing the multi-project membership value on the daily cost of projects and the TPT of the project portfolio (My own editing)

This indicates that promoting the execution of framework program projects in a multi-project structure increases the total portfolio duration to a lesser extent compared to the cost savings achieved, up to an average multi-project membership value of 0.3. However, beyond this threshold, the increase in portfolio duration outweighs the potential for cost reduction. Highlighting an example, if the expected average multi-project membership value is increased from nearly zero to 0.2, the relative daily cost decreases by approximately 40 %, while the total portfolio duration increases by less than 5 % (see Figure 6). The steep rise of the curve beyond the 0.3 multi-project membership value clearly demonstrates that above this threshold, the increase in duration outweighs the potential for cost reduction.

This indicates that the implementation of multi-project structures should only be encouraged as long as the associated benefits can be leveraged without significant increases in project portfolio duration.

- **T.3.b.** Increasing the proportion of multi-project structures in the execution structure of the Seventh Framework Programme results in a smaller increase in project portfolio-level duration than the achievable cost reduction, up to an average multi-project membership value of 0.3. However, above this value, a higher increase in duration must be expected than the potential cost reduction. The magnitude of the average multi-project membership value aligns with the proportion of multi-project structures within the project portfolio.

I have determined that the execution structure of the Seventh Framework Programme is characterized by a very high proportion of single projects. In the identified

execution structure, projects operating within multi-project or program structures accounted for approximately 10 % of all projects. However, my results highlight that in the Seventh Framework Programme, both relative costs and performance (measured by the number of publications) can be improved with minimal change in duration by altering the execution structure. This can be achieved by moderately increasing the proportion of complex project execution structures, rather than maintaining the high share of single projects. In practice, this was accomplished in the simulations by modifying the average membership values.

- **T.3.** Increasing the proportion of complex project execution structures in the Seventh Framework Programme results in a smaller increase in the project portfolio-level duration than the cost reduction and publication performance improvement achieved through the restructuring.

These results provide a new perspective on the implementation approach of the Seventh Framework Programme projects, which policymakers should consider when planning and executing future framework programmes.

5. Summary

In my dissertation, I focused on project portfolios and the Seventh Framework Programme structured in this way, through both theoretical and practical investigations. I applied a matrix-based project planning technique to support the planning, scheduling, and risk analysis of framework programmes. As the foundation for the matrix-based project planning method extended to framework programmes, I presented the MPR algorithm, which can be used in a corporate environment. To validate it, I created a corporate case study and conducted simulations to demonstrate its practical applicability. I applied the developed FPM algorithm in practice — after structuring the Seventh Framework Programme as a project portfolio — for risk analysis. In this process, we performed simulations, which revealed the benefits that arise from uncovering and accounting for the execution structure of framework programme projects, such as the potential for increased publications and cost reduction resulting from restructuring, while considering the duration of the framework programme. On a theoretical level, I demonstrated the algorithm's applicability in supporting the planning and scheduling of framework programmes.

5.1. The applicability of the research results and its limitations

The primary objective of my dissertation was to develop a matrix-based project planning methodology that supports the design, scheduling, and risk analysis of framework programs. I hypothesized that the approach and methods of corporate project portfolio management could also be applied to EU framework programs—a setting not initially designed or managed as a project portfolio. Based on this assumption, I refined a methodology effective in corporate environments to accommodate the characteristics of framework programs.

As a starting point, I introduced a project planning and scheduling methodology that can efficiently support the design, scheduling, and modeling of project portfolios using both flexible and traditional project management approaches. Additionally, the MPR algorithm I presented enables the modeling and management of shared resources across projects and accounts for deterministic and stochastic relationships between projects. The results demonstrated that the MPR algorithm could identify optimal solutions for project portfolios and projects in multi-project environments, while also offering permissible solutions in flexible project management contexts and increasing the number of feasible projects within constraints. The method's effectiveness was further validated through a case study in practice, underscoring the broader applicability of the MPR algorithm for corporate project portfolio planning and scheduling, independently of framework program-specific investigations.

Since an important prerequisite for extending the model to framework programmes was the exploration of the project portfolio project execution structure composed of framework programme projects, before presenting the formal description and application possibilities of the model, I defined logical structures (single project structures, multi-project structures, and program structures) based on literature characteristics of portfolio elements. Than I classified the projects that won funding into these categories. By structuring the Seventh Framework Program as a project portfolio, I demonstrated that the structure of an "unstructured" project portfolio — formed without deliberate intervention — can be accurately mapped using limited, often publicly available data. Although the applied and extended methods and simulations were demonstrated using data from the Seventh Framework Program, the developed project structuring methodology is not confined to this framework program. The only requirement is that the following five attributes of projects be known: budget, duration, project outcomes (in this case, publication counts), executing organization, and project description. This approach reveals not

only the collaborative network within framework programs but also the structure and relationships of projects.

Using the developed FPM algorithm, the capabilities of the MPR algorithm applicable in corporate project portfolio contexts were extended to framework programs. However, a limitation noted in the dissertation is that I could not validate its use for planning and scheduling through simulations due to the unavailability of decision-making preferences used during proposal evaluations and the absence of complete data on time, cost, and outcomes for all submitted proposals.

Through risk analysis of framework programs based on project portfolio execution structures, simulations focused on multi-project and program structures shed new light on the relationships between framework program-level duration, costs, publication performance, and project implementation methods. These findings highlight opportunities that should be considered in the planning and execution of future framework programs. The possibilities explored in the dissertation are as follows:

- The scientific output of the Framework Programmes (of which I examined the number of publications in my analyses) can be greatly increased - with little impact on costs and duration - by transforming the execution structure of the Framework Programme. However, the prerequisite for this is the practical introduction and application of the project portfolio approach and tool system.

- Despite the fact that one of the main objectives of the EU in funding projects under the Framework Programmes is to enhance cooperation between organisations (Decision N° 1982/2006/EC; European Parliament (2006)), the results presented show that the project portfolio of the Seventh Framework Programme still consists predominantly of separate, single projects. By encouraging complex project execution structures, the EU could more effectively meet the objective of enhancing cooperation between organisations under the Framework Programmes. (I will highlight some of the incentives for complex project execution structures below.)

The presented results also highlighted that the literature findings regarding the effects of the distribution of single projects, projects and programs running in a multi-project environment on time, cost and results are also valid in the case of an initially unstructured project portfolio (like the Seventh Framework Programme).

As I mentioned above, one of the prerequisites for the benefits that can be applied to future framework programmes is the practical introduction of the project portfolio approach and tools into the planning process of framework programmes. However, this has a limitation, which has appeared several times in my thesis,

namely that publicly funded R&D&I programmes often cannot be planned and structured in a forward-looking manner, since they - like framework programmes - are implemented by bottom-up networks, and therefore are not characterized by the top-down selection logic of project portfolio management. Nevertheless, my findings are applicable even within such an organizational framework, which underscores the true value of my research objective: to demonstrate why it is worthwhile to design and schedule framework programs as project portfolios and to perform risk analysis while considering the structural characteristics of project portfolios. The potential of the developed method in a bottom-up organizational context includes the following:

- Leveraging the structural characteristics of past framework programs for future ones:
  - Structural characteristics identified from completed programs can inform future calls by allowing funders to influence project execution structures during the proposal phase.
  - For example, prioritizing professional experience (as with the H2020 framework program) might favor organizations with prior framework program experience, resulting in a higher proportion of program-structured projects. Conversely, emphasizing excellence and imposing entry barriers could limit the number of winning institutions, forcing them to allocate limited resources across concurrent projects. This would likely increase the share of multi-project environments.
- Practical introduction of the role and task of project portfolio management, similar to emerging strategy:
  - The role of project portfolio management extends beyond executing planned strategies to effectively managing emergent elements (projects in framework programs) and incorporating them into strategies.
  - The PPM mechanisms allow for continuous coordination and control activities. In this way, in the framework programmes, PPM could address challenges arising from the dynamic external and internal environment, and tasks related to achieving project objectives and managing risks could be better managed. Projects could respond more effectively to environmental challenges, such as the more effective use of the results of already implemented projects and the validation of the benefits derived from them, or the more effective management of the consequences of a project's delay (delays of subsequent projects, control of resource constraints).

The investigations and highlighted benefits in my dissertation validate the argument that EU framework program decision-makers should consider treating framework programs as project portfolios and applying at least basic portfolio management tools. Furthermore, framework programs would benefit from governance structures that not only define goals and scopes more precisely but also prioritize organizing project structures before project initiation. Implementing such governance could realize the advantages identified through my risk analysis simulations.

Finally, the utility of my findings depends on the fact that the framework program risk analysis simulations relied on a proxy variable (publication counts) to represent outcomes. I fundamentally believe that the results, especially the effects of the distribution of project categories on cost, duration and outcome, are valid for all R&D&I project portfolios, including highly structured, managed project portfolios. (This is confirmed by the fact that the results obtained during the simulation met the expectations given in my third assumption.) However, it would be worth testing the specific effects on other research project portfolios, especially in cases of different planning and management philosophies.

Among the limitations of the usability of the results, it is also important to mention that during the analyses I used only publicly available data (CORDIS), thus I relied on the accuracy of third-party data and the results of project reports. During my analyses, I outlined the project execution structure of only one framework program. Due to the lack of available data, no studies were conducted on the internal views of the project owners - especially regarding politics and the structure of the project portfolio - due to the lack of available data.

In relation to the results it is important to mention, that all Python codes are available, so the proportions of the project execution structures can be freely varied, thus testing the characteristics, parameters, cost, duration and result data of the desired or optimized project portfolio structure.

6. Publications

Publications in hungarian and international refereed journals:
Publication related to the exploration of the execution structure of framework programs and the risk analysis of the projects contained therein:

- Kosztyán, Zs. T., Katona, A. I., Kuppens, K., Kisgyörgy-Pál, M., Nachbagauer, A., & Csizmadia, T. (2022). Exploring the structures and design effects of EU-funded R&D&I project portfolios. Technological Forecasting and Social Change, 180, 121687. URL: https://www.sciencedirect.com/science/article/pii/S0040162522002141

Publication presenting matrix-based project planning techniques supporting the planning and scheduling of projects in a flexible multi-level project management environment, along with the MPR algorithm, validated through simulations and case studies:

- Kosztyán, Zs. T., Sebrek, Sz. S., Csizmadia, T., & Kisgyörgy-Pál, M. (2022). Rugalmas, többszintű projektttervezési és ütemezési technikák. Szigma, 53(1), 33-71. URL: https://unipub.lib.uni-corvinus.hu/7700/1/document-3.pdf

The publication of the developed FPM algorithm supporting matrix-based planning, scheduling, and risk analysis of framework program projects will take place in the future.

List of publications:
https://m2.mtmt.hu/gui2/?type=authors&mode=browse&sel=10069123&view=simpleList

Conferences:
Presentations given on the exploration of the execution structure of framework programs and the risk analysis of the projects contained therein:

- Kisgyörgy-Pál, M. (2023). Európai Uniós keretprogramok strukturális jellemzőinek feltárása projekt portfóliók vizsgálatával. New Trends and Challenges in Management Conference, 2023. Debrecen, University of Debrecen

- Kisgyörgy-Pál, M. (2023). Európai Uniós Keretprogramok strukturális elemzése a résztvevők adatai alapján projekt portfólió környezetben. 9th Winter Conference of Economics PhD students and Researchers, 2023. Óbuda

- Kosztyán, Zs. T., Katona, A. I., Kisgyörgy-Pál, M., Csizmadia, T., Kuppens, K. & Nachbagauer, A. (2022). Az Európai Unió által finanszírozott K+F+I projekt megvalósítások szerkezeti vizsgálata. 1. Innovációs konferencia - „A Tűztorony lépcsőin – Továbblépési lehetőségek az innovációban" Veszprém, University of Pannonia, Faculty of Business and Economics

- Kosztyán, Zs. T., Katona, A. I., Kisgyörgy-Pál, M., Csizmadia, T., Kuppens, K. & Nachbagauer, A. (2022). Comparing risks of EU-funded project portfolios. PMUni International Conference on Project Management - PMUni 2022 Workshop, Budapest Corvinus University of Budapest

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- Kisgyörgy-Pál, M., & Novák, G. (2019). Többszintű projekttervezés és szimuláció mátrixalapú modell alkalmazásával a késedelmi költség hatásainak bemutatására. Abstract. Ipar napjai konferencia 2019, Conference Proceedings, pp. 53-54., University of Debrecen, Debrecen, Hungary.

- Kisgyörgy-Pál, M. (2019). "Az idő pénz" - A késedelem - illetve az erőforráskorlát túllépésének költsége többszintű projektkörnyezetben. 5th Winter Conference of Economics PhD students and Researchers 2019, Szent István University, Gödöllő

Presentation on research showcasing the role of universities - as one of the most significant participants in framework programs - in research networks:

- Fehérvölgyi B., Kosztyán, Zs. T., Kisgyörgy-Pál, M., Csizmadia, T. & Kerekes, K. (2019). Measuring third mission activities of the universities by multilayer networks. ICEBM 2019 – 4th International Conference on Economics and Business Management, Cluj-Napoca, Romania

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