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AN INTEGRATIVE REVIEW OF PROJECT PORTFOLIO MANAGEMENT RANKING CRITERIA - UNDERSTANDING BETTER THE DECISION-MAKING PROCESS

Анотація. *Управління портфелем проектів (PPM) ґрунтується на рейтингах проектів, що може бути складним через багато факторів і залучених людей. Пріоритезація проектів є важливою, коли бізнес працює над декількома проектами одночасно, незалежно від того, чи є вони повністю незалежними чи взаємозалежними. Управління проектами, які вже є в портфоліо компанії, і вибір нових для додавання до портфоліо є одними з основних завдань для багатьох компаній. Організація повинна визначити пріоритетність відповідних ініціатив у своєму різноманітті для досягнення своїх цілей і завдань. Підхід до ранжування — це спосіб розставити проекти за пріоритетністю, розташувавши їх у порядку від найбільш важливого до найменш важливого, присвоївши кожному завданню рейтинг на основі набору критеріїв. Вони можуть бути дуже різними і залежати від багатьох факторів, таких як різні фінансові та нефінансові наслідки. Це дослідження має на меті забезпечити комплексну оцінку існуючої літератури щодо досліджень рейтингу управління портфелем проектів, зосередившись на використовуваних критеріях рейтингу та ідентифікації журналів, які опублікували статті, вибрані нами для цього аналізу. Перед ранжуванням необхідно визначити, які критерії найбільше відповідають цілям організації. У дослідженні представлено основні критерії та підкритерії, які використовуються для ранжування портфоліо проектів, щоб краще зрозуміти потенціал PPM для оптимального вибору більш прийнятних і цінних проектів для організації. Розуміння критеріїв, які використовуються для процесу, визначення можливостей їх застосування та отримання додаткових знань про них дозволяють компанії краще керувати портфелем проєктів.*
Ключові слова: *управління портфелем проектів; ранжування портфоліо проектів; критерії ранжування.*

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Absztrakt. *A projektportfólió-kezelés (PPM) projektminősítéseken alapul, amelyek a sok tényező és érintett személy miatt összetettek lehetnek. A projektek prioritása fontos, ha egy vállalkozás több projekten dolgozik egyidejűleg, függetlenül attól, hogy azok teljesen függetlenek vagy kölcsönösen függenek egymástól. A cég portfóliójában már meglévő projektek menedzselése és a portfólióba való újak kiválasztása sok vállalat fő feladatai közé tartozik. A szervezetnek a maga sokszínűségében meg kell határoznia a releváns kezdeményezések prioritását céljai és célkitűzései elérése érdekében. A*

rangsorolás a projektek rangsorolásának egyik módja a legfontosabbtól a legkevésbé fontosig történő elrendezéssel, és az egyes feladatokhoz egy kritériumrendszer alapján rangsorolnak. Ezek nagyon eltérőek lehetnek, és számos tényezőtől függhetnek, például különböző pénzügyi és nem pénzügyi tényzőktől. A tanulmány célja, hogy átfogó értékelést adjon a projektportfólió-menedzsment rangsorolási technika szakirodalomról, összpontosítva a használt rangsorolási kritériumokra, és azonosítva azokat a folyóiratokat, amelyek közzétették az elemzéshez kiválasztott cikkeket. A rangsorolás előtt meg kell határozni, hogy mely szempontok vonatkoznak leginkább a szervezet céljaira. A tanulmány bemutatja a projektportfólió rangsorolásához használt fő kritériumokat és alkritériumokat, hogy jobban megértsük a PPM-ben rejlő lehetőségeket a szervezet számára elfogadhatóbb és értékesebb projektek optimális kiválasztásában. A folyamathoz használt kritériumok megértése, alkalmazási lehetőségeinek meghatározása, azokkal kapcsolatos további ismeretek megszerzése lehetővé teszi a vállalat számára a projektportfólió jobb menedzselését.
Kulcsszavak: *projekt portfólió menedzsment; projekt portfólió rangsorolása; rangsorolási kritériumok.*

Abstract. *Project portfolio management (PPM) relies on rankings of projects, which can be challenging due to the many factors and people involved. Project prioritization is essential when a business works on multiple projects simultaneously (whether the projects are wholly independent or interdependent). Managing the projects already in the company's portfolio and selecting new ones to add to the portfolio are among the essential tasks for many companies. The organization must prioritize the proper initiatives within its diversity to attain its goals and objectives. The ranking approach is a way to prioritize the projects by placing them in order from most important to least important by assigning each task a rating based on a set of criteria. These can be very diverse and depend on many factors, such as different financial and non-financial impacts). This study aims to provide a comprehensive assessment of the existing literature on studies in project portfolio management ranking, focusing on the ranking criteria employed and identifying the journals that published the papers we selected for this analysis. Before ranking, it is necessary to specify which criteria are most relevant to suit the organization's goals. This research presents the main applicable criteria for ranking project portfolios and their sub-criteria to understand the potential of PPM better, leading to selecting more suitable and valuable projects for the organization. Based on this review, exploring the criteria used for the process, identifying the possibilities for their application, and gaining further knowledge of them enable better portfolio management for the company.*
Key words*:project portfolio management; project portfolio ranking; ranking criteria.*

Introduction. A business's investments and capital projects are managed in the portfolio, which is directly related to the company's value and is a significant concern for business stakeholders. According to the [38], "a portfolio is a collection of projects, programs, subsidiary portfolios, and operations managed as a group to achieve strategic objectives." Managing a single project is not enough today when many projects are being worked on simultaneously [31, 44]. The traditional method of managing each project separately, called single-project management (SPM), has been replaced by project portfolio management, which tries to get the most out of a group of related projects at the same time [2, 24, 43]. One of the most vital tasks for many businesses is to decide which projects to include in the organization's portfolio and then manage those projects in order of priority [3]. PPM relies on rankings to prioritize the most critical projects for the organization's strategy. These significant projects must be prioritized and finished by concentrating and allocating business resources.

When different projects in a company compete for the same amount of time and money, a priority list could help decide which one gets done first [31, 44].

Due to its importance, creating detailed rankings for all projects is vital to effective portfolio management. Knowing how to select the most appropriate ranking method is just as crucial as identifying the proper criteria and implementing them precisely. Even now, businesses still need help with this challenging task since only some solutions work for all industries and companies. Standard practice calls for establishing evaluation criteria for ranking projects in the portfolio and comparing them to determine where in the portfolio each one stands. This research presents the main applicable criteria and sub-criteria that can be used to rank project portfolios. Based on this review, management will understand PPM's potential better and choose more suitable and valuable projects for the organization. The most prominent project portfolio management can be achieved by exploring the criteria used for the process, identifying the possibilities for their application, and gaining further knowledge about them.

This literature first identifies the primary sources from which relevant articles for this study were drawn; second, it provides a concise summary of the prior studies that have examined which criteria have been used to rank projects in a portfolio and how they were applied. Therefore, the structure of the article is constructed as follows. Section 2 considers the most significant concepts, along with the description of the research topics and methods used to conduct the study. Section 3 discusses the research results, providing an evaluation summary of the best findings from the articles and books. The final section is Section 4, which presents the findings and conclusions.

Literature Review. Determining how to accurately describe the ranking criteria used for project portfolio management could be challenging, and the language typically used is not always necessarily the most suitable. In addition to conducting a thorough literature review analysis, the researchers behind this study followed the research format recommendations of [14, 40, 41] as a guide to conducting a comprehensive review. By covering the ground set out to study and adhering to the research style suggestions, they ensured that their investigation encompassed the topics they set out to cover.

The following essential terms, presented as a starting point because they are fundamental to introducing the concept, can be expressed differently depending on the author. A project is a complex endeavor with a stated goal, schedule, and budget. It could be a short- or long-term task, where the project work or its phases have a start and an end, completed by multiple organizations [2, 37, 38]. Portfolios are comprised of a variety of competing projects, subsidiary portfolios, and operations, which are the cornerstones of a portfolio [2, 25, 41, 43]. They share a common sponsor or manager to reach overarching strategic goals [37]. Every proposal that fits the organization's basic standards on some parameters must compete for the limited resources (such as people, cash, and time) available from the sponsor [2, 27, 37, 38]. In light of this, organizations must evaluate their unique realities and establish how to maximize and manage the portfolio features more effectively [37].

An organization's initiatives that it will fund or manage are called its project portfolio. These initiatives must compete for the limited resources (i.e., people, finances, and time) available from the sponsor [2, 25]. Since there are rarely enough resources to implement every proposal that satisfies the organization's minimal requirements on some parameters, these proposals must fulfill the organization's minimal requirements on some parameters.

As a result of globalization in business and the management of projects across international borders, an increasing number of projects need to be handled simultaneously, making the work more difficult [42]. In a setting where numerous projects are being worked on simultaneously, managing a single project needs to be improved [31, 44].

Project Portfolio Management is a term that refers to the process that project managers and PMOs use to determine the value of potential new projects. Since the 1970s, when industrial firms first recognized the applicability of Markowitz's financial PPM theories [13], this topic has been the research subject. In contrast to the conventional approach, which involves managing each project in isolation, this strategy offers optimization benefits across numerous projects simultaneously [3, 4,24, 43]. PPM is viewed as a significant barrier by many companies, even though it is a valuable tool that can assist them in managing several projects [31, 44].

Choosing a healthy mix of ongoing and recently completed projects is one of the most critical responsibilities of a project portfolio manager. According to [6], the resulting portfolio will optimize the utility of the company's existing assets in order to increase the company's position in the competitive market.

The presence of a Project Management Office (PMO) in project portfolio management offers the benefit of providing centralized oversight, coordination, and standardization, leading to improved project governance and alignment with organizational objectives. Additionally, PMOs facilitate knowledge sharing, best practices dissemination, and lessons learned, enhancing project success rates and overall organizational performance [16, 45].

The PPMOs have three leading roles in working with PPM: coordinating, controlling, and supporting. The first role, coordinating, involves allocating project portfolio resources, selecting and reviewing projects, and ensuring teamwork. The second role, controlling, comprises the information organization to assist decision-making for project portfolio steering. Information, planning, sharing, and problem-solving are among the main activities. The supporting role encompasses training and motivating firm project management standards and operations during project implementation [45].

The first significant authors in this field [3] described project portfolio selection as a process that involves selecting a portfolio of planned and ongoing projects that will assist organizations in achieving their goals without exceeding their resources or other restrictions. Project portfolio selection was described as a process involving selecting a portfolio of planned and ongoing projects to help organizations achieve their goals [3]. It is carried out through a few processes, with the data produced in each step functioning as the input for the following action.

Archer & Ghasemzadeh [3] established a set of principles to follow called the portfolio selection framework, which consists of three stages: pre-process, the portfolio selection process, and post-process, to standardize and improve the process of choosing between projects for a portfolio. During the first stage, the portfolio's emphasis is narrowed, and it is determined how much money will be distributed among the many projects. In the second stage, multiple approaches can be used to evaluate the project independently. In the third stage, the portfolios are selected based on the established criteria and how the individual projects will interact with each other regarding resource limits and other requirements.

This literature review is divided into three main parts: Research and review process, Utilized criteria for evaluation in the articles, and Main ranking criteria.

1. Research and review process. This research aims to give an organized and comprehensive assessment of how the literature presents criteria to assist businesses in critically evaluating the criteria system used for their PPM process and identifying chances for development. The bottom line of this study is to help companies find areas where they may improve their PPM process. The purpose of the literature research and the examination was to gain further understanding regarding rankings in project portfolio management and the criteria employed to construct these rankings. This study used traditional sources that were knowledgeable about the topic to ensure its credibility. This research was carried out via an approach that involved a systematic and objective review process. The following subsections contain detailed explanations of the techniques we took in conducting our research which can be found below. In all of our studies, we adhered to the guidelines for a literature review established by [20]. These standards were utilized as guidelines for a systematic literature review by Savolainen et al. [41]. A preliminary examination found that even though a large number of studies had been completed on selecting projects for portfolio management, there is very little research on how projects should be ranked. However, this study investigates the criteria used to rank projects within a portfolio and the ranking selection procedure used for projects inside a portfolio.

The first thing that needed to be done was to figure out where the data for this study came from and how the research was conducted. The selection of factors, such as databases and keywords, was the focus of the project's second phase. The selection of the articles was the focus of the third phase, followed by the extraction of crucial data from the selected papers and a synthesis of those data. The procedure followed in carrying out this systematic review of the relevant literature is depicted in **Fig. 1**.

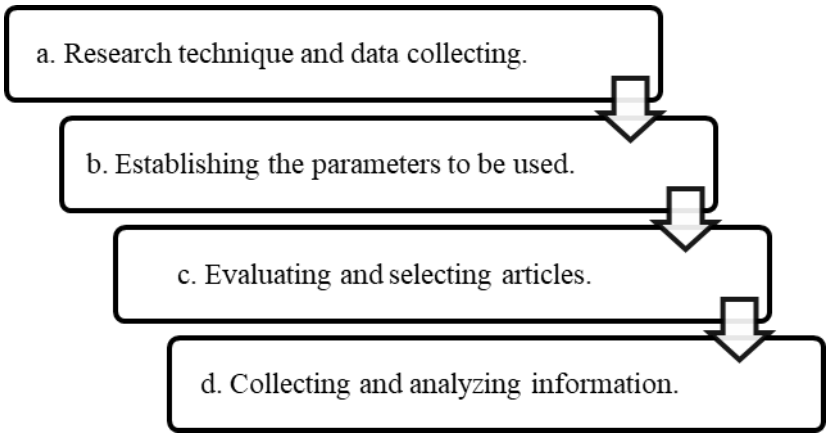

Fig. 1. Literature review process

a. Research technique and data collecting. First, searches were conducted using the search engines and databases provided by the publisher (Google Scholar was also used). The following journals contain the publications that are the most relevant to the research topic of Project Portfolio Ranking Criteria, even though there is still a great deal to learn about this field: Additionally, the Journal of Sustainable Finance and Investment; Environment, Development, and Sustainability; Engineering Economist; Journal of Project Management; and a few Brazilian production engineering congresses were combed through for relevant information. During the previous five years, the leading project management journals did not publish the publications considered the most pertinent to the subject. This investigation looked at all the databases rather than concentrating on particular journals. The journals and proceedings containing the primary articles utilized in this investigation are listed in Table 1.

Table 2.

Journals and Conferences

Published on	Quantity
International Journal of Project Management	4
ACM International Conference Proceeding Series	1
Wireless Networks	1
International Symposium on Project Management, Innovation, and Sustainability	1
Sustainability (Switzerland)	1
Society of Petroleum Engineers - SPE Oil and Gas India Conference and Exhibition	1
PMI, 2007	1
Procedia - Social and Behavioral Sciences	1
Renewable and Sustainable Energy Reviews	1
Research-Technology Management	1
XXXV Encontro Nacional de Engenharia de Producao	1
Arabian Journal for Science and Engineering	1
Benchmarking	1
Biology of Blood and Marrow Transplantation	1
Brazilian Journal of Operations & Production Management	1
Construction Research Congress 2016	1
Cutter IT Journal	1
Economic Annals-XXI	1

Published on	Quantity
Engineering Economist	1
European Project Management Journal	1
IEEE 23rd International Enterprise Distributed Object Computing Workshop	1
IEEE Transactions on Engineering Management	1
IFIP Advances in Information and Communication Technology	1
Information & Management	1
International Journal of Approximate Reasoning	1
International Journal of Intelligent Systems	1
International Journal of Management and Decision Making	1
International Journal of Production Economics	1
International Journal of Project Organisation and Management	1
JAWRA Journal of the American Water Resources Association	1
Journal of Civil Engineering, Science and Technology	1
Journal of Infrastructure Systems	1
Journal of Petroleum Science and Engineering	1
Journal of Project Management	1
Journal of Real Estate Portfolio Management	1
Journal of Sustainable Finance and Investment	1
Journal of Technology Transfer	1
Management Research News	1
Omega	1
Organization, technology & Management in Construction: an international journal	1
Peninsula Center for Project Management in Hampton	1

b. Establishing the parameters to be used. Since the research topic was the ranking criteria for project portfolio management, the terms “ranking” and “criteria” were included in the research by default. The search for materials required the combination of at least two keywords to be successful. The technique shown in Figure 2 may be found above.

The connection between the following key terms: “Project Portfolio,” “Project Portfolio Ranking,” and “Project Portfolio Ranking Criteria,” “Project Portfolio Management,” “Project Portfolio Management Ranking,” and “Project Portfolio Management Ranking Criteria,” “Project ranking,” and “Project ranking criteria,” “PPM ranking,” and “PPM ranking criteria,” “Portfolio ranking,” and “Portfolio ranking criteria.” The keywords are logically connected and can be combined in various ways to produce the best results for finding relevant articles in the databases (Appendix A).

Among the scientific databases utilized for literature research in this sector, it is feasible to single out the sources pertinent to the investigation. For this investigation, the databases used for the most recent articles on project portfolio management were also utilized. As a consequence, we concluded that it would be more beneficial to search all of the databases rather than just a few journals.

Therefore, the Scopus, Mendeley, and Science Direct databases offered by Elsevier were selected as the database to use for the investigation (as stated in Table 3, Table 4) because Elsevier is the industry-leading publisher. It is unparalleled in terms of the number of abstracts and citations it provides for academic works such as books,

journals, and conference papers. It provides a worldwide perspective on research being conducted on many subjects. It consists of helpful tools for monitoring, analyzing, and visually representing the information gathered. It is utilized in over 3,000 educational, governmental, and commercial establishments worldwide [12].

Table 4.

Databases used for searching the articles

Database	Address
Scopus	https://www.scopus.com
Mendeley	https://www.mendeley.com
ScienceDirect	https://www.sciencedirect.com

Table 5 demonstrates that many articles were discovered across multiple sources using the keywords with no additional filtering applied. Therefore, the initial original sample size was 164,755 articles.

Table 5.

Keywords used in the database and the number of articles found

Keywords	Scopus	Mendeley	ScienceDirect
Project Portfolio	9,320	15,832	4,976
Project Portfolio Ranking	186	293	6,590
Project Portfolio Ranking Criteria	68	97	8,486
Project Portfolio Management	4,477	6,853	16,737
Project Portfolio Management Ranking	98	147	18,034
Project Portfolio Management Ranking Criteria	37	55	19,410
Project ranking	7,816	13,797	6,003
Project ranking criteria	1,744	3,663	7,919
PPM ranking	174	293	1,869
PPM ranking criteria	9	83	4,114
Portfolio ranking	929	1,532	2,591
Portfolio ranking criteria	215	308	4,804

c. Evaluating and selecting articles. Reading the titles and abstracts of the articles was the first step in the research process to determine once more whether or not the publications were pertinent to the problem being investigated. Following this, the whole articles were read in their entirety to validate the claims, descriptions, and criteria used to rate the projects.

d. Collecting and analyzing information. After gathering all the most relevant articles on the studied topic, a bibliographic portfolio was produced. This portfolio compiled in this study synthesizes a comprehensive collection of relevant articles on the investigated subject. Through the selection process, this portfolio serves as a valuable resource for the next steps of the research.

2. Utilized criteria for evaluation in the articles. The ranking is a vital part of the project portfolio management process. In addition to choosing the suitable ranking methodology, an important question is what criterion or criteria to consider and how to consider them. Portfolio projects are usually ranked by first determining the criteria by which they will be evaluated and then making comparisons between those criteria. First and foremost, portfolio projects are categorized by choosing the criteria by which

they will be assessed and then making comparisons between those criteria. We incorporated the ranking criteria data from the studied articles and generated the following sub-criteria used in the ranking project mechanism (**Table 6**).

Following the method described above, we have collected articles on the criteria used in project portfolio management. The original sample size was 169,559 articles. The criteria were organized into major categories, resulting in the main types, including sub-criteria. The classes were chosen to be distinct enough in terms of content. Thus, the following main categories were developed: Financial, Strategic, Stakeholder, Learning experience, Risk, Resources, and Urgency. To properly support practitioners in the initial steps of the ranking process, this paper describes these main criteria in more detail later in this paper.

Table 6.

Criteria and sub-criteria in the researched articles

Criteria	Sub-criteria
Financial	Capital asset pricing model (CAPM); Cost minimizing; Economic and Financial benefits; Economic viability – positive NPV; Expected Net Present Value (ENPV); Expected Value (EV) usually uses: IRR; Fuzzy net present value; Fuzzy return on investment; Internal Rate of Return (IRR); Investment; Maximum assets return; Net Present Value (NPV); Net Return; Pay Back Period (PBP); Return on Average Investment (RAI); Return on Original Investment (ROI).
Risk	A new risk index based on lower semi variance; Amount of risk that the project controls; Conditional value at risk; Downside risk measure, Mean-semivariance, Lower semi variance, skewness risk, mean variance; Expected risk of implementing project, Minimization of Average Project Risk; Investment risk tolerance; Risk control; Risk of Bankruptcy; Risk of each project in mathematical modelling; Risk of investment; Risk of possibly overtime for subcontractors; Risk preference of decision makers; Risks regarding cash; Technical, public acceptance, political acceptance, customer risk addressed by AHP; The risk endurable level of company (RELC); Underperformance Risk.
Strategy	Asset strategy; Optimal investment strategy; Reinvestment strategy; Scope management; Strategic alignment; Strategic balance; Strategic fit; Strategic framework; Strategic gains in mathematical modelling; Strategic level decision making; Strategic planning; Strategic response and goals; Strategic selection algorithm; Strategic weights of competencies in objective function; Strategy Development (determination of strategic focus, using techniques such as strategic Mapping, and setting resource constraints); Strategy for differentiating products and services; Strategy-oriented process model; The strategic benefits accrued from the increments of the efficiency values in objective function.
Environment	Agro By-Products project portfolio selection; Considering Clean Development Mechanism (CDM) in PPS; Environment friendliness; Environmental analysis; Environmental aspects in product development; Environmental impacts such as carbon emission reduction and water pollution reduction; Environmental protection; Environmental requirements in Infrastructure Sector.
Social	A DSS for social PPS; Analyzing human resources; Ant-Colony Outranking System for social PPS; Argumentation theory in public PPS; Employee competencies and Staff assignment; Maximizing the overall social efficiency of the market; Public project portfolio selection with highest social returns; Social analysis; Social analysis

Criteria	Sub-criteria
	such as the provision of employment, health and safety, public acceptance; Social Effect (Direct social effect of a portfolio of the project in a long-term period); Social impacts; Social objectives like maximizing social benefits and customer satisfaction; Social, welfare and health; Staff issue and social changes in Infrastructure Sector.
Sustainability	Model of sustainable PPS in production environment; Sustainability considered in VIKOR method; Sustainability-oriented financial resource allocation; Sustainable development project selection; Sustainable project portfolio selection; Sustainable strategic decision making in an electricity company; Sustainable strategic framework for PPS.
Stakeholder	Internal stakeholder; External stakeholder.
Others	Balancing the portfolio; Budget Allocation, Budget Slack; Dynamic Allocation of Resources; Interdependency, Synergies; Monetary and nonmonetary criteria; Opportunity, Technology; Organizational readiness, Non-financial benefits; payback period, flexibility; Synergy; Technical interdependency, resource interdependency, project completion time; Technological; Value creation, Resource-availability, Flexibility provided by the alternatives in case of future changes (real options).

On the other hand, some authors consider evaluating proposals from five perspectives: reasonableness, attractiveness, responsiveness, competitiveness, and innovativeness. Several criteria represent each one of the perspectives [6, 39]. The reasonableness reflects that the management first considers if the project is feasible, then considers whether or not it can be finished effectively. The ability to generate new ideas indicates a company's reasonableness. The main criteria evaluated from this point of view are tools, skills, facts, methods, and subcontracting.

The feasibility and desirability of a project are factors in an attractiveness evaluation. The project's success is measured by how much it boosts the efficiency of the business. An appealing project has strong management backing and fits the company's overall strategy well. Considering that a project seems viable, it is crucial to consider whether ethical, moral, environmental, or legal considerations might make it more or less desirable. One way in which a business can improve its reputation is by undertaking ethical projects, whereas the opposite is true if unethical behavior is tolerated. From this point of view, the main criteria evaluated are a strategic fit, influencing actors, and the track record of the submitter.

Responsive projects concerning ethical considerations can strengthen the firm's image just as unethical actions can be seriously detrimental. From this point of view, the main criteria evaluated are ethics, morality, ecology, and regulatory constraints.

Decision-makers consider how a project affects the company's competitiveness. How does the initiative boost the firm's efficiency and effectiveness? Reasonable, attractive, responsive, and competitive projects are rated on how well they encourage innovation. The main criteria evaluated from this point of view are capability and competency.

Finally, realistic, appealing, responsive, and competitive proposals are evaluated based on their ability to increase the company's resourcefulness. From this point of view, the main criteria considered are technological components, novelty, research lifecycle phase, and source of the project idea, which comprises its innovativeness.

Main ranking criteria. Describing and understanding the primary ranking criteria in project portfolio management is essential as it provides a foundation for effective decision-making and resource allocation. A precise knowledge of these criteria enables organizations to align projects with strategic goals, prioritize initiatives based on their potential impact, and optimize resource allocation for maximum value generation. Furthermore, organizations can enhance their project selection processes by identifying and comprehending the primary ranking criteria, facilitating several benefits throughout the portfolio management lifecycle.

The simple criteria approach is used when it is necessary to keep things simple (concentrating on the essential aspects and ignoring the small details). The multicriteria technique should be considered when dealing with a more complicated and real-world problem. Making decisions based on many criteria is called multicriteria decision-making, which is especially true when soft data are incorporated into the prioritization process [34, 42, 43].

Ranking projects is a complex undertaking task involving various variables and decision-makers [2, 7, 23, 30], and it is used in project portfolio management to choose the best projects. Financial and non-financial ratings are commonly used to categorize projects in a portfolio. Defining and quantifying a company's strategic goal is challenging when employing a project portfolio approach. After selecting and prioritizing projects, an excellent project portfolio management system would carefully manage several projects from a single resource pool. Even though today's decision-making environment is more complex than ever due to the challenges of the global marketplace, having a standardized method for assessing the quality of potential projects and ranking them can be of considerable assistance in keeping track of everything [6].

- Financial. Among the earliest criteria to be explored in Project Portfolio Selection issues was the financial one [3]. Many academic investigations have laid the groundwork for using the theory of finance principles to develop a financial component model for project examination and selection [32]. There are several ways to break down the financial ranking criteria, all of which relate to economic return [43]. Some examples of the evaluation metrics used in the financial sector are Net Present Value (NPV), Profitability Index (PI), Return on Investment, and Liquidity Risk [3, 27].

a. Net Present Value (NPV). The Net Present Value (NPV) is one of the most essential financial criteria for Project Portfolio Ranking [3], shows a company's profitability concept, and helps assess if a project is viable [3,43]. It is a single-criterion ranking algorithm because all information is in one variable. A set of projects with the highest summarised PI and CAPEX budget should be undertaken [43]. It is used to analyze a project's feasibility when all initiatives with a positive net present value are completed [3, 27, 43]. Not all projects with a positive NPV will be

implemented if there are limits (e.g., shortage of funds or resources) [43]. In a perfect world where anticipated NPV incorporates all project data, project ranking is based on the ratio of ENPV and Capital Expenditure (CAPEX), known as the Profitability Index (PI) [43]. One of the tendencies of NPV is to examine it alongside financial risk [27]. On the other hand, one of the downsides of using NPV is that uncertainty significantly affects this index. Considering that the beginning project phases are uncertain, the results lose their dependability [27]. Expected Net Present Value (ENPV) as a criterion for the project ranking eliminates the financially weakest projects from the portfolio [43].

b. Profitability Index. The profitability index is a basic grading system that considers the expected return on investment for each unit of capital spent [11, 32, 43]. The most straightforward approach to ranking these projects is their predicted financial value per dollar invested, measured by the net present value (NPV) divided by their capital expenditures (CAPEX) [43]. The portfolio's most promising endeavors increase the ranking priority and most likely are selected for implementation, while those with the lowest financial profiles are shelved [11, 32, 46].

c. Liquidity Risk. Companies have options to reduce their exposure to liquidity risk, but it may be challenging to make up for a shortfall that was not anticipated. Consequently, initiatives with a higher LRI should be ranked lower on the priority list [43].

When only so many resources are available, firms must determine which projects should take precedence over others. When estimating a project's value, industry professionals strongly emphasize the measurable components that can be purchased with money [43]. Conversely, the ranking hierarchy might be adjusted based on some organizations' "soft" information, such as the company's liquidity, strategic goals, learning capacity, and organizational development [43].

- Strategic criteria. Project portfolio management must be aligned with the organization's objectives and strategies [3, 43] without exceeding available resources or violating any other constraints to select or prioritize the ideal project portfolio for the organization [1, 3]. It consists of evaluating the projects based on the organization's strategy using strategic management theories. Projects that are more closely aligned with the organization's strategy are prioritized over those that do not have a strong relationship with the organization's strategy [10, 17, 21, 33]. The portfolio management process should be expanded to include strategic issues [19, 26, 29]. The effectiveness of a company's project portfolio can be enhanced if the portfolio selection process is aligned with its strategic goals; therefore, these criteria must be integrated into the portfolio ranking process [23, 27, 43]. This component has always been included from the earliest to the most recent studies [27]. Before deciding which projects to take into account in a portfolio, each organization must choose the one that best suits its long-term goals [8, 9, 22] and organizational culture [9, 22, 28].

In the body of research on project portfolio management, appraisal, prioritization, and selection of initiatives that are grounded in strategy are all commended. When assigning resources to different enterprises, its core concepts require that businesses use a strategic approach [25].

- Stakeholder criteria. A project stakeholder is a person, group, or organization that can be affected by a project's decision, activity, or outcome [24, 38, 43]. Describing and understanding the stakeholders in project portfolio management is crucial as it allows for effective identification, analysis, and engagement of individuals or groups with an interest or influence over portfolio outcomes. This knowledge enables organizations to assess stakeholder expectations, manage relationships, make informed decisions that align with their interests, and trigger stakeholder satisfaction and support. The inclusion of stakeholder management as the latest domain in the Project Management Body of Knowledge (PMBOK) highlights its growing significance in modern project portfolio management practices [5].

The success or failure of a project depends on how well it fits in with society, communities, and established political regimes and rules [43]. Successful portfolio management requires understanding and managing stakeholder behavior since stakeholders directly affect the success of a project portfolio [5]. Due to its importance in project success, decision-makers must consider stakeholders' interests [5,43]. Since 2013, the Guide to the Project Management Body of Knowledge has featured prominently in the PMI's efforts to prioritize stakeholders [35, 36, 43]. The project could run into serious problems with implementation, or even premature project termination can arise if stakeholders' interests are disregarded, ignored, or given less weight than they deserve. Due to stakeholders' critical role in portfolio management, many organizations have set up centralized divisions called project portfolio management offices to oversee the portfolio and balance stakeholder interests, requirements, and business goals [43]. The projects with more significant stakeholder approval should be placed higher than those with noncompliance or opposition [5,43]. The project's stakeholders are classified into external and internal [43].

a. Internal stakeholders. Internal stakeholders are the participants in a project who have a significant stake in its outcome. The second internal group is the employees responsible for the execution of the project. The organization will likely guarantee the quality of the project if the staff shows enthusiasm for the tasks. Projects with more support from internal stakeholders (IS) should be prioritized over those with less support [43].

b. External Stakeholders. Political system and community expectations may be necessary to be taken into account. A project will perform better if the company's health, safety, environmental, and corporate social responsibility policies are aligned with local laws. Building a partnership with a recognized company can improve a business's reputation. On the other hand, when someone leaves, the company's reliability may be questioned, and the if it harms outside stakeholders, the partnership's benefits may be lost. Considering these factors, projects less affected by external stakeholders must be placed higher than neutral projects [43].

- Learning criteria. Determining the learning criteria group is recommended to ensure that the organization obtains the benefits of increasing learning throughout the project [43]. The ability of a company to learn from its past mistakes is a critical factor in how successful it will be in the long run [43]. In Gutjahr et al. [15], experts created elaborate models concentrating on one aspect of human resource management to assist

workers with tasks better. In addition, [19] highlighted the value of education and expertise, highlighting the necessity for project and portfolio management training, applying strategic management theories, building a substantial knowledge background, and gaining experience. Even though estimating how much knowledge may be achieved through a PPM process is complex, there will be long-term advantages [15, 18].

- Risk criteria. A risk is an uncertain event or circumstance that, if it occurs, significantly affects one or more of a project portfolio's goals [3]. The portfolios are classified as structural, component, or overall risks [27,38]. Expert opinion, technical data, and learned experience from past projects are all excellent sources of information for risk assessment [35,36]. A portfolio should be "balanced" so that an organization's future is not jeopardized by excessive time spent on high-risk projects [27, 35, 36]. In a project portfolio, the most common risks include balancing projects in terms of resources (human, financial, and infrastructure) and change requests that propagate to other dependent projects or interdependent ones [35,36]. The total project risk can then be estimated using a model considering the hazards associated with every project phase [27]. Finding the optimal project portfolio includes thinking about how to mitigate potential dangers. It is also common for risk as a criterion to be understood and comprehensibly as part of the financial criterion.

- Time criteria. Portfolio selection must consider project interactions involving direct dependency or resource rivalry. Many portfolio selection strategies do not account for the time-dependent resource needs of projects, and the majority implicitly assume that all picked initiatives will begin immediately. In the project management reality, projects that compete for limited resources should be scheduled to use resources as efficiently as possible and must be completed within a predetermined time frame. A portfolio selection should consider the time-dependent nature of project resource use [2].

Applications in the industry. PPM manages investments according to the project's scope, timeline, and budget to guarantee that the project will be finished on time. The portfolio examines and evaluates potential initiatives and readily available resources. Since it was first developed, PPM has seen widespread application in a variety of industries, including construction, information technology (IT), research and development (R&D), oil exploration (E&P), and construction (**Table 7**).

Table 7.

PPM applications in the industry

Industry	References
Agriculture	Borjy et al., 2019.
Automotive	Castro and Carvalho, 2010.
Construction	Pionório & Sebestyén, 2022; Castro and Carvalho, 2010; Masoumi and Touran, 2016; Sebestyen and Toth, 2015; Vinayagam et al., 2021.
Energy system	Aldea et al., 2019; Mussoi and Teive, 2021; Wu et al., 2012.
Information Technology	Rahmani et al., 2012.
Medicine	Derenska, 2019.
Oil exploration	Castro and Carvalho, 2010; Szilágyi et al., 2020; Walls, 2004.
Pharmacist	Castro and Carvalho, 2010.

Industry	References
R&D	Bitman and Sharif, 2008; Bohanec et al., 1995; Carlsson et al., 2007.
Transportation	Csendes and Fülöp, 2018.
University management	Andrade and Oliveira, 2018; Oliveira et al., 2017.

Conclusions and prospects for further research. Managing a portfolio of projects relies on identifying which initiatives are most critical to achieving the organization's goals (the primary projects that will receive the most significant portion of the company's resources and commitment). Even though project portfolio management is nothing new, the topic has recently become popular in industries outside the R&D field, mainly because managing a portfolio of projects is essential when working on many projects simultaneously.

The management of a project portfolio depends on prioritizing projects to establish the most essential for accomplishing the organization's objectives (the main projects that are to be finished by devoting the majority of the company's resources to them). Project portfolio management relies on a project's ranking to identify the projects with the greatest impact on the organization's goals (the significant projects to be completed through concentrating business resources). If many enterprises within an organization compete for the same set of resources (time and money), using a ranking system can be a valuable tool for prioritizing them.

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