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Uncertainty in the Planning Phase of Public Projects—Its Scope, Consequences, and Possible Remedies

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Abstract: The aim of the study was to assess the uncertainty scope and types present in public projects, with uncertainty defined as a lack of knowledge, and to formulate recommendations for improving the success rate of public projects. Apart from a literature review, a questionnaire was administered among 60 Italian and 40 Polish public-project managers. Questions about the level of knowledge of various project aspects (e.g., project stakeholders or project environment) in the project-planning phase were asked. It was found that, in their own opinion, knowledge of essential aspects of public projects in the planning stage was fairly low among public-project managers. On top of that, the results showed in which areas, and in which of the two countries, the uncertainty was mostly present. This type of research has not been identified in the literature. In both countries, an especially high uncertainty level characterized project stakeholders. The survey's conclusions are juxtaposed with results from the literature: the negative influence of lack of knowledge (i.e., uncertainty) on project success, specific features of public projects and public-project managers, and the fact that certain negative phenomena influencing project success are significantly more present in the public than in the private sector. Our results indicate which aspects of public projects in both countries should be subject to deep changes—as far as information collecting and processing, in the project-defining and planning phase, is concerned. All this leads to recommendations of measures to be introduced in the public sector with respect to public-project management, e.g., the establishment of project management offices, project knowledge sharing, project management training—all focused on the identified uncertainty types in public projects, such as management of project stakeholders. The main limitations of the study were the relatively small sample sizes, a non-random sample selection, a bias due to misinterpretation of the questions, and cultural differences.

Keywords: public project; uncertainty in projects; public-project planning; public-project manager

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1. Introduction

In public administration (PA), in all sectors (health, procurement, education/training, research, etc.), and in all countries, there is a strong push for technological and organizational innovations aimed at, for example:

- Improving the quality of services to users;
- Offering new services to users;
- Simplifying administrative procedures;
- Computerizing and digitalizing administrative processes;
- Rationalizing organization charts and optimizing work processes;
- Updating staff skills;
- Implementing sustainable development policies;
- Digitalizing services.

This tendency, that requires the implementation of numerous expensive and complex projects, has not been accompanied by a significant investment in project-management training in public bodies. A recent survey performed in May 2022 in Poland among 183 public-project managers from public administration showed that fewer than 13% of the managers held a project-management certificate (PMI 2022). The lack of proper training in the public research sector was also proven by Kuchta et al. (2022).

According to Atkinson et al. (2006), lack of knowledge and experience in planning and control processes and methods is a significant source of uncertainty in all projects, thus also in public projects. Furthermore, in the scientific literature we can find several indications that risk may not be managed sufficiently in public projects (Bock and Trück 2011; Kapuscinska and Matejun 2014; Keban 2017; Levy 2010), and uncertainty management is not even mentioned with respect to public projects. It also clearly stresses an urgent need for such practices in the public sector. It is difficult, however, to introduce management methods for a phenomenon that has not been investigated and, to the best of our knowledge, hardly any literature items mention risk or uncertainty types or features in public projects, let alone their degree evaluation.

In light of the above, the research presented below aimed to assess the level of uncertainty (in the sense of incomplete knowledge) in different domains relating to the planning phase of public projects on a sample of public-sector project managers in Italy and Poland (See Appendix A), in the context of the necessity to introduce tailor-made uncertainty-management methods into the PA. The specific objective was to find out how public-project managers evaluate their level of knowledge, in the planning phase of the projects they have led, with respect to project cost, duration, influence on the environment, human resources needed, legal constraints, project stakeholders, and influence on the local community. Further, we aimed to draw from this information recommendations concerning project management in public administration, focused on the areas where the knowledge is judged as most missing. Despite the topic's relevance, to our knowledge, this is the first study that pursues a specific investigation related to these issues.

Based on the above as well as the findings of the literature review presented in Section 2, the hypothesis underlying our research was that due to possibly low experience in project management and inadequate PM knowledge, project managers in the PA may underestimate the potential criticalities and uncertainties of the project, above all in the initial stages of the project life-cycle. If the uncertainty existing in the initial stages of public projects is not adequately identified and analyzed, it is very likely to manifest itself in the execution phase in a drastic way. The lack of adequate PM training combined with the lack of project-uncertainty management can lead to negative outcomes related to creating public value, satisfying community needs, and wasting public resources (Kuchta et al. 2022).

Our specific hypothesis was that public projects are characterized by a high degree of uncertainty in their initial phases. In view of the importance of the uncertainty degree in the initial phases of projects for their final outcome, we believe it is essential to verify its scope, as well its distribution among various project areas.

The structure of the paper is as follows: in Section 2, we characterize public projects, public-project management, and managers, and we present uncertainty in projects generally as an essential project failure factor. We also discuss our aims and hypotheses, justify the choice of the two countries and describe the research method. In Section 3, we present the quantitative results. Sections 4 and 5 contain a discussion of the results, their practical implications for the public sector, limitations of the study, and further research perspectives.

2. Literature Review

In this section we present the results of the literature review that constituted the research background of our paper, as well as the identified literature gap and the aim of the research. The research background was based on four themes, which in our view are related to the issue of uncertainty in public projects:

- Main features of public projects;

- Public-project management;
- Uncertainty and risk management in public projects;
- Optimism bias in public-project management.

2.1. Main Features of Public Projects

Public projects are defined as projects that are undertaken, managed, or supervised by one or more publicly founded organizations (Kassel 2017), called in the following "public organization" or "public agency". Additionally, public projects are projects with products used by the public and where profitability is not the main goal (Gasik 2016, 2018). There are several types of public organization. Examples include agencies that provide services to the public on a self-supporting basis (e.g., municipal utilities that supply water or electricity), organizations financed partially by the state (e.g., universities), government and self-government agencies, and agencies that supervise other public agencies (Wirick 2009). However, all of these organizations operate to serve the public, whereas private companies provide their products to their business clients. In this paper, we concentrate on a subset of public projects: the public-sector projects, for which a government institution bears the full responsibility of implementation.

Literature (Gasik 2018; Jałocha 2018; Rainey and Chun 2009; Volden 2018) indicates numerous differences between projects and project managers in the public and private sectors. Public projects have the following features:

- They are often started not only on the basis of real needs, but out of the calls for projects that are proposed by funding agencies. The quantity of funds spent on public projects depends on the availability of public funds, whereas in the private sector, this type of decision results from business analyses.
- Their success cannot be measured by simple measures, such as ROI, profit, or the iron-triangle measures (time, cost, scope). More complex and softer, socially determined measures are required. Public-project goals and performance have to be placed not only in the context of a particular public agency and the stakeholders of the specific projects, but in the overall national perspective. "In order to be truly successful, public projects must not only perform well operationally, but also tactically and strategically" (Volden 2018).
- They are evaluated less strictly than projects in the private sector with respect to the justification of their goals and cost, but are subject to formal rules regarding the eligibility of expenditures, possibilities of cost overruns or underruns, or delays in payments. This problem is discussed in the literature (Abeysekara et al. 2021; Callegari et al. 2018; Catalão et al. 2019; Flyvbjerg et al. 2018; Locatelli et al. 2017; Love and Ika 2021; Love et al. 2012; Odeck and Kjerkreit 2019; Tokede et al. 2018; Volden 2019). All cited research mentions the omnipresent "creative accounting" that concentrates on making financial reports fulfill the rules rather than revealing the project information. There exists a phenomenon that is much more present in the public domain than in the private, called "strategic misinterpretation" (Flyvbjerg 2008), which means that project costs are often underestimated and project benefits overestimated.
- The number of public-project stakeholders is usually greater than the number of private projects stakeholders (Dotti 2018), and the most important stakeholder, e.g., a specific group within the public, is often highly heterogenous and more difficult to communicate with than private companies' customers. Stakeholder involvement is essential for the success of public projects. As Godenhjelm and Johanson (2016) point out, in public projects, the participation and selection of stakeholders require activity by the project organization. The selection of communication channels to inform stakeholders about the project and how it will proceed is central. The same authors also state that stakeholder involvement in public projects is important to ensure institutional embeddedness, build trust, and establish a common ground between stakeholders and project organization.

- Public projects' goals are often considerably more fuzzy and unspecific than the goals of projects in the private sector. They are often deduced from generally formulated programs' (defined as groups of projects managed together) objectives (e.g., "increasing public security", "increasing environmental protection"), and their specification frequently leads to contradictory criteria, rejected by some and accepted by other representatives of the public.

There are various peculiarities of public-sector project managers as compared to commercial project managers (Gasik 2018; Jałocha 2018; Rainey and Chun 2009; Volden 2018):

- They are motivated to undertake measures aimed at cost reduction or efficiency increase in a significantly weaker way than managers in the private sector.
- They are subject to complicated and rigorous formal and legal state restrictions. Consequently, they have less autonomy in their decision-making than project managers in the private sector.
- They are subject to political pressure, lobbying, and influence of various informal groups to a much higher degree than managers in the private sector. Public-project managers have to take into account the interests of politicians of different political affiliations (Devi and Ananthanarayanan 2017), which is rarely necessary in the private sector.
- They face more expectations (regarding their decisions and actions) from the environment with respect to justice, sensitivity, honesty, and social responsibility than managers in the private sector. The media are more focused on spotting any actual or alleged irregularity in the public sector than in the private sector.
- They have less power over their employees than their counterparts in the private sector because of various systems of employment guarantees existing in the public sector.
- They have to spend a much bigger portion of their working time on activities which they perceive, and not without reason, to be useless or at least not to not add any value (formal reporting, meetings, etc.).
- They have to cooperate to a higher degree than project managers in the private sector with persons with limited expertise in project management, especially within their own organization (humane resource department, accounting department, procurement department, etc.).
- They are expected to assume dual, often conflicting roles—those of a public servant and those of a project manager (Darrell and Baccarini 2010).

2.2. Public-Project Management

Concerning project management, researchers mostly agree that, although there exist generally accepted approaches to project management, public-sector projects must be managed differently than most private projects (Jałocha 2018; Wirick 2009).

According to an international survey reported in (Gasik 2018), public-project management is sometimes considered to be significantly more complex than private-project management—and this in all management areas. Additionally, we have to remember that megaprojects are often public projects, and they are extremely complex and difficult to manage (Ajam 2020). However, if we examine public-project reports (e.g., Public Disclosure of Project Reports 2020) or (Annual Report on Major Projects, Reporting to Cabinet Office and HM Treasury, UK) or interview public servants (Jałocha 2018), we may get a very positive view of public-project outcomes: "Public projects have a huge positive impact on people and the world, and practically all the projects are successful." Most objective research results on public-projects outcomes, however, perturb this image, showing huge budgets and delay overruns in public projects (Adam et al. 2017; Arditi et al. 1985; Flyvbjerg et al. 2002; Idrees and Shafiq 2021; Miranda Sarmento and Renneboog 2017). This is also true in the case of countries where public-project management and evaluation is considered to be relatively mature, more mature than in the two countries considered in this paper (Jacob et al. 2015). We have thus a contradiction: many public servants, when interviewed,

do not see any problems in their projects, but research results and media reports prove a high failure rate in public projects. This more negative perspective is consistent with the fact that project success rate in the business sector remains below 50% (Chaos Report 2015) and public projects are often even more challenging to implement. The optimistic opinions quoted above must be isolated cases or, more probably, be caused by other issues (e.g., the tendency to "creative accounting", political influences, or reluctance to admit failures).

2.3. Uncertainty and Risk Management in Public Projects

Project understanding can be described by seven Ws (Chapman and Ward 2011): (1) who (who are the parties involved?), (2) why (what do the parties want to achieve?), (3) what (what is the deliverable product that the parties are interested in?), (4) which way (how will all relevant plans in each lifecycle stage deliver what is needed?), (5) wherewithal (what key resources are required to achieve execution of these plans?), and (6) when and where (what tasks will be performed, and in which locations).

Lack of knowledge in the seven W areas can be defined as uncertainty. It has a decisive impact on project failure. Mitigating its impact requires mastering advanced knowledge, uncertainty-management methods, and several years of project-management experience, which is extremely rare in the public sector. In the face of the complexity of public projects and the peculiar nature of their environment, as well as the above-mentioned frequent "fuzziness" of project objectives and a complex set of (not always transparent) factors influencing project selection and definition, it would be difficult to expect a good knowledge of the seven Ws in the initialisation and planning stage of public projects. A survey on business projects shows that this knowledge is seen by business project managers to be at least medium (i.e., medium, high, very high, or complete) only in approximately 30% of cases (Kuchta et al. 2022). As mentioned earlier, we hypothesized that in the case of public projects, the situation is likely to be still worse, which may be an important factor in the failures reported in the literature that would require the attention of PA management. Our hypothesis was based on the features of public projects discussed above.

Lack of knowledge in project understanding generates uncertainty and risk. Risk and uncertainty are closely related notions and are sometimes even interchanged, and secondly, risk management is more widely used than uncertainty management. If project risk management is not properly applied in an organization, this is even more true for uncertainty management, and, according to the literature, risk is not managed properly in public projects (Bock and Trück 2011; Kapuscinska and Matejun 2014; Keban 2017; Levy 2010), let alone uncertainty. Only a few contributions to risk or uncertainty management in public projects have been identified. To start with, there exists a list of the main uncertainty factors in public investment projects: unclear work scope, project complexity, and incomplete design (Zaigham et al. 2020). In (Xiao and Zuo 2011), project and product complexity are indicated as uncertainty factors for public infrastructure projects. Advanced risk and uncertainty management techniques, such as simulation, are not used in the public sector (Bock and Trück 2011). The degree or magnitude of uncertainty in different areas of public projects is rarely analyzed in the literature: only one recent item has been identified (Demirel 2022), and that covers mainly the contractual issues. Thus, even if scientific literature strongly recommends the introduction of proper planning, risk, and uncertainty-management processes into public-project management, it is difficult to apply this piece of advice without knowing the occurrence degree of various risk and uncertainty types in public projects.

2.4. Optimism Bias in Public-Project Management

Optimism bias in the context of project management has been studied by a number of scholars (Prater et al. 2017). Based upon the state of knowledge presented by the literature, we can conclude that the phenomenon is widespread in public institutions and, to some extent, accepted by the PA community. It refers to the expectations regarding specific outcomes and is defined as overestimating the likelihood of experiencing positive outcomes

or underestimating the likelihood of experiencing negative outcomes (Klein and Helweg-Larsen 2002). Optimistic bias has clear implications for project performance: several papers (Flyvbjerg 2008; MacDonald 2002; Morris and Hough 1987) show that the basis of poor project performance was often not a wrong project execution, but cost underestimation in the project-planning phase (Eizakshiri et al. 2015), and that one significant cause of the underestimation is the optimism bias (see Prater et al. 2017 for a review). It also can result in avoidance of pertinent information or denial of risk (e.g., Wiebe and Black 1997).

2.5. Literature Gap and Aim of the Research

Summarizing the above, we can say that literature on project management in the public sector highlights four main aspects regarding public-project managers and projects:

- A fairly frequent lack of knowledge and experience in project management among public-project managers;
- Underestimation of uncertainties and risks;
- Insufficient project-risk and uncertainty management;
- Chances of achieving project objectives estimated based on excessive optimism rather than adequate and in-depth estimates of time, costs, and other project parameters.

There exists, however, no research on types of risks and uncertainty in public projects and their distribution or intensity. Without this information, it would be difficult to propose tailored methods for project-risk and uncertainty management in public institutions that, in view of the above features of public projects, their managers, as well as public projects' failure frequency, are necessary to improve the performance of public projects (Kapuscinska and Matejun 2014). Hence, the aim of the research was to describe and assess the uncertainty scope and types present in public projects, using information from two surveys among public-project managers, performed in Italy and Poland.

3. The Present Study

3.1. Research Design

In this study we intended to find out how public-project managers, in two different EU countries, saw their "project understanding" in the initial project phases—did they feel that their knowledge about substantial project elements was fairly complete when they entered into projects or did they start projects without actually understanding them? In particular, we wanted to identify the perception of public-project managers of their knowledge (in initial project phases) about the seven Ws: project objectives, activities, resources, duration, stakeholders, etc. (see Figure 1).

The research was conducted in Italy and Poland. The two selected countries are both members of the European Union and share the mission of becoming more innovative and more competitive (Fino and Rosiek 2016). They have a similar innovation index and the same corruption index (measured as perceived corruption according to https://www.transparency.org/en/cpi/2021/index/usa (accessed on 29 May 2022). They also share similar infrastructure indices (roadways, railways, etc.), per 1000 inhabitants (https://www.worlddata.info/country-comparison.php?country1=ITA&country2=POL, accessed on 28 March 2023). Still, there obviously exist differences between the two countries. We hypothesized that these differences influence the uncertainty degree in the initial phases of public projects in both countries. The most important (in the context of the present study) differences between Italy and Poland are:

- Poland is characterized by a higher uncertainty avoidance than Italy, which is closely linked to the lower long-term orientation in the case of Poland (https://www.hofstede-insights.com/country-comparison/italy,poland/, accessed on 29 March 2023). A high uncertainty avoidance may signify that Polish public servants would be more inclined not to admit to their lack of knowledge about projects. The lower long-term orientation may mean that Polish public servants are less concerned about reliable project planning. Additionally, Poland has a higher power distance than Italy, which may mean lower participation of project team members in the project-planning process.

- Poland's GDP per capita 2021 was equal to half of that of Italy, and Poland's government expenditures per capita 2021 were less than half of those in Italy (https://countryeconomy.com/countries/compare/poland/italy, accessed on 30 March 2023), which means that Italy is a richer country and can finance more public high-risk or high-uncertainty projects.
- Italy, including the Italian public sector, has a longer tradition of managing projects than Poland, because Poland started departing from the command system towards a democratic state with an economy based on market mechanisms only in 1989. This may mean that Italian public servants are more used to projects in general and the inseparable uncertainty linked to them.

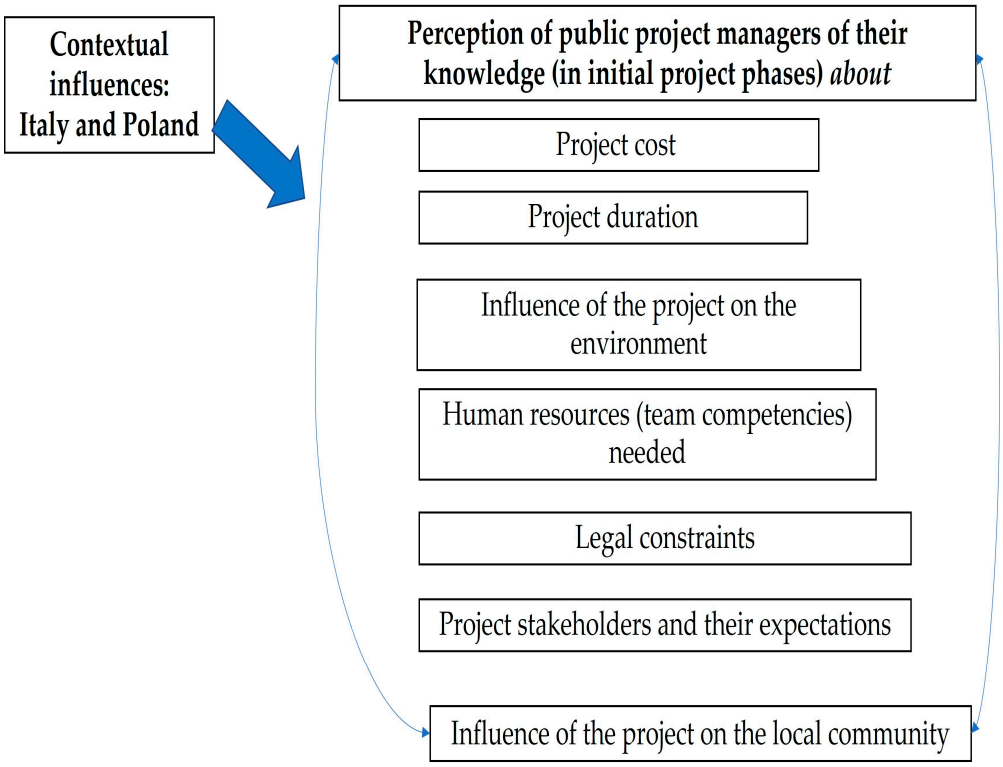

Figure 1. Research framework.

3.2. Participants

The participants were Italian and Polish public-project managers. Participants voluntarily completed a self-report questionnaire which took approximately 15 min. They were recruited through a convenience sampling strategy. Participation was anonymous; no incentive was given. All procedures followed were in accordance with the ethical standards and the Helsinki Declaration of 1975, as revised in 2000. In Poland, the database of the international company Bisnode was used, where organizations were classified by location and type of municipality (urban, rural, urban-rural). A total of 379 local administration units were addressed, out of which 60 responded. In Italy, the PMs were contacted by direct knowledge and then, by snowball sampling, they were asked to indicate at least one other colleague. Sixty participants were contacted, but only 36 agreed to fill in the questionnaire.

3.3. Measures and Procedures

The survey was carried out by administrating an online questionnaire in December 2020 in Poland and in the period from March to June 2021 in Italy. All participants were given the option to withdraw at any moment. They were asked to recollect a typical project they had managed and answer the survey questions in relation to it.

The questionnaire was designed in a very simple way, as its only aim was to determine the opinion of public-project managers about the degree of knowledge, with respect to the elements from Figure 1, that they had in the planning phase of their projects. Later on, this subjective opinion was to be compared with the features of the public-project managers, the public projects, and their environment, in order to formulate recommendations for public-project management.

The questionnaire was prepared to detect the level of uncertainty relating to the dimensions in Figure 1. These dimensions were derived from the seven Ws listed above and adapted to the public-sector context, where the law, environment, and local community context cannot be disregarded. Thus, in the questionnaire, one question about the level of knowledge for each element of Figure 1 was asked.

For each of the aspects from Figure 1, we asked the following question: "What was your degree of knowledge of the respective aspect in the planning stage of the project?" The questions were formulated in the following way: "The level of knowledge of the project team (prior to the start of the project) regarding (project duration, human resources needed, etc.), can be judged as . . . ". The response scale was a Likert scale from 1 (almost zero) to 7 (complete), as follows:

1 = almost zero;
2 = very low;
3 = low;
4 = medium;
5 = high;
6 = very high;
7 = complete.

The questionnaire was constructed specifically for the objectives of this work by university researchers experienced in organization, project management, and social-research methodology. Although a validation study of the scale was not carried out, the Chronbach's alpha was 0.92 for both groups of participants, indicating a good reliability of the measure.

The size, distribution, and other features of the Italian and Polish samples are shown below (Tables 1 and 2).

Table 1. Size and distribution of the samples (It (Italy), Pl (Poland)) among various public administration sectors.

PA Sectors	% It (Italy)	% Pl (Poland)
1. Education and research	42.3	
2. Public health	11.5	
3. Local administration	19.3	100.0
4. National organism	26.9	
Total	100	100.0
Sample	36	60

Table 2. Distribution of the samples (It (Italy), Pl (Poland)) concerning the department in which the project manager was employed.

Employment Area	% It (Italy)	% Pl (Poland)
1. Education and research	42.3	
2. Technical office and administration	16.7	100.0
3. Quality management	8.3	
4. Design/planning	16.7	
5. Other	16	
Total	100	100.0
Sample	36	60

We can see that both samples were slightly different: the Polish one was homogenous, while the Italian one was more diversified. This was caused by the different accessibility of respective public managers in both countries. However, in both cases, we dealt with public servants, operating in a similar environment (public institutions in an EU country) subject to similar constraints (determined by the features of public projects discussed in Section 2).

4. Results

In order to make the presentation as clear as possible, we do not present detailed results but assume that a threshold is defining uncertainty. We presume, thus, that a medium or smaller level of knowledge (4, 3, 2, or 1 in the assumed scale) means uncertainty. The choice is, in a way, arbitrary, but having in mind the above-presented features of public projects, such as the rigidity of budgets, we feel that a medium level of knowledge already practically means not knowing, and thus being uncertain about the respective aspect of the project.

The level of uncertainty was thus calculated as the ratio between the responses relating to values 1, 2, 3, and 4 of the scale and the total of the responses. The value of the uncertainty level was reported below for both samples, for each investigated aspect.

In the Italian sample, the highest uncertainty (almost 55% of projects) was linked to project stakeholders and their expectations. This suggests a low ratio of public-project success because project stakeholder satisfaction is nowadays considered one of the most important project success criteria for projects generally and, as discussed above, in the case of public institutions, it is primordial: public institutions implement their projects not for profit, but to satisfy the public generally, and various stakeholders in the society. If their expectations are not known, it is difficult to satisfy them, especially when one operates in a public institution context, with rigid project budgets, deadlines, and procedures. Uncertainties close to 50% also occur for cost, which explains the number of public-project budget overruns we observe in everyday life; and for impact on the environment. Public institutions have a mission to take care of the environment, so it is also a bad piece of news: it seems that they are not capable of assessing the impact of their projects on the environment, and, consequently, of planning adequate planet-friendly measures. All the uncertainties in Table 3 referring to Italy exceed 30%.

Table 3. Uncertainty levels in both samples (It (Italy), Pl (Poland)) (percentage of cases with knowledge less than or equal to medium).

Sources of Uncertainty	% It (Italy)	% Pl (Poland)
Project duration	32.4	22.0
Human resources needed	35.2	10.0
Material resources needed	41.2	13.0
Project cost	50.0	20.0
Project stakeholders and their expectations	54.6	17.0
Legal constraints	29.4	15.0
Impact on the environment	48.5	18.0
Impact on the local community	35.5	10.0

Differences were observed between the Italian and Polish results; this will be referred to in the Discussion section. Here, let us analyze the hierarchy within the 3rd column of Table 3 and compare it to the 2nd column. In the Polish sample, a high uncertainty was linked to project cost, project stakeholders, and impact on the environment. The most elevated uncertainty characterized, however, project duration, which was not the case in the Italian sample. In view of the rigid rules in the public sector, the high uncertainty with respect to time is not good news, either. For Poland, the uncertainties were in the range of 10–22%, whereas the respective range for Italy was 32.4–54.6%.

5. Discussion

At the beginning of a project, certainty or knowledge about its features and parameters (the seven Ws mentioned above) is a decisive factor in the success of the project. Of course, it has to be decided where the uncertainty starts. We assumed that the situation in which an aspect of the project is known to the medium, low, very low, or practically zero level means uncertainty in the sense of the lack of full knowledge. We can affirm that in both countries, the public-project managers questioned identified a non-negligible percentage of projects with uncertainty defined in this way.

5.1. The Percentage of Projects with Uncertainty in Italy and Poland

The percentage of projects with uncertainty was high in both Italy and Poland. Analyzing the absolute values, however, we can see that the scores seem higher for Italian participants, especially in some areas. The difference between the two countries may—but it is only as a hypothesis still needing to be verified—be due to the long experience Italy has with public projects, as well as the higher uncertainty avoidance and lower long-term orientation in Poland than in Italy: Polish public servants may be less willing to analyze and admit long-term uncertainty. In Poland, this tendency may have been intensified by a higher power distance, that does not encourage free discussions about unknowns in projects in their planning phase. Another hypothetical explanation might be that Italy is a richer country and can take the risk of implementing more projects, and riskier ones, than Poland.

In any case, we can state that in both countries we are dealing with a high uncertainty in the planning stage of public projects.

5.2. The Reasons for Uncertainty

One of the reasons for this result is probably the status of project managers who lack the necessary competencies. Literature provides proof that such a situation occurs, at least in some public institutions. In many cases, public PMs have not gained sufficient knowledge and experience in project management, hardly use even the basic project-management methods, and might not be even aware of the necessity of properly managing knowledge and information in order to collect the most reliable data for the planning stage (this includes experts' inquiries, lessons learned, databases from terminated projects, and advanced methods such as simulation (Hulett 2011)). They may not be aware of the importance of having access to reliable data in the project-planning stage. Consequently, the uncertainty in the planning stage of public projects in both countries may not even upset them, and yet, in view of the projectification scope in the public sector, its consequences, although hidden, may be enormous. Public projects are undertaken with vast, but fixed, budgets, in a situation where their seven Ws are, to a large extent, unknown. No wonder the "fixed" budgets are often stretched tens of times, and the societies have to pay for it. This results in huge amounts of public money being spent in an inefficient way.

5.3. The Limited Knowledge of Stakeholders and Its Influence on Uncertainty

In both samples, at the top of the uncertainty degree ranking, we have project stakeholders and their expectations. This means that public-project managers in both countries realize that in the planning stage of their projects, they often do not really know what the stakeholders expect. Public projects are implemented for the stakeholders, not for the organization owner and his/her financial profits. This conclusion is thus a serious warning about a possibly low project success probability of public projects.

5.4. The Relationship between Poor Knowledge of Stakeholder Expectations and Optimism

The lack of knowledge of stakeholder expectations may be one of the causes of the optimism bias. As shown in Figure 2, through the analysis of stakeholder expectations (in particular of the end-users of the project outputs, the project manager identifies which deliverables are to be realized and delivered to the end-users, and which quality require-

ments the deliverables must fulfill in order to guarantee full satisfaction of the end-users. The more adequately the project manager has analyzed the stakeholders' needs, the more he/she will be able to thoroughly analyze the activities necessary for the realization of the deliverables and provide an adequate and realistic estimate of the project duration and costs. On the contrary, an inadequate and superficial analysis of stakeholders' expectations may lead to an underestimation of the activities to be realized (see Figure 2). This, in turn, may lead to an optimistic view of the effort required to realize the project deliverables, and thus unrealistic time and cost estimations.

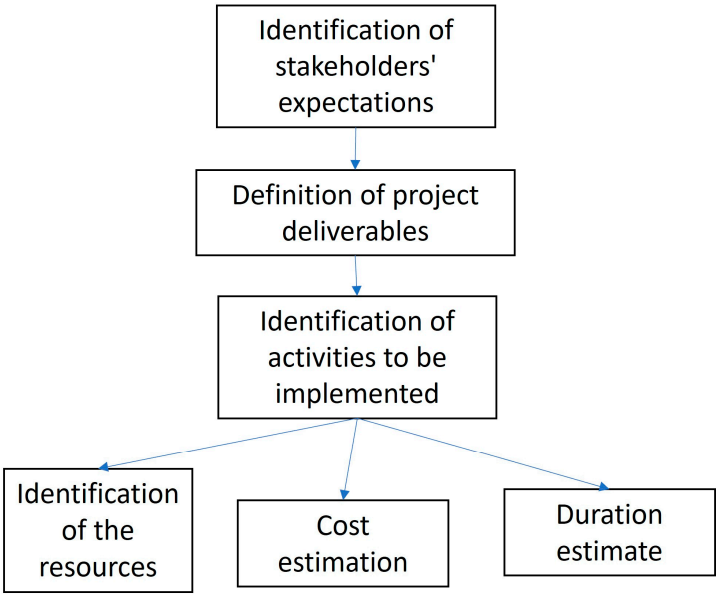

Figure 2. From stakeholders' expectations to time, cost, and resource estimation.

5.5. The Effect of the Lack of Knowledge Combined with Optimism Bias

The effect of the lack of knowledge combined with optimism bias may be strengthened by a condition called "illusory self-efficacy" (Bandura 2001). In project-management literature, self-efficacy was identified as a potential positive influence on performance (Dainty et al. 2003), knowledge-sharing (Lin and Huang 2010), or commitment to the project (Jani 2011). However, illusory beliefs of efficacy, not based on experience, lead people to underestimate obstacles and overestimate their own possibilities. This may cause the level of uncertainty in public projects, during their planning phase, to be even stronger than that reported in Table 3. If we additionally consider the scope of projectification—the fact that most public servants' activities are project-related—public projects may be wasting considerable amounts of public money due to uncertainty.

This is the bad news. However, there is also some good news: some of the features of public projects detailed earlier in this paper (a frequent lack of project-management competencies, the rare usage of project-management methodologies, less responsibility for the consequences of decisions and money than in the public sector, etc.), mean that there is large room for improvement.

Introducing business-based or public administration tailor-made project-related decision-making, and project-management processes, as well as methodologies, advanced methods of data and information processing, uncertainty management included, will certainly decrease the uncertainty and increase the project success chances in PA.

6. Conclusions and Implications: Recommendations for Improving the Success Rate of Public Projects

Although our research was based on a limited sample from two countries, we believe that its results, i.e., mainly the frequency of various types of uncertainty identified by the

Italian and Polish public-project managers juxtaposed with public projects and public-project-manager features, allow us to outline some important implications, which we submit to the reader's attention and, hopefully, further research.

6.1. The Role of the Project Manager in Public Administration

The first implication concerns the prevalent absence of formal recognition of the role of project manager in public administration and the repercussions this may have on project management. This circumstance determines a "hybrid" profile of the accidental project manager (APM) concerning the public project in which they operate. The occasional nature of the role and the absence of its formal recognition contribute to the ambiguity of the APM's role, which the literature identifies as one of the main elements of conflict and obstacles for those who, by choice or by chance, find themselves in this role (Akkermans et al. 2020). Often, the APM finds themselves operating as an 'isolated' professional in their organisation, without sufficient support or the possibility of interacting with other professional resources that might help them manage the numerous and inevitable problems that characterize project life. Public administration institutions should therefore take steps to ensure adequate support for these professionals. This leads us to another recommendation:

6.2. Project Management Offices in Public Institutions

Essential for an adequate support of public-project managers is the establishment of project management offices capable of fostering the dissemination of the culture of project management through the definition of methodological approaches that are both streamlined and essential but take into account the specificity of projects in public-administration organisations. A special emphasis should be put on knowledge-management: lessons learned, estimations and variances collected, etc. Another task of the project management offices should be to provide periodic training for both aspiring and current project managers. The work of project management offices should focus on the main uncertainty aspects identified in this study, which are: project cost, project stakeholders, the project's influence on the environment, project duration, and other elements from Figure 1. Our research provides the first indications of the weight of the lack of knowledge of individual project aspects from Figure 1 in both countries.

6.3. Optimism Bias Issue

Another implication concerns the presence of optimism bias. As we mentioned above, the optimism bias probably means that the uncertainty in the planning phase of public projects is even higher than that identified in our survey. Obviously, this fact negatively affects the reliability of planning and, consequently, the success of projects in public administration. Several approaches are proposed in the literature for reducing optimism bias. They include:

- De-biasing cost estimates with reference-class forecasting (Flyvbjerg et al. 2018; Servranckx et al. 2021);
- Introducing external quality assurance of cost-benefit analyses (Abeysekara 2020; Volden 2019);
- Using a decision support system for evaluating planning quality (Féris et al. 2017).

6.4. Other Recommendations

There are other solutions, whose implementation should be considered by public administration institutions because of their potential to reduce uncertainty or its impact in the public-project planning stage:

- Creation of databases, containing actual versus planned parameters for completed projects, categorized by project types. Such databases might have an inter-organizational or even international character in the future. For example, actual Italian and Polish (and those from other EU countries) data for rail infrastructure projects might be recorded in

the same database and used in the planning of future similar projects, adjusted by a factor expressing the cultural differences (which, as shown by our research, may considerably influence the perceived uncertainty). In theory, this should be possible because, in contrast to the business sector, we deal here with public data, that should be transparent and made accessible to other public institutions for such purposes.

- Development of methods of project planning, including expert panels (again, possibly interinstitutional or even international); the precondition that has to be fulfilled here is the recognition of the primordial importance of project planning based on reliable data.
- Recognition of the existence of uncertainty in public projects. Public servants should no longer be forced to deliver crisp numbers or single scenarios, even in cases where it is not possible. Stochastic or fuzzy modelling, scenario-based planning, decision trees, etc., should also be used to manage uncertainty (Hulett 2011; Skórski 2022).

In addition, appropriate project-management methodologies should be systematically and thoroughly implemented in the public sector. In view of the results of the survey, showing that uncertainty about project stakeholders' expectations and environmental requirements was placed high in the ranking both for Italy and Poland, we recommend the introduction of the (PRiSM Methodology 2009–2022) that integrates holistic project management with sustainable project management (Toljaga-Nikolić et al. 2020).

6.5. Further Research and Limitations of the Study

Certainly, the introduction of the proposed steps will be difficult due to the well-established culture of public institutions and the general resistance to change. There exists no systematic research on this issue. Still, the authors of this paper can confirm the problem severity through analysis of the established culture of organisations they know fairly well: public universities and generally public systems of research funding. Although constantly improving, project-management quality in these organisations is still far from that achieved in business, and it seems that introducing the above recommendations is the only way to spend public funds more efficiently. This will happen only if we know the public projects we implement or if we admit that we do not know them and act accordingly. The quantitative results we provide in our paper, showing in black and white (independently of the differences between the two samples) that uncertainty in public projects is high, and that this is true for crucial areas such as project stakeholder expectation and project environment requirements, are likely to prompt decision makers to accelerate the necessary changes in public-project management.

Finally, the results of this study suggest that uncertainty in the planning phase of public projects is a fertile ground for further research. It would be useful to investigate which factors in the planning stage of public projects significantly impact project success. These factors should be identified through the literature on public projects (mainly, case studies) and through interviews or surveys so that dimensions that have not been identified in the literature, but are important, can be considered. Furthermore, to our knowledge, the problem of interdependence between these variables has not yet been addressed. The results presented here can be used as a starting point to reflect on how PMs may underestimate potential criticalities and uncertainties in public-project management and to investigate the relationships between them and project success.

Project management usually focuses on the ability to deliver the project's product with an agreed scope, time, cost, and quality. However, there are other requirements for good project management, some concerning the ability to control the level of uncertainty in a project and some related to establishing and maintaining appropriate communication channels, and there is also the applicative aspect of the project. All these dimensions are related to each other. In public-project management it is essential to consider, in the initial phase, all the aspects of end-product design and all the skills required of the personnel involved. These factors will influence the cultural context and the relationship with the stakeholders, as well as the legal constraints. It goes without saying that the perception of

certainty/uncertainty with respect to these dimensions influences the conduct of the APM, and thus the success of the project.

Our research had numerous limitations. The size of the samples, the non-random sampling strategy, and the number of countries used are the main ones. In addition, the questions in the questionnaire were not very specific and may have been understood in various ways; more specific questionnaires are thus needed, including information about the respondents' background, experience, and qualifications. The questionnaire should be subject to validity analyses. The distribution of the sectors was also different in the two samples. The results have to be verified in light the results of more similar research steps for other samples. More research is also needed on the culture of public institutions in different countries (Capaldo et al. 2021), which may have influenced our survey's results (clearly different for Italy and Poland with respect to absolute numbers). Without the knowledge of different cultures, any attempt to assess and improve the quality of public-project planning, or, more generally, public-project management, is doomed to failure.

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Appendix A. The Items Used in the Study to Assess the Level of Uncertainty

At the start of the project . . . .

My knowledge regarding the duration of the various phases of the project was:

My knowledge regarding the costs of the various phases of the project was:

My knowledge regarding the number of professional resources required was:

My knowledge regarding the types of human resources needed, was:

My knowledge regarding the need for additional resources (materials, equipment, supplies), was:

My knowledge of any regulatory constraints for the project, was:

My knowledge related to stakeholders (all people, groups and organisations that may have a significant impact on the project or who are, or may be, interested in the outcome or performance of the project), was:

My knowledge related to the environmental impact of the project was:

My knowledge related to the impact of the project on the local community was:

My knowledge of the project's impact on future generations was:

Range of the items: 1 = almost zero, 2 = very low, 3 = low, 4 = medium, 5 = high, 6 = very high, 7 = complete.

References

Abeysekara, Baudhi. 2020. Application of Fuzzy Set Theory to Evaluate Large Scale Transport Infrastructure Risk Assessment and Application of Best Practices for Risk Management. Paper presented at IEEE International Conference on Industrial Engineering and Engineering Management (IEEM), Singapore, December 14–17; pp. 385–89.

Abeysekara, Baudhi, Piyaruwan Perera, Gyan Kumar Chhipi Shrestha, Lalithasiri Gunaruwan, Amal Kumarage, Rehan Sadiq, and Kasun Hewage. 2021. Improving the capital deployment efficiency: An infrastructure investment planning process in transportation project. *Research in Transportation Economics* 88: 101048. [CrossRef]

Adam, Abderisak, Per-Erik Bertil Josephson, and Göran Lindahl. 2017. 'Aggregation of factors causing cost overruns and time delays in large public construction projects', Engineering, construction, and architectural management. *Engineering, Construction and Architectural Management* 24: 393–406. [CrossRef]
Ajam, Mounir A. 2020. *Leading Megaprojects: A Tailored Approach*, 1st ed. New York: Auerbach Publications. [CrossRef]
Akkermans, Jos, Anne Keegan, Martina Huemann, and Claudia Ringhofer. 2020. Crafting project managers' careers: Integrating the fields of careers and project management. *Project Management Journal* 51: 135–53. [CrossRef]
Annual Report on Major Projects. 2020–2021. Reporting to Cabinet Office and HM Treasury, UK. Available online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1002310/IPA_AR2021_final_14Jul.pdf (accessed on 4 October 2022).
Arditi, David, Guzim Tarim Akan, and San Gurdamar. 1985. Cost overruns in public projects. *International Journal of Project Management* 3: 218–24. [CrossRef]
Atkinson, Roger, Lynn Crawford, and Stephen Ward. 2006. Fundamental uncertainties in projects and the scope of project management. *International Journal of Project Management* 24: 687–98. [CrossRef]
Bandura, Albert. 2001. Social cognitive theory: An agentic perspective. *Annual Review of Psychology* 52: 1–26. [CrossRef]
Bock, Katrin, and Stefan Trück. 2011. Assessing Uncertainty and Risk in Public Sector Investment Projects. *Technology and Investment* 2: 105–23. [CrossRef]
Callegari, Camila Ludovique, Alexandre Szklo, and Roberto Schaeffer. 2018. Cost overruns and delays in energy megaprojects: How big is big enough? *Energy Policy* 114: 211–20. [CrossRef]
Capaldo, G., V. Capone, J. Babiak, B. Bajcar, and D. Kuchta. 2021. Efficacy Beliefs, Empowering Leadership, and Project Success in Public Research Centers: An Italian–Polish Study. *International Journal of Environmental Research and Public Health* 18: 6763. [CrossRef]
Catalão, Francisco Pinheiro, Carlos Oliveira Cruz, and Joaquim Miranda Sarmento. 2019. Public management and cost overruns in public projects. *International Public Management Journal* 25: 677–703. [CrossRef]
Chaos Report. 2015. Available online: https://www.standishgroup.com/sample_research_files/CHAOSReport2015-Final.pdf (accessed on 4 October 2022).
Chapman, Chris, and Stephen Ward. 2011. *How to Manage Project Opportunity and Risk*. Hoboken: John Wiley and Sons Ltd.
Dainty, Andrew R. J., Mei-I Cheng, and David R. Moore. 2003. Redefining performance measures for construction project managers: An empirical evaluation. *Construction Management & Economics* 21: 209–18.
Darrell, Vanessa, and David Baccarini. 2010. Demystifying the Folklore of the Accidental Project Manager in the Public Sector. *Project Management Journal* 41: 56–63. [CrossRef]
Demirel, Hatice C. 2022. Dealing with Uncertainty in Infrastructure Public-Private Partnership Projects. Doctoral thesis, Delft University of Technology, Delft, The Netherlands. [CrossRef]
Devi, Cindrela A., and K. Ananthanarayanan. 2017. Factors influencing cost over-run in Indian construction projects. *Proceedings of MATEC Web of Conferences* 120: 02023. [CrossRef]
Dotti, Nicola Francesco. 2018. Knowledge that matters for the 'survival of unfittest': The case of the new Brussels' rail junction. *Transport Policy* 63: 131–40. [CrossRef]
Eizakshiri, Farhad, Paul W. Chan, and Margaret W. Emsley. 2015. Where is intentionality in studying project delays? *International Journal of Managing Projects in Business* 8: 349–67. [CrossRef]
Féris, Marco A. A., Ofer Zwikael, and Shirley Gregor. 2017. QPLAN: Decision support for evaluating planning quality in software development projects. *Decision Support Systems* 96: 92–102. [CrossRef]
Fino, Valerio, and Janusz Rosiek. 2016. R&D: Italy and Poland Compared. *Argumenta Oeconomica Cracoviensia* 15: 109–31.
Flyvbjerg, Bent. 2008. Public Planning of Mega-Projects: Overestimation of Demand and Underestimation of Costs. In *Decision-Making on Mega-Projects: Cost-Benefit Analysis, Planning and Innovation*. Cheltenham: Edward Elgar Publishing Ltd., pp. 120–44.
Flyvbjerg, Bent, Atif Ansar, Alexander Budzier, Søren Buhl, Chantal Cantarelli, Massimo Garbuio, Carsten Glenting, Dan Lovallo, Daniel Lunn, Eric J. E. Molin, and et al. 2018. Five things you should know about cost overrun. *Transportation Research Part A: Policy and Practice* 118: 174–90.
Flyvbjerg, Bent, Mette K. Skamris, and Soren Buhl. 2002. Underestimating Costs in Public Works Projects: Error or Lie? *Journal of the American Planning Association* 68: 279–95. [CrossRef]
Gasik, Stanislaw. 2016. Are Public Projects Different than Projects in other Sectors? Preliminary Results of Empirical Research. *Procedia Computer Science* 100: 399–406. [CrossRef]
Gasik, Stanislaw. 2018. A framework for analysing differences between public-sector and other-sector projects. *Zarządzanie Publiczne/Public Governance* 3: 73–88. [CrossRef]
Godenhjelm, Sebastian, and Jan-Erik Johanson. 2016. The effect of stakeholder inclusion on public sector project innovation. *International Review of Administrative Sciences* 84: 42–62. [CrossRef]
Hulett, David. 2011. *Integrated Cost-Schedule Risk Analysis*. Farnham: Gower Publishing Limited.
Idrees, Shehryar, and Muhammad T. Shafiq. 2021. Factors for Time and Cost Overrun in Public Projects. *Journal of Engineering, Project, and Production Management* 11: 243–54.
Jacob, Steve, Sandra Speer, and Jan-Eric Furubo. 2015. The institutionalization of evaluation matters: Updating the International Atlas of Evaluation 10 years later. *Evaluation* 21: 6–31. [CrossRef]

Jałocha, Beata. 2018. Are projects changing public servants into projectarians? Projectification's influence on employees in the Polish public sector. *International Journal of Contemporary Management* 17: 63–83. [CrossRef]
Jani, Arpan. 2011. Escalation of commitment in troubled IT projects: Influence of project risk factors and self-efficacy on the perception of risk and the commitment to a failing project. *International Journal of Project Management* 29: 934–45. [CrossRef]
Kapuscinska, Karolina, and Marek Matejun. 2014. Risk Management in Public Sector Organizations: A Case Study. *International Journal of Business and Management Studies* 3: 129–43.
Kassel, David S. 2017. *Managing Public Sector Projects: A Strategic Framework for Success in an Era of Downsized Government*. Oxford: Routledge. [CrossRef]
Keban, Yeremias T. 2017. Risk management: A neglected vital instrument in public administration in Indonesia. *Management Research and Practice* 4: 5–21.
Klein, Cinthya T. F., and Marie Helweg-Larsen. 2002. Perceived control and the optimistic bias: A meta-analytic review. *Psychology and Health* 17: 437–46. [CrossRef]
Kuchta, Dorota, Barbara Gładysz, and Agata Klaus-Rosińska. 2022. Symmetry in project management. *Symmetry: Culture and Science* 33: 69–94. [CrossRef]
Levy, Roger. 2010. New Public Management: End of an Era? *Public Policy and Administration* 25: 234–40. [CrossRef]
Lin, Tung-Chin, and Chien-Chih Huang. 2010. Withholding effort in knowledge contribution: The role of social exchange and social cognitive on project teams. *Information & Management* 47: 188–96.
Locatelli, Giorgio, Diletta C. Invernizzi, and Naomi J. Brookes. 2017. Project characteristics and performance in Europe: An empirical analysis for large transport infrastructure projects. *Transportation Research Part A: Policy and Practice* 98: 108–22. [CrossRef]
Love, Peter E. D., and Lavagnon A. Ika. 2021. The 'context' of transport project cost performance: Insights from contract award to final construction costs. *Research in Transportation Economics* 90: 101062. [CrossRef]
Love, Peter E. D., David J. Edwards, Zahir Irani, and Amir Sharif. 2012. Participatory action research approach to public sector procurement selection. *Journal of Construction Engineering and Management* 138: 311–22. [CrossRef]
MacDonald, J. A. 2002. Finely-tuned project management provides competitive market edge. *Gas Turbine World* 32: 30–34.
Miranda Sarmento, Joaqium, and Luc Renneboog. 2017. Cost Overruns in Public Sector Investment Projects. *Public Works Management & Policy* 22: 140–64.
Morris, Peter W., and George H. Hough. 1987. *The Anatomy of Major Projects: A Study of the Reality of Project Management*. Houston: Wiley.
Odeck, James, and Anne Kjerkreit. 2019. The accuracy of benefit-cost analyses (BCAs) in transportation: An ex-post evaluation of road projects. *Transportation Research Part A: Policy and Practice* 120: 277–94. [CrossRef]
PMI. 2022. Available online: https://www.pmi.org/-/media/pmi/documents/public/pdf/learning/salary-survey-10th-edition.pdf (accessed on 31 May 2023).
Prater, James B., Kostantinos Kirytopoulos, and Tony Ma. 2017. Optimism bias within the project management context: A systematic quantitative literature review. *International Journal of Managing Projects in Business* 10: 370–85. [CrossRef]
PRiSM Methodology. 2009–2022. Available online: https://greenprojectmanagement.org/prism-methodology (accessed on 29 May 2023).
Public Disclosure of Project Reports. 2020. Available online: https://www.entwicklung.at/en/projects/public-disclosure-of-project-reports (accessed on 19 December 2022).
Rainey, Hal G., and Young-Han Chun. 2009. *Public and Private Management Compared*. The Oxford Handbook of Public Management. Oxford: Oxford University Press. [CrossRef]
Servranckx, Tom, Mario Vanhoucke, and Tarik Aouam. 2021. Practical application of reference class forecasting for cost and time estimations: Identifying the properties of similarity. *European Journal of Operational Research* 295: 1161–79. [CrossRef]
Skórski, Mateusz. 2022. Analysis of success and failure factors of infrastructural projects implemented by local government units in Poland (in Polish). Master thesis, Wroclaw University of Science and Technology, Faculty of Management, Wroclaw, Poland.
Tokede, Olubukola O., Peter E. D. Love, and Dominic D. Ahiaga-Dagbui. 2018. Life cycle option appraisal in retrofit buildings. *Energy and Buildings* 178: 279–93. [CrossRef]
Toljaga-Nikolić, Danijela, Marina Dobrota Todorović, Tijana Obradović, and Vladimir Obradović. 2020. Project Management and Sustainability: Playing Trick or Treat with the Planet. *Sustainability* 12: 8619. [CrossRef]
Volden, Gro H. 2018. Public project success as seen in a broad perspective. Lessons from a meta-evaluation of 20 infrastructure projects in Norway. *Evaluation and Program Planning* 69: 9–117. [CrossRef] [PubMed]
Volden, Gro H. 2019. Assessing public projects' value for money: An empirical study of the usefulness of cost–benefit analyses in decision-making. *International Journal of Project Management* 37: 549–64. [CrossRef]
Wiebe, Debora J., and David Black. 1997. Illusional beliefs in the context of risky sexual behaviors 1. *Journal of Applied Social Psychology* 27: 1727–49. [CrossRef]
Wirick, David. 2009. *Public-Sector Project Management: Meeting the Challenges and Achieving Results*. Hoboken: John Wiley & Sons, Inc., pp. 267–70. [CrossRef]

Xiao, Hua Jin, and Jian Zuo. 2011. Critical Uncertainty Factors for Efficient Risk Allocation in Privately Financed Public Infrastructure Projects in Australia. *International Journal of Construction Management* 11: 19–34.

Zaigham, Ali, Ahmad Ifzal, and Hussain Zahid. 2020. Analysis of critical causes of transaction cost escalation in public sector construction projects. *Pakistan Journal of Commerce and Social Sciences* 14: 838–65.