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Assessment of risk and uncertainty by internal and external stakeholders in an e-health megaproject

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Abstract

The paper examines differences in the perceptions of risks and uncertainties associated with an e-health megaproject in Poland, as viewed by internal and external stakeholder groups. In addition to describing the project, its stakeholders, and the related risks and uncertainties, the paper presents the results of statistical analyses. These results indicate that risks and uncertainties are seen as non-negligible, and certain risks and uncertainties are perceived differently by various stakeholder groups. The underlying reasons for these differences are identified. The paper also outlines specific implications of the identified patterns of perception, along with their causes, for the management of similar projects in the future.

Keywords: *megaproject, risk, uncertainty, project stakeholders.*

1. Introduction

In recent years, the number of megaprojects has been increasing worldwide, with similar trends observed in Poland. This development is driven by economic growth, the ambitions and resources of states, societal expectations, and the strategic plans for digital transformation outlined by the European Union and national governments. The citizen-centric focus of the EU's digital transformation agenda is prominently reflected in the Declaration of Digital Rights and Principles for the Digital Decade, adopted by the European Parliament, the Council, and the European Commission on 23 January 2023. This Declaration sets out principles guiding Europe's digital transformation, ensuring that emerging technologies and the resulting digital advancements serve human needs and welfare.

One significant area for megaprojects is the ICT (Information and Communication Technology) sector, particularly in e-government projects. The human benefits of such projects are particularly evident in e-government initiatives related to healthcare. Examples include Electronic Medical Documentation

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(EMD) systems, such as electronic prescriptions and similar innovations. These projects have the potential to enhance patient safety, improve treatment outcomes, and generate cost savings for medical clinics, hospitals, and patients [19], [21]. However, despite their potential, such projects have received limited attention in the scientific literature to date.

Megaprojects are subject to risks and uncertainties (regardless of the specific definitions, which vary in the literature) to a significantly greater extent than smaller-scale projects, primarily due to their complexity [4]. Given their immense budgets and intricacy, issues related to risk and uncertainty have a disproportionately greater impact on financial losses in megaprojects compared to smaller-scale projects. This applies universally to all megaprojects, but in some cases, such as those involving Electronic Medical Documentation (EMD), risks and uncertainties may also adversely affect human well-being, for example, by compromising the efficacy of medical treatment.

Furthermore, megaprojects are characterised by a wide range of stakeholders, both in terms of their number and types. As each stakeholder may have a unique perspective on the project and its success [7], they are also likely to perceive risks and uncertainties differently. These differing perceptions can influence their behaviour within the project and their interactions with other stakeholders.

Consequently, the aim of this paper is to analyse how various stakeholders perceive risks and uncertainties in an EMD megaproject, determine whether these risks are regarded as significant, identify the reasons behind differences in perception, and propose recommendations for improving risk and stakeholder management in EMD megaprojects.

The paper is structured as follows. Section 2 provides brief definitions and a review of the relevant literature. Section 3 describes the case study, the P1 project – Electronic Platform for Analysis and Sharing of Digital Medical Records – along with its stakeholders and the risks and uncertainties it faces. Section 4 outlines the methods employed in the study, including the use of questionnaires and statistical techniques. Section 5 presents the results obtained from applying these methods. The paper concludes with a discussion, offering recommendations for the management of e-health projects and highlighting the limitations of the research.

2. Basic definitions and literature review

In this section, we discuss three aspects based on the existing literature: megaprojects, risk and uncertainty, and the issue of how project stakeholders perceive risk and uncertainty.

Megaprojects are defined as "large-scale, complex ventures that typically cost a billion dollars or more, take many years to develop and build, involve public and private stakeholders, are transformational, and impact millions of people." They are characterised by their large scale, use of advanced technologies, complex environments, lengthy development and construction cycles [8], significant investment requirements, extensive complexity (particularly in organisational terms), and enduring impact on the economy, environment, and society [5]. Additionally, megaprojects face numerous techno-socio-economic and organisational challenges [17] , [?]. Wang et al. give an overview of the management of megaprojects [22].

Megaprojects exist across all sectors of the economy and often create positive value for many stakeholders. In this paper, we focus on megaprojects within the medical sector, where the added value relates

to healthcare services and their quality. Megaprojects are prevalent in this sector, encompassing not only the construction of large facilities, such as public hospitals, but also the implementation of Electronic Medical Documentation (EMD) systems.

Risk and uncertainty in projects are defined in the literature in various ways [24] . Here, we provide only the basic definitions. Project risk refers to the potential occurrence of an event or condition that can positively or negatively affect a project's objectives. Risks are typically identifiable and often measurable in terms of their likelihood and impact [16]. In contrast, project uncertainty pertains to the absence of complete knowledge about future events or conditions that may influence project outcomes. Unlike risks, uncertainties often relate to unknown or poorly understood factors and cannot always be quantified [23].

For the purposes of this paper, we have adopted the following definitions of risk and uncertainty:

Risk refers to a situation where making a particular decision results in various possible outcomes, with the probability distribution of these outcomes being known. If such a probability distribution is not known, decisions are made under conditions of uncertainty. The materialisation of risk can be positive—beneficial to the project—or negative, potentially leading to loss or deterioration in relation to the project's objectives. Risk is inherently associated with any action that brings about change and pertains exclusively to future events. Risks may arise during project implementation and can, to some extent, be managed before they materialise.

Uncertainty refers to the inability to effectively address the causes of a problem due to its sporadic occurrence, a lack of knowledge, or its unverifiable nature. Uncertainty cannot be quantified using numbers or, more broadly, mathematical models. It can only be practically managed at the moment when the events materialise. The causes of uncertainty cannot be influenced, only its potential consequences can be addressed when they arise.

Finally, let us examine, on the basis of the existing literature, how risks and uncertainties are perceived by different stakeholder groups and project managers, depending on their roles, and the extent to which these perceptions vary based on circumstances, knowledge, and experience in the context of the given project. Numerous studies highlight the importance of selecting a representative group and accurately capturing perceptions of risk and uncertainty, along with their dimensions, depending on the purpose of the research [15].

Investigating the perception of risk and uncertainty among project stakeholders provides a fresh perspective on their management. Jia et al. [?] conducted a questionnaire-based survey to explore the concerns of various stakeholder groups regarding risks throughout the process of a large-scale power project in China. The survey employed a Likert scale ranging from 1 to 5 to measure stakeholders' levels of concern about risks from their subjective perspectives (1 - not concerned, 2 - somewhat concerned, 3 - neutral, 4 - concerned, 5 - very concerned). The authors distributed 450 questionnaires and obtained 172 valid responses from four different stakeholder groups. These responses were used to develop a proactive approach to managing the identified risks.

The literature contains proposals for specific methods of communication with stakeholders based on their roles in influencing risks identified by project managers [6], [12], [13]. However, the use of questionnaires for risk identification is not a common practice. An alternative perspective on risk perception is offered by the stakeholders themselves. Stakeholders, as a significant source of uncertainty in projects, and the ways they influence the project lifecycle and express their concerns, represent the need to trans-

form project risk management into project uncertainty management [23].

Mengqi et al. [20] proposed a novel approach using social network analysis to manage stakeholder-related risks within the project lifecycle. Their method applies the theoretical foundations of graph theory, sociology, and anthropology as quantitative tools, integrating mathematical applications and computational techniques to analyse differences in stakeholder perceptions of risks. The authors identified ten key risks associated with prefabrication design in construction and emphasised that the primary theoretical and methodological implication is the necessity of recognising the interdependence of risks associated with stakeholders. Overlooking this interdependence poses a significant threat to effective risk management.

A research gap has been identified in the area of differences between stakeholders' assessment of risk and uncertainty based on their roles, particularly concerning risks and uncertainties throughout the project life cycle and their impact on project outcomes. There is a notable scarcity of scientific literature on this subject. Very few studies address the comparison of risk prediction across specific categories of project stakeholders in private and public sector projects. These studies are primarily focused on construction or infrastructure projects, such as roads or waste-to-energy facilities [14], [18]. Findings suggest that different stakeholder groups prioritise different types of risks; for instance, some focus on technical risks, while others place greater emphasis on environmental protection or political and administrative risks.

3. The subject of the study - P1 project

The project 'Electronic Platform for Collection, Analysis and Sharing of Digital Resources on Medical Events', commonly referred to as the P1 project, is one of the most significant and largest ICT initiatives ever undertaken in Poland [1]. It forms the cornerstone of the country's eHealth ecosystem. The project was implemented alongside other initiatives within the e-Government group, as part of priority axis 2 of the Operational Programme Digital Poland, under measure 2.1: High Accessibility of Public e-Services. Its importance to the country and the impact of stakeholders on the flow of information within healthcare services are discussed in Frączkowski [10].

The eHealth system project (P1) facilitates the collection, processing, and sharing of patient treatment data, such as e-prescriptions, e-referrals, and visit histories. In essence, it enables the use of Electronic Medical Documentation (EMD).

The project spanned from 2007 to 2022 and comprised two phases:

- Phase 1 (2007–2015): Design and production of subsystems, at a cost of PLN 485 698 271.42.
- Phase 2 (2016–2022): Completion of the remaining subsystems, their integration with Phase 1 products, and implementation, at a cost of PLN 291 588 893.09.

The total budget of the P1 project was therefore PLN 777 287 164.51. The P1 project was implemented in parallel with regional e-Health projects such as: 'Lower Silesia e-Health', 'Świętokrzyskie e-Health', 'Podkarpackie e-Health'[1] and other central projects such as 'National registers within the P2

[1]Dolnośląskie (Lower Silesia), Świętokrzyskie, and Podkarpackie are regions (voivodeships) in Poland. Voivodeships are the highest-level administrative divisions in the country.

project' whose total value exceeded 4 billion PLN [10]. The project was co-funded by the European Union and encompassed all healthcare service entities in Poland, which were considered external project stakeholders (ES). These entities were the intended users of e-prescriptions in their daily operations and can be classified into three groups:

- AHS (Ambulatory Health Services): 3 193 entities
- HOSPITALS (Stationary and 24-Hour Health Services): 612 entities
- SOH (Stationary and 24-Hour Health Services Other than Hospitals): 379 entities.

The project management structure was headed by the Steering Committee of the Healthcare Informatics Programme (SC HIP). The Supervisory Board of the P1 project comprised teams of experts representing various internal stakeholders from the IT industry, eHealth domain, and other relevant sectors. These included:

- UAG: User advisory groups.
- eEG: eHealth experts
- ITCG: IT contractors.
- OBC: Owners of businesses.

The P1 project meets the criteria of a megaproject [11], featuring innovative components in applied technologies and transformations in the business model for delivering healthcare services, alongside a substantial budget.

During the project, two surveys were conducted, which are presented in the following section.

4. Methods

The survey was conducted in 2018 by the eHealth Centre in Poland in the form of a questionnaire sent to both internal and external stakeholders of the project. The questionnaire sought to determine whether, and to what extent, stakeholders recognised the importance of various risks and uncertainties listed in the survey, within the P1 project life cycle. All the external stakeholders (see Section 3) were sent the questionnaire directly. Internal stakeholder representatives were tasked with gathering the opinions of the internal stakeholder groups they chaired.

The questionnaire included ten items (five risks and five uncertainties) identified using two types of sources:

- A previous survey on the state of preparedness and financial situation of healthcare entities. This survey has been conducted by the National eHealth Centre on a regular basis since 2012, with the primary aim of identifying critical success factors for the P1 project by assessing the state of preparedness and the attitudes of healthcare entities towards digitalisation [9].
- Literature on eHealth projects.

Table 1. Barriers to EMD implementation, and the resulting risks and uncertainties related to the P1 project

Label	Risk/Uncertainty	Barriers due to resistance to change
	Risk	
R1	Insufficient funding for equipment	Technical and economic
R2	Lack of support from central and local institutions with institutional oversight	Organisational
R3	Resistance from IT companies to making the software compliant with the requirements	Technical economic, organisational
R4	Unclear benefits from EDM, mainly for doctors and nurses	Organisational and psychological
R5	Deficiencies in the area of knowledge dissemination and mandatory requirements of interoperability rules	Social and psychological
	Uncertainty	
U1	Legal regulations and deadlines for EDM implementation	Organisational and social
U2	Globalisation phenomena related to the dynamics of IT change	Social
U3	Changes in the business model of service provision of private, state-owned entities	Organisational and financial
U4	Impact of the medical community on EMD developments	Social and psychological
U5	Excessive elevation of EMD security risks	Social

Both sources facilitated the identification of potential barriers to the changes introduced in the P1 project, which subsequently allowed for the generation of the risks and uncertainties included in the questionnaire (see Table 1).

Let us describe the above items and the process of risk and uncertainty identification based on the identified barriers.

To begin, consider Risk R1: 'Insufficient funding for equipment infrastructure'. This risk was identified due to the existence of technical and economic barriers, as changes and new investments require financial resources. The economic situation of the external stakeholders was unstable, and the projected expenditure was difficult to estimate. Securing EU funding for such investments posed additional challenges, as technical and economic barriers could often be addressed more easily through self-funding or by accessing funding sources that did not impose challenging requirements, such as proof of achieving specific indicators or agreements ensuring project interoperability.

Risk R2: 'Lack of support from central and local institutions with institutional oversight' emerged from complaints by regional eHealth project leaders regarding insufficient dissemination of project information, such as details about HL7 CDA standards [2], in the Electronic Medical Documentation (EMD) [25]. Relevant studies and their findings were released with significant delays, contributing to this risk.

This issue also led to the identification of Risk R3: 'Resistance from IT companies to introduce the necessary changes to make the software compliant with the requirements', and Risk R5: 'Deficiencies in the area of knowledge dissemination and mandatory requirements of interoperability rules'. Both risks highlighted challenges related to the dissemination of information and the adaptability of external stakeholders to the required changes.

Risk R4: 'Unclear benefits from EMD, mainly for doctors and nurses' stemmed from organisational barriers, specifically internal issues within healthcare entities. Factors such as employee and managerial attitudes, the efficiency of information acquisition and processing systems, and the time required to access aggregated reports and analyses played a significant role in shaping this risk.

These risks collectively highlight the critical barriers to the implementation of changes introduced in the P1 project, encompassing technical, economic, organisational, and informational challenges.

Uncertainty U1, described as 'Legal regulation and deadlines regarding EDM implementation', relates to the limitations or even the lack of effective influence on the scope and pace of legislative work. Resistance in this area has been expressed by medical self-governing organisations and politicians. It is undeniable that political and legal barriers are decisive factors. The underlying rationale stems from the extent of autonomy afforded to healthcare organisations and the direction of their development. While the state model nominally assumes organisational autonomy, it is centrally restricted in many aspects. The political model heavily influences the formulation of legal solutions. The existence of low-quality legislation can result in bureaucratic barriers, which, if misused, hinder the implementation of necessary changes.

Uncertainty U3 – 'Changes in the business model of service provision by private and state-owned entities' – and U4 – 'Impact of the medical community on EMD developments' – were attributed to observable social, psychological, organisational, and financial barriers.

The identification of Uncertainty U5, 'Excessive elevation of EMD security risks', stemmed from published incidents involving the surveillance of hospital information systems by hackers and the loss of medical data due to improper storage practices.

Respondents rated the subjective importance of the above items on a 5-point Likert scale (1-minor, 2-small, 3-medium, 4-large, 5-very large).

Nonparametric tests, including the Kruskal–Wallis test, Chi-squared test, and Wilcoxon rank-sum test, were employed to analyse the assessment of risks and uncertainties by project stakeholders. Homogeneous risk classes were identified, and the variation in the level of risk and uncertainty assessment across different stakeholder groups was analysed.

Principal Component Analysis (PCA) was utilised to identify latent variables representing the analysed risks and uncertainties of the P1 project. PCA was applied to reduce the number of variables by combining correlated variables and presenting a smaller set of uncorrelated components. This approach aimed to distinguish groups of similar risks and uncertainties, providing a wider view of stakeholder perceptions regarding risks and uncertainties.

5. Results

We will now examine the different perspectives of P1 project stakeholders concerning the risks and uncertainties associated with EMD implementation, as discussed earlier. This analysis is based on the results of the survey described in Section 4. We will begin by analysing the assessments of EMD risks by external stakeholders and subsequently compare them with the assessments made by internal stakeholders.

5.1. Evaluation of risks/uncertainties by external stakeholders

Table 2 presents the average assessments of the level of threat as perceived by external stakeholders. The following hypotheses were formulated:

H_0: The average assessments of the various risks/uncertanties are the same.

H_1: The average assessments of the various risks/uncertanties vary.

The null hypothesis (H_0) was rejected based on the results of the Kruskal–Wallis test ($H = 3637.16, \chi^2 = 16.92$, significance level 5%). Five homogeneous classes of average item assessments by EDM service providers were identified (see Table 2).

Table 2. Assessment of risks and uncertainties associated with the P1 project by external stakeholders – homogenous classes

Label	Risk or Uncertainty	Mean importance	Class 1	Class 2	Class 3	Class 4	Class 5
R1	Insufficient funding for equipment	3.90	x				
U1	Legal regulations and deadlines for EDM implementation	3.84	x				
U5	Excessive elevation of EMD security risks	3.70		x			
R2	Lack of support from central and local institutions	3.65		x			
R5	Deficiencies in knowledge dissemination and requirements of interoperability	3.47			x		
U4	Impact of the medical community on EMD developments	3.44			x		
U3	Changes in service provision by private and state-owned entities	3.38			x	x	
U2	Globalisation phenomena related to the dynamics of IT change	3.36			x	x	
R4	Unclear benefits from EDM for doctors and nurses	3.26				x	
R3	Resistance from IT companies to making the software compliant with requirements	2.54					x

The average assessments of the level of threat range from 2.54 to 3.9, on a scale from 1 to 5. It should be emphasised that the P1 community of external stakeholders is not homogeneous in its assessment of the analysed risks and uncertainties regarding the EDM system. The following hypotheses were formulated:

H_0: The average ratings of threat in the implementation of the P1 system by the different external stakeholder groups (AHS, HOSPITALS, SOH) are equal.

H_1: Not all of the average ratings of threat in the implementation of the P1 system by the different external stakeholder groups (AHS, HOSPITALS, SOH) are equal.

The null hypothesis (H_0) was rejected based on the results of the Kruskal–Wallis test ($H = 3637.16, \chi^2 = 16.92$, significance level 5%). Table 3 presents the average ratings of threats to the implementation of the EDM system from these risks/uncertainties where these ratings varied among the external stakeholder groups. The remaining items were rated equally by external stakeholders.

The largest difference observed in average ratings was 0.54. Principal Component Analysis (PCA) was subsequently employed to identify latent variables representing the risks associated with the P1 project, as perceived by external stakeholders. PCA was used to reduce the dimensionality of the data. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.890, and Bartlett's test of sphericity yielded a value of 14 778.558 (significance level $p \approx 0$), indicating that a dimensional reduction analysis would have a measurable effect. Using the Kaiser criterion, four principal components were

Table 3. Heterogeneity of mean assessments of risks and uncertainties associated with P1 implementation as evaluated by external stakeholders.

		Average risk assessment		
Label	Risks and uncertanties	Overall	Health services	Other stakeholders
R1	Insufficient funding for equipment	3.90	3.85	4.02
R2	Lack of support from central and local institutions	3.65	3.54	3.72
U1	Legal regulations and deadlines for EDM implementation	3.84	3.77	3.92
U4	Impact of the medical community on EMD developments	3.44	3.38	3.92

extracted (Tables 4 and 5), which together explain 73.7% of the variation in the external stakeholders' assessments regarding the risks and uncertainties in the implementation of the P1 megaproject.

Table 4. Total variance explained (external stakeholders' assessments). Method of extraction: Principal component analysis.

Component	Eigenvalue	%age of variance	Cumulative	Rotated - Eigenvalue	%age of variance	Cumulative
1	4.672	46.720	46.720	2.845	28.448	28.448
2	0.997	9.967	56.687	1.830	18.297	46.745
3	0.949	9.491	66.178	1.661	16.613	63.359
4	0.757	7.569	73.747	1.039	10.389	73.747
5	0.573	5.726	79.474			
6	0.480	4.801	84.274			
7	0.443	4.429	88.703			
8	0.429	4.285	92.988			
9	0.375	3.749	96.737			
10	0.326	3.263	100.000			

Table 5. Matrix of rotated component loadings (external stakeholders' assessments). Method of extraction: Principal Component Analysis. Method of rotation: Varimax with Kaiser Normalization.

Label	Risk/Uncertainty	Component 1	Component 2	Component 3	Component 4
R1	Insufficient funding for infrastructure	0.210	0.125	**0.858**	-0.013
R2	Lack of support from central and local institutions	0.219	0.213	**0.807**	0.168
R3	Resistance from IT companies to making the software compliant with requirements	0.167	0.215	0.099	**0.918**
R4	Unclear benefits from EDM for doctors and nurses	0.212	**0.837**	0.104	0.197
R5	Deficiencies in knowledge dissemination and requirements of interoperability rules	0.273	**0.755**	0.289	0.140
U1	Legal regulations and deadlines for EDM implementation	**0.626**	0.413	0.225	-0.137
U2	Globalisation phenomena related to the dynamics of IT change	**0.803**	0.093	0.153	0.238
U3	Changes in service provision by private and public entities	**0.789**	0.094	0.193	0.181
U4	Impact of the medical community on EMD developments	**0.662**	0.439	0.087	0.037
U5	Excessive elevation of EMD security risks	**0.712**	0.268	0.227	0.032

Four internally correlated, but uncorrelated among themselves, latent variables, or dimensions, have been identified:

- Risk related to the relationship with central and local government institutions (R1,R2).
- Risk related to the relationship with IT companies (R3).
- Risk related to the relationship with medical personnel (R4,R5).
- Uncertainty (U1,U2,U3,U4,U5).

5.2. Evaluation of Risks/ Uncertainties by Internal Stakeholders Compared to External Stakeholders

Table 6 describes the assessments of the risks (risks and uncertainties) of the P1 project given by the external stakeholders (ES) and by the representatives of the different groups of internal stakeholders (IS).

Table 6. Respondents' mean assessment of risks associated with EMD implementation

Label	Risk/uncertainty	ES	UAG	eEG	ITCG	OBC	IS	Wilcoxon Rank Test
R1	Insufficient funding for infrastructure	3.90	5	2	5	5	4.25	-136.173
R2	Lack of support from central and local institutions	3.65	3	2	3	3	2.75	488.631
R3	Resistance from IT companies to making the software compliant with requirements	2.54	1	1	1	2	1.25	466.496
R4	Unclear benefits from EDM	3.26	4	3	4	3	3.5	-34.626
R5	Deficiencies in knowledge dissemination and requirements of interoperability rules	3.47	4	3	4	2	3.25	-56.600
U1	Legal regulations and deadlines for EDM implementation	3.84	4	2	1	3	2.5	557.899
U2	Globalisation phenomena related to the dynamics of IT change	3.36	2	2	2	2	2	514.297
U3	Changes in service provision by private and public entities	3.38	1	1	1	2	1.25	663.81
U4	Impact of the medical community on EMD developments	3.44	4	3	3	4	3.5	-8.413
U5	Excessive elevation of EMD security risks	3.70	2	3	3	4	3	328.494

The following hypotheses were formulated:

$H_{0,hi}$: The average rating of the i-th risk/uncertainty ($i = 1, ..., 10$) is the same for external stakeholders and internal stakeholders.

$H_{1,hi}$: The average rating of the i-th risk/uncertainty ($i = 1, ..., 10$) differs for external stakeholders and internal stakeholders.

where: $h_1 = R1, ..., h_5 = R5$ (representing the five risks) $h_6 = U1, ..., h_{10} = U5$ (representing the five uncertainties).

The null hypotheses ($H_{0,hi}$) for all $i = 1, ..., 10$ were rejected with the p-value being ≈ 0 in each case (see Table 6). The key findings indicate that the following risks/uncertainties:

R4: Unclear benefits of EMD, particularly for doctors and nurses

U4: The impact of the medical community on EMD developments

R1: Insufficient funding for equipment infrastructure,

are assessed as being more threatening by internal stakeholders compared to external stakeholders. Conversely, the remaining risks and uncertainties are rated as being less threatening by internal stakeholders than by external stakeholders.

6. Discussion

First and foremost, it should be emphasized that none of the risks and uncertainties identified, as described in Section 4, were deemed negligible by any stakeholder. This indicates that stakeholders were acutely aware of the complexities involved in managing project risks and uncertainties.

The homogeneous groups identified in Table 2 reveal that external stakeholders (hospitals and other health service organisations) on the average think that the most important risks/uncertainties are:

- Insufficient funding for hardware infrastructure.
- Uncertainty about regulations and deadlines for EMD implementation.

Both average ratings are close to 4 on a scale from 1 to 5. They also identified other significant risks/uncertainties, with average ratings close to 3.7:

- Excessive elevation of EMD security risks.
- Lack of support from central and local institutions with institutional oversight.

To ensure the active engagement of external stakeholders, measures should be implemented to mitigate these concerns. These include providing formal guarantees of funding and securing clear commitments from central and local institutions responsible for institutional oversight regarding regulations, security requirements, and the type of support offered. Consequently, funding and oversight institutions should be actively included in the project's stakeholder management process. More specifically, the relationship between these institutions and hospitals, as well as other health service organisations, should be carefully managed.

Hospitals and other health service organisations assessed as being slightly less threatening (average ratings between 3.5 and 4) the risks and uncertainties associated with:

- Deficiencies in the dissemination of knowledge and mandatory requirements of interoperability rules.
- Unclear benefits of EMD, particularly for physicians and nurses.
- The impact of the medical community on EMD developments.
- Changes in the business model for service provision by private and public entities.
- The globalisation phenomena linked to the dynamics of IT changes.

To address these concerns, it is essential to include other stakeholders in the stakeholder management process. Specifically, individual members of the medical community should be engaged through seminars and workshops designed to familiarise them with the project, its objectives, and their role in the global healthcare ecosystem.

According to external stakeholders, the lowest-rated risk, with an average rating of approximately 2.5, is the resistance of IT companies to necessary changes resulting from software adaptation. Since this risk is perceived as relatively low, it does not require proactive management but should instead be addressed reactively if and when relevant issues arise with significant severity.

External stakeholders rated the following risks/uncertanties as being more threatening on average than the health services rated them, as shown in Table 3:

R1: Insufficient funding for equipment infrastructure.

R2: Lack of support from central and local institutions with institutional oversight.

U1: Legal regulations and deadlines for EMD implementation.

U2: Impact of the medical community on EMD developments.

The following reasons may explain these phenomena:

a) R1: Hospitals in Poland have achieved a significantly higher degree of computerisation compared to other health service institutions. Between 2006 and 2013, 396 hospitals benefited from a World Bank loan under the Project Informatics in Health Care (PIWON), which aimed to modernise IT infrastructure, improve medical information management, and enhance the efficiency of healthcare delivery. Additionally, in 2010, Poland received a €1 billion loan from the World Bank, part of which was allocated to support hospital development and mitigate the effects of the economic crisis. Other health service institutions, however, did not receive similar assistance and were excluded from these programmes. As a result, they have had to implement IT processes using their own resources, leading to greater concern about the lack of financial resources to meet the requirements of the P1 project.

b) R2: Hospitals benefited from training courses organised by the National eHealth Centre, had greater access to funds for eHealth projects, and typically have dedicated IT departments staffed with IT specialists. In contrast, other health service institutions, which often employ only 20–50 people and serve no more than 50–70 patients, generally lack dedicated IT departments to support their IT needs. Consequently, these institutions express a stronger expectation for additional support in implementing centralised IT solutions.

c) U1: Hospitals began implementing IT systems as early as the late 1990s, with the introduction of the Patient Movement System. Around the same time, initial legal regulations on medical records standards were introduced, along with Ministry of Health directives on medical records. Although these regulations are still considered inadequate and subject to frequent amendments, hospitals have adapted to operating within this legal and organisational framework, particularly in relation to medical statistics and contracts with the National Health Service. In contrast, smaller health service institutions face significant challenges with legal and regulatory compliance. These facilities have long raised concerns about the rigidity of regulations, such as staffing requirements and patient eligibility, which they often cannot meet. Additionally, the coordination of patient transitions between inpatient, outpatient, and long-term care is notably deficient in smaller facilities.

d) U2: Hospitals generally have more experienced users of IT systems and applications designed to support the treatment process, resulting in less resistance to EMD implementation. Conversely, other health service facilities face greater staff shortages, and EMD solutions are perceived as an additional

burden on medical staff. Furthermore, the financial costs of implementing EMD solutions are viewed as competing with other pressing needs in these facilities.

To alleviate the concerns of health service facilities other than hospitals regarding the aforementioned risks and uncertainties, concrete actions need to be undertaken. These include organising meetings, seminars, negotiations, hiring additional staff, and addressing the fears expressed by members of the organisations under consideration.

Thus far in this section, we have focused on the average ratings provided by external stakeholders. However, the application of Principal Component Analysis (PCA) (see Table 5) has provided a wider view of the unaveraged results. Four internally correlated, but uncorrelated among themselves, latent variables, or dimensions, have been identified:

- Risk related to the relationship with central and local government institutions (R1,R2).
- Risk related to the relationship with IT companies (R3).
- Risk related to the relationship with medical personnel (R4,R5).
- Uncertainty (U1,U2,U3,U4,U5).

The identified dimensions provide important insights. For instance, it is evident that all external stakeholders perceive uncertainties in a similar manner. Similarly, risk associated with relationships with central and local government institutions (R1, R2), risk associated with relationships with IT companies (R3), and risk associated with relationships with medical personnel (R4, R5) are perceived consistently across the groups. This suggests the feasibility of introducing a targeted programme for managing selected groups of risks or uncertainties that encompass all external stakeholders. The stakeholders' similar perception of these issues enhances the prospects of implementing such a programme. Additionally, each dimension highlights the importance of managing relationships with specific types of stakeholders, which should be addressed by the relevant programme.

Now, let us turn to the opinions of the internal stakeholders, represented in the survey by experts representing the following groups:

- User Advisory Groups.
- eHealth Experts.
- IT Contractors.
- Business Owners.

It is important to note the significant variation in the assessment of risks among internal stakeholders (see Table 6). The eHealth experts generally rate all of the analysed risk categories as relatively unthreatening, describing the threat as being negligible, small, or medium. In contrast, other internal stakeholders perceive certain risks or uncertainties as being threatening or very threatening, underscoring the diverse perspectives within the internal stakeholder community. These categories are:

R4: unclear benefits, mainly for doctors and nurses, of EDM implementation.

R5: deficiencies in the area of knowledge dissemination and mandatory requirements of interoperability rules.

U4: the impact of the medical community on EMD developments.

R1: insufficient funding for equipment infrastructure.

U1: legal regulations and deadlines for EDM implementation.

The group of eHealth experts primarily consists of initiators and promoters of EMD. This group was responsible for providing the foundational assumptions for the design and legislation of the P1 project. Their strong identification with the project sets them apart from other stakeholders. Consequently, it would be advisable to implement an information campaign and training programme targeted at other internal stakeholder groups. Such initiatives would help these groups better understand and accept the project and its objectives.

The results reveal significant discrepancies in the assessment of certain risks and uncertainties among some project stakeholders. These differences can be attributed to variations in knowledge, experience, and roles within the large-scale P1 project, as well as differing objectives, responsibilities, and interests. Furthermore, disparities in understanding various aspects of the project play a crucial role.

These differences underscore the need for further steps to mitigate the largely negative perceptions of certain risks and uncertainties held by some stakeholders and to address their corresponding concerns. This analysis of the primary stakeholders also highlights the importance of identifying and engaging additional stakeholders who should be considered in the project management process.

7. Conclusions

Analysing risks through a large-scale survey of opinions on risk and uncertainty in large projects is an organisationally complex undertaking, and requires accuracy in the selection of questions and stakeholder representation. The survey (described in Section 4), which for the first time included questions related to risk and uncertainty assessment, was different from previous surveys addressed by the National eHealth Centre to healthcare entities in Poland, and from any survey described in the literature. It was probably not an easy study for the survey respondents, because usually in such surveys they had answered questions in which they had indicated their state of ownership, e.g., how many workstations or servers they had, or the type of software in use in the hospital. In this survey, the respondents needed to quantitatively assess risks and concerns, as well as distinguish risk from uncertainty. These respondents included beneficiaries from three groups of health service providers (external stakeholders), and four domain expert groups (internal stakeholders), whose perspectives, knowledge and way of involvement in the project are extremely different.

Change management in a project with multiple contractors, multiple groups of future users, complex functionality and innovative technologies is a difficult and complex undertaking, both organisationally and technically. The handling of changes in an EMD project requires the preparation of adequate organisational and technical support and adherence to the agreed procedures of change. Large-scale information and promotional activities undertaken by the National eHealth Centre, creating a friendly and acceptable message regarding the changes brought about by the projects is a task for all those who should care about

improving the efficiency of health care. This cannot be done without reengineering existing processes, and these activities entail changes on an unprecedented scale. The undeniable result of the changes is that 453 million electronic prescriptions were already issued in 2022 (95.8% of all prescriptions). Breaking down barriers to implementing e-prescriptions has been an administrative issue, but the Covid-19 pandemic was also a significant driver [3]. Actions are needed to reduce people's resistance - building appropriate awareness among organisational participants, building positive attitudes towards change in the organisation. Organisation and management theory assumes that preparing people for change should be a continuous task of the project manager. In large projects like the P1 project, this is a challenge for government. Threats and concerns are often not officially formulated directly, as evidenced by the survey results.

An interesting result is the risk assessment of R4—"Unclear benefits mainly for doctors and nurses from EDM"—by external stakeholders, who are healthcare providers. The respondents represented doctors, nurses, and other medical staff. It can be assumed that some of the questionnaires were completed by these professionals or by managers after consulting the medical staff regarding the above risks. Therefore, the results for this group should be interpreted in relation to the assessment provided by the internal stakeholders—representatives of expert groups—who indicate that service providers have no doubts about the benefits of EDM implementation. Nevertheless, in their desire to postpone EDM implementation, they highlight other obstacles in the form of risks and uncertainties beyond their control, such as those related to the lack of support from central and local institutions and insufficient funding for infrastructure. Risk R3—"Resistance of IT companies to the necessary changes to adapt the software to the requirements"—should be interpreted in a similar manner.

It is strongly advisable not to classify stakeholders and assign a priori risks and uncertainties to them without their active participation [18]. It is not only important to create a stakeholder impact matrix from the perspective of within the project by the PM with the participation of the sponsor. The demonstrated differences in the perception of risk between external and internal stakeholders and the revealed perceptions regarding uncertainty are consistent with other studies and lead to the recommendation that they should be used in anticipating conflicts and better preparing for dialogue and proactive risk and uncertainty management through stakeholder involvement. In some works, their authors attribute differences in the assessment of risks by different stakeholders - mainly uncertainty - to differences in knowledge and access to information between stakeholder groups [9].

The analysis of the survey results confirmed that the identified risks and uncertainties, from the perspective of the National Coordinator of Regional eHealth Projects with the P1 project, were appropriate, as internal stakeholders rated the average risk (R1-R5) as 3 and the average uncertainty (U1-U5) as 2.5 (on a scale from 1 to 5). Among external stakeholders, the average risk (R1-R5) is 3.4 and the average uncertainty (N1-N5) is 3.3. Thus, none of these risks were rated as negligible in the average opinion of project stakeholders.

External stakeholders such as inpatient and 24-hour non-hospital health services assessed the risks due to insufficient funding for equipment infrastructure (R1) to be greater. This result allowed the management of the Ministry of Health to pay more attention to the financial condition of these facilities, which had problems with stable contracts with the National Health Service at the time. The management recommendation that emerged from the surveys led to an increase in the National eHealth Centre efforts

to make EDM-related information widely available by launching a series of training courses on HL7 CDA standards and proactive risk management, accelerating legislative action to enable the introduction of the P1 project results. To summarise, managers of medical megaprojects should:

- Define and identify risks and uncertainties linked to their projects, leveraging lessons learned from previous megaprojects in the health sector (this paper likely provides one of the first lessons learned to be utilised).
- Identify project stakeholders.
- Engage stakeholders to understand how they perceive risks and uncertainties and the reasons behind these perceptions.
- Address the concerns and fears expressed by individual stakeholders, tailoring the approach to their specific needs. Tools such as Principal Component Analysis (PCA) may be used to group stakeholders with similar perceptions, enabling personalised responses through seminars, meetings, legal steps, or other specific forms of support.
- Identify additional stakeholders if necessary and apply a similar approach to include them in the process. By following this methodology, the likelihood of success for medical megaprojects can be significantly increased.

This paper, however, has certain limitations. It examines only one project, does not address all the potential stakeholders, and lacks follow-up research. Nevertheless, the information presented here can serve as a valuable starting point for accumulating further insights and experience with other megaprojects in the medical sector.

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