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FROM INDIVIDUAL CANDIDATE SUITABILITY TO EXPERT PANEL COMPOSITION IN COMPLEX SYSTEMS REENGINEERING

Expert group composition significantly affects the validity and reliability of decisions in complex systems reengineering. Existing expert evaluation methods mainly address the elicitation, reconciliation, and aggregation of judgments, while expert-finding approaches typically focus on assessing individual candidate suitability. This study distinguishes candidate suitability assessment from subsequent expert group selection and examines their relationship. A formal problem statement is proposed in which an expert group is selected from an available candidate pool according to the target domain, required functional roles and competencies, as well as institutional, independence, and conflict-of-interest constraints. The proposed formulation provides a methodological basis for developing intelligent expert selection systems for complex systems reengineering.

Keywords**:** *candidate suitability, expert panel, panel composition, expert selection, complex systems reengineering, requirements specification, expert evaluation, decision support systems.*

Introduction

The development of reengineering projects in complex socio-technical, organizational, and information systems is accompanied by an increasing role of expert knowledge in decision-making processes. The construction of intelligent expert systems for reengineering design requires consideration of the characteristics of the object under study, the nature of the design tasks being solved, and the conditions under which decisions are made. The requirements for the subject-matter competencies and func-

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tional roles of the specialists involved depend on the content of a particular reengineering task and, consequently, determine the principles according to which the expert panel should be composed.

Reengineering is applied when local improvement of individual system elements is insufficient to achieve the established objectives. Unlike gradual modernization, which is mainly directed at improving particular characteristics of an existing system, reengineering involves reconsidering its operating principles, structure, processes, and relationships between components. The concept was initially associated primarily with business-process transformation [1–7]. The development of information technologies and process-management methods subsequently extended reengineering principles to organizational processes, information systems, and digitally supported business transformation [8, 9]. Related assessment and adaptation tasks are also considered in the reengineering of critical infrastructure facilities [10].

According to contemporary systems engineering principles, a complex system may include hardware and software, data, personnel, processes, procedures, infrastructure, and other interconnected elements [11–12]. A change in one element may affect other components and the operation of the system as a whole. For this reason, reengineering cannot be limited to designing a new structure or automating individual operations. It must also address system objectives, stakeholder needs, functional and non-functional requirements, processes, information flows, resource limitations, risks, and the expected consequences of transformation. Many decisions arising in this context cannot be made solely from quantitative data. Some criteria are qualitative, some indicators are predictive or incomplete, and their importance may vary according to project objectives and stakeholder interests.

The problem statement. Expert judgments are used to identify deficiencies in the current state of a system, clarify requirements for its target state, develop and screen design alternatives, establish evaluation criteria, assess qualitative characteristics, anticipate the consequences of transformation, and analyze risks and constraints. The reliability of the resulting decisions depends both on how these judgments are collected and processed and on whether the selected specialists possess the knowledge and experience required for the task under consideration.

Analysis of recent studies and publications. Previous research indicates that involving specialists whose expertise is insufficiently related to the problem may reduce the validity of the final assessment, even when their judgments are processed correctly [13]. Other studies associate non-formalized panel composition with subjective candidate selection, incomplete coverage of the required competencies, institutional dependence, and limited reproducibility of the selection procedure. Candidate suitability assessment and expert panel composition represent two related but distinct decisions. An individual suitability score describes the correspondence between one candidate and a particular task or subject domain.

It does not show whether a group of highly ranked candidates jointly covers all required areas, competencies, and functional roles. A panel composed only of the candidates with the highest individual scores may lack a specialist needed for a particular aspect of the reengineering task. It may also violate requirements concerning independence, institutional representation, conflicts of interest, inter-candidate relationships, or panel size.

This distinction is particularly important in complex systems reengineering. Different tasks within the same project may require different types of knowledge, and candidate suitability is therefore not an absolute professional characteristic. A specialist may have extensive experience and a strong publication record but still have limited relevance to the target domain of a particular task. Likewise, subject-matter relevance alone does not establish that the candidate can perform the required function within the panel. Individual assessment must therefore precede panel composition, while the final decision must consider both candidate-level characteristics and panel-level requirements.

Established expert evaluation methods address a different part of this process. Delphi, the Analytic Hierarchy Process, SHELF, and Cooke's Classical Model provide procedures for eliciting, structuring, calibrating, weighting, reconciling, or aggregating judgments [14–17]. Their application normally begins after the participants have been identified. The composition of the panel is either treated as a predefined condition of the study or determined through a separate organizational procedure. These methods can improve the treatment of expert judgments, but they do not explain how the initial candidate pool should be searched, how candidate suitability should be assessed for a particular domain, or how the final panel should be assembled. Candidate identification and assessment are studied under the terms expert finding, expertise retrieval, expert recommendation, reviewer recommendation, and reviewer assignment. Expert finding methods use information retrieval, text analysis, topic modeling, graph-based techniques, and professional profile representations to estimate the correspondence between a candidate and a target subject area [18, 19]. Fuzzy-logic methods can also be used to construct and process expert matrices under uncertainty [20]. Reviewer recommendation and assignment systems additionally consider thematic correspondence, workload, conflicts of interest, and assignment constraints [12, 21–22]. Most approaches construct a representation of individual expertise from publications, documents, professional activities, or links to particular topics. The general result is a suitability estimate for a candidate in relation to a given evaluation object. More recent studies also account for multiple thematic aspects, reviewer preferences, workload, conflicts of interest, assignment fairness, and uncertainty in the initial estimates.

Existing studies thus provide methods for processing judgments, estimating individual candidate suitability, and generating constrained reviewer assignments. However, the transition between individual assessment and the composition of an expert panel for complex systems reengineering

remains insufficiently specified. In this setting, the selected experts must jointly cover the target domain, required competencies, and functional roles while satisfying restrictions related to independence, institutional representation, conflicts of interest, inter-candidate dependence, availability, and panel size. These requirements characterize the panel as a whole and cannot be replaced by individual suitability scores.

The research goal. The purpose of this paper is to formalize the transition from individual candidate suitability assessment to expert panel composition in complex systems reengineering. The study separates these procedures and defines the information required at each stage. A reengineering task is associated with a target domain, a set of functional roles, a set of required competencies, and constraints governing panel composition. Individual suitability estimates are treated as inputs to the composition problem rather than as substitutes for panel-level requirements.

The main result is a formal problem statement in which an expert panel is selected from an available candidate pool according to individual suitability, role and competence coverage, and constraints related to panel size, independence, conflicts of interest, institutional representation, inter-candidate dependence, and availability. This formulation establishes a clear boundary between assessing a candidate and evaluating a panel as a whole.

Problem Statement

For complex systems reengineering design tasks, it is important not only to ensure the consistency of expert positions but also to involve specialists who jointly cover the required subject areas and functional roles. This creates a methodological gap between the stage of expert panel composition and the subsequent stages of eliciting, reconciling, and aggregating expert assessments:

$$\textit{expert panel composition} \rightarrow \textit{elicitation of expert assessments} \rightarrow \rightarrow \textit{reconciliation and aggregation of assessments}.$$

Methods for eliciting, reconciling, and aggregating expert assessments are described in detail in the scientific literature, whereas the preliminary stage of expert panel composition remains insufficiently formalized. It is not always established from which pool of candidates the panel was composed, which indicators were used to compare the candidates, how their correspondence to a particular subject area was determined, how the required roles were covered, and how institutional constraints were taken into account.

This problem is particularly important for the reengineering design of complex systems. Since different tasks within the same project may require different types of knowledge, specialist suitability is not an absolute characteristic. A candidate may have a high overall level of qualification but not correspond to the subject area of a particular task. Like-

wise, a large number of publications or extensive professional experience does not guarantee the ability to perform the required functional role within the panel.

Definition 1. The requirements specification for an expert panel for the reengineering design task T^* is defined as the ordered set

$$\mathrm{Re}\, q_E(T^*) = \left(D^*, R^*, C^*, O^*\right), \tag{1}$$

where D^* is the target domain within which the task is addressed; R^* is the set of functional roles required for its expert examination; C^* is the set of competencies required to perform the defined functional roles; and O^* is the set of constraints concerning panel size, expert independence, conflicts of interest, institutional representation, interdependence among candidates, and other properties of the panel composition.

The initial set of potential candidates for participation in the expert examination is denoted as

$$\Omega = \{e_1, e_2, ..., e_N\}, \tag{2}$$

where e_i is the i-th candidate for the expert panel, $i = 1–N$. The problem of expert panel composition then consists in determining a subset

$$E^* \subseteq \Omega, \tag{3}$$

whose composition corresponds to the requirements specification in (1).

Relations (1)—(3) define the general statement of the problem under study. Its solution requires the formalization of procedures for processing heterogeneous professional data about candidates, determining their correspondence to the requirements of a particular task, and justifying the expert panel composition with consideration of both the individual characteristics of the candidates and the requirements for the panel as a whole.

The requirements for an expert panel cannot be established independently of the content of a particular task. A specialist with considerable experience in a certain field may meet the requirements of one reengineering design task but be insufficiently suitable for another, even if both tasks concern the same object. This is caused by differences in the content of design decisions, the set of required competencies, the functions of the participants in the expert examination, and the constraints imposed on the panel composition. Candidate suitability should therefore be considered not as a permanent characteristic of a specialist but as the result of comparing the candidate's professional profile with the requirements of a particular task defined in (1).

The components of (1) describe requirements not only for individual candidates but also for the panel as a whole. At the individual level, correspondence to the target domain, professional and project experience, possession of the required competencies, ability to perform a defined role, independence, and evidence supporting professional achievements are

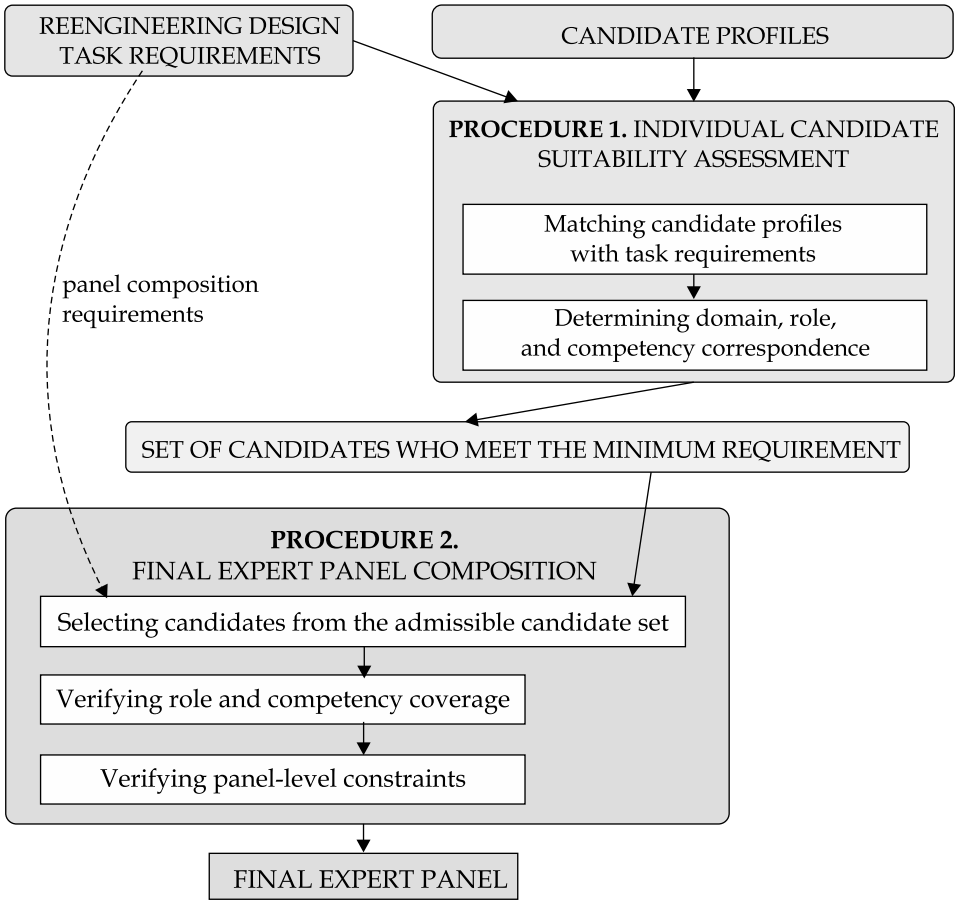


Fig. 1. Relationship between individual candidate suitability assessment and final expert panel composition

considered. At the panel level, the completeness of role and competence coverage, the balance of professional positions, panel size, institutional representation, and the admissibility of professional or organizational relationships among participants are evaluated. It is therefore necessary to distinguish between two interconnected procedures: individual candidate suitability assessment and final expert panel composition.

Individual candidate suitability assessment is aimed at determining the correspondence of each candidate to the target domain, functional role, and competence requirements of a particular reengineering design task. Its result is an individual candidate suitability assessment and the identification of a set of persons who satisfy the established minimum requirements.

Final expert panel composition involves selecting from this set a panel that provides the required role and competence coverage and satisfies the constraints concerning panel size, compatibility, independence, and organizational representation. High individual candidate suitability is a necessary but insufficient condition for inclusion in the expert panel. The final

decision depends not only on the characteristics of an individual candidate but also on the candidate's contribution to the integrity, balance, and admissibility of the panel composition. The conceptual distinction between these procedures is presented in Fig. 1. The result of individual suitability assessment is used as input information for panel composition but does not determine the final composition automatically. The first procedure establishes whether individual candidates correspond to the task requirements, whereas the second verifies whether the selected set of candidates satisfies the requirements for the panel as a whole.

Formalization of Expert Panel Composition Requirements

The first component of the requirements specification is the target domain D^*. It is determined by the content of the reengineering design task and covers the concepts, processes, objects, technologies, and regulatory requirements that must be understood by the participants in the expert examination. For complex systems, the target domain may have a multicomponent structure and include technical, informational, economic, organizational, legal, and social aspects. Domain competence characterizes a candidate's ability to understand the nature of the reengineering object, analyze its current state, identify problems, and justify possible directions for transformation. It is formed through theoretical knowledge, practical experience, participation in relevant projects, research activities, development of methodological materials, publication activity, and the performance of professional functions in the corresponding field.

An academic degree, a large number of publications, or extensive professional experience is not sufficient grounds for including a candidate in the panel. These characteristics reflect the candidate's general professional level but do not always confirm correspondence to a particular task. For example, a large number of publications on a related topic does not guarantee experience in analyzing the specific processes or technologies addressed by the reengineering project. Similarly, extensive professional experience may be accompanied by a lack of experience in applying contemporary design methods and tools. Assessment of domain competence must therefore take into account not only the scope of a candidate's professional activity but also its substantive correspondence to the target domain D^*. Information about the candidate must be compared with the thematic areas of the task. Sources of such information may include curricula vitae, publication lists, digital research profiles, descriptions of completed projects, information about professional positions, certificates, expert reports, and other available evidence of professional activity.

For candidate e_i, correspondence to the target domain can be represented by the mapping

$$q_D(e_i, D^*) \to [0, 1], \tag{4}$$

where $q_D(e_i, D^*)$ determines the assessment of the correspondence between candidate e_i and the target domain D^*, 0 — the absence of sufficiently confirmed correspondence, 1 — high correspondence.

Formula (4) specifies only the general assessment principle and does not determine a particular method for calculating the indicator. The value may be derived from a set of features characterizing the thematic proximity of the candidate's professional activity to the task, the duration and recency of the candidate's experience, participation in relevant projects, the availability of professional results, and the degree to which the data used are supported by evidence.

The recency and duration of experience should be distinguished. Information about activities undertaken many years ago may be less significant for tasks involving rapidly changing technologies. In other cases, particularly when long-term organizational or manufacturing processes are analyzed, accumulated experience may be especially valuable. The importance of temporal characteristics should be determined by the specific features of task T^* rather than applied equally to all candidates. The reliability of the available information also requires separate consideration. Professional characteristics reported by a candidate have a different level of confirmation from information obtained from official registers, institutional websites, bibliographic databases, or documentation relating to completed projects. Candidate assessment must therefore consider not only the presence of a particular characteristic but also the quality of the evidence supporting it.

The next component of specification (1) is the set of functional roles $R^* = \{r_1, r_2, \ldots, r_K\}$. A functional role defines the purpose of an expert in solving the task, that is, the type of analysis, assessment, or professional representation that the expert must provide. A role is not identical to a candidate's position, specialty, or academic title. The same position may involve different types of professional activity, while specialists with the same education may perform different functions during the expert examination.

Reengineering design tasks may require experts who analyze system architecture, functional and information processes, the technical feasibility of proposed solutions, economic viability, risks, regulatory constraints, user needs, or the organizational consequences of transformation. The set of roles depends on the type of system and the objectives of reengineering and must therefore be established separately for each task. For example, the transformation of an information system may require the roles of a system architect, domain specialist, business-process analyst, data specialist, information security specialist, user representative, and independent evaluator. For the reengineering of a manufacturing or socio-technical system, the set of roles will be different and may include technological, economic, environmental, legal, and social specialists.

A candidate may be able to perform one or several roles. Candidate correspondence to a role can be represented as

$$q_R(e_i, r_k) \to [0, 1], \tag{5}$$

where $q_R(e_i, r_k)$ is the assessment of the ability of candidate e_i to perform role r_k.

This representation is particularly important for interdisciplinary tasks, where the distribution of functional roles makes it possible to determine which aspects of a design decision must be represented and examined.

The set of competencies required to solve task T^* is defined as $C^* = \{c_1, c_2, \ldots, c_M\}$. A competency is understood as a confirmed ability of a specialist to apply knowledge, skills, and professional experience in performing defined functions. Competencies specify the content of functional roles and make it possible to move from a general role name to characteristics that can be identified and assessed using the available information about candidates. For each role, a subset of the required competencies must be established. The presence and confirmation of competency c_m in candidate e_i can be represented as

$$q_C(e_i, c_M) \to [0, 1]. \tag{6}$$

Candidate suitability for the task can be represented in generalized form as

$$S_i(T^*) = F(q_D(e_i, D^*), \{q_R(e_i, r_k)\}, \{q_C(e_i, c_m)\}, u_i), \tag{7}$$

where $S_i(T^*)$ is the assessment of the individual suitability of candidate e_i can for task T^*, and u_i represents other characteristics of the candidate.

The values $S_i(T^*)$ characterizes the individual suitability of a candidate but does not automatically determine the candidate's inclusion in the final expert panel. The decision also depends on the role and competence coverage already provided by other candidates and on the constraints imposed on the panel composition.

During panel composition, the requirements specification O^* must be satisfied. It may include:

- Minimum and maximum panel-size constraints.
- Requirements for functional-role coverage.
- Requirements for the presence of critical competencies.
- Restrictions on the number of representatives from the same institution.
- Requirements concerning the involvement of internal and external experts.
- Conditions concerning independence and the absence of unacceptable conflicts of interest.
- Restrictions on interdependence among panel members.
- Requirements concerning expert availability during a specified period.
- Resource, time, and organizational constraints.

Constraints may be mandatory or desirable. Mandatory constraints determine whether a panel composition is admissible: if any of them is violated, the resulting panel cannot be used. Desirable constraints are ap-

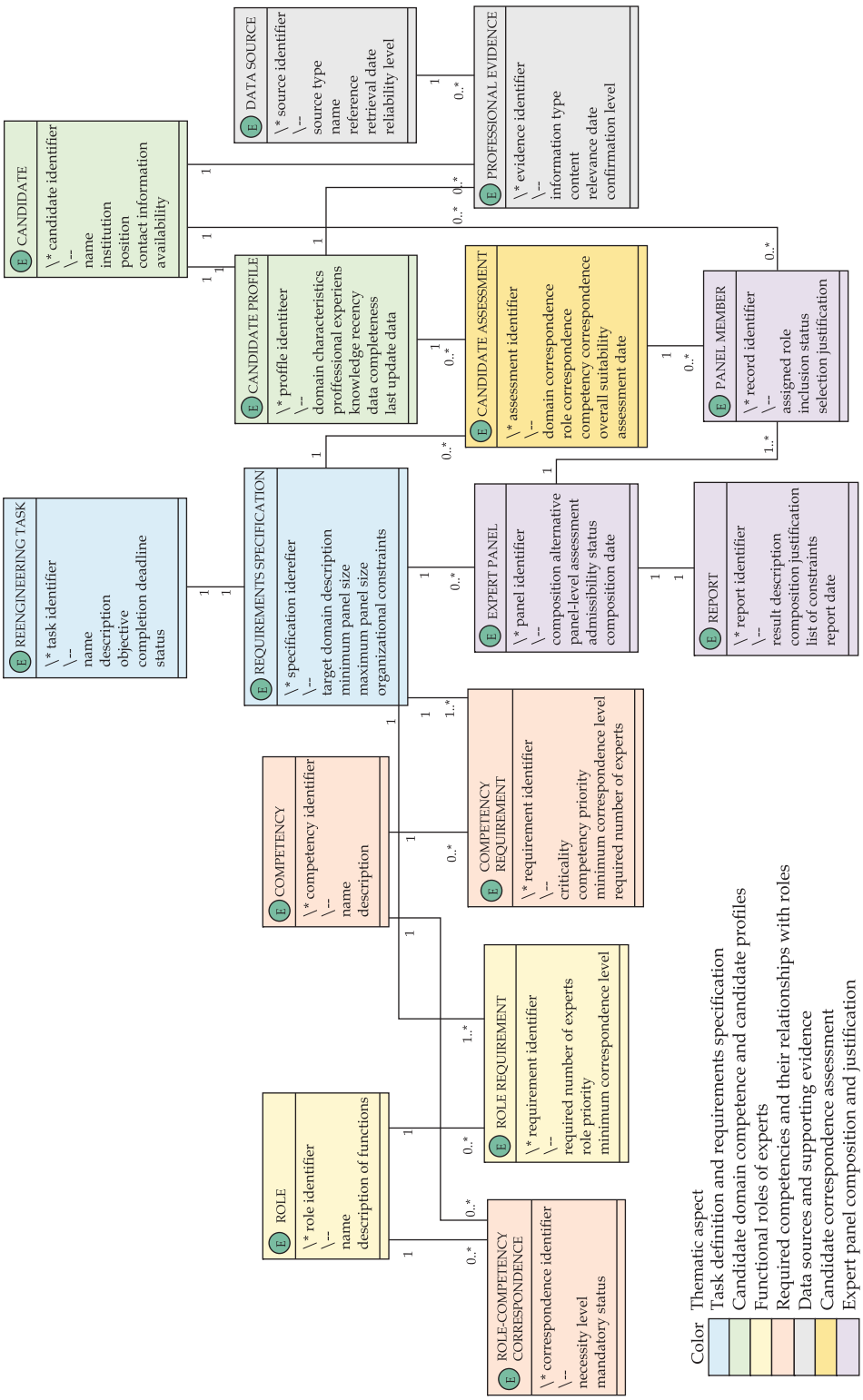


Fig. 2. Information model of the entities involved in expert panel composition for reengineering design tasks

plied to compare several admissible alternatives and select a more balanced composition.

The requirements considered above are interrelated and form a unified information structure for expert panel composition, as presented in Fig. 2.

The main groups of entities in Fig. 2 are distinguished by color according to the considered aspects of panel composition. The model connects the reengineering design task with the target domain, functional roles, competencies, candidate characteristics, individual suitability assessment, panel-level constraints, and the resulting expert panel composition.

Conclusions

The study distinguishes two interconnected procedures involved in expert selection for complex systems reengineering: individual candidate suitability assessment and final expert panel composition. The result of the first procedure provides input data for the second but does not determine the final panel automatically.

Individual suitability characterizes the correspondence of a candidate to the target domain, required functional roles, and competencies of a particular reengineering task. High individual suitability is a necessary but insufficient condition for inclusion in the panel. The final decision also depends on the candidate's contribution to role and competency coverage and on compliance with the constraints imposed on the panel as a whole. The requirements for expert panel composition are represented by the target domain, functional roles, required competencies, and panel-level constraints. The latter include panel size, institutional representation, independence, conflicts of interest, interdependence among candidates, availability, and organizational limitations. Separating individual characteristics from panel-level requirements prevents these different factors from being combined into a single candidate score.

The resulting formalization connects the reengineering task, candidate profiles, individual suitability assessments, and the final expert panel composition within a unified information structure. It can be used as a basis for developing decision-support procedures in which the selected panel is justified not only by the suitability of its individual members but also by the completeness, balance, and admissibility of its composition. Further research should address the development of a panel composition algorithm and its evaluation using real candidate data and reengineering tasks.

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matting and standardization of the reference list in accordance with the journal's requirements. The use of AI was limited exclusively to technical, linguistic, and editorial assistance. All scientific content, mathematical formulations, research results, conclusions, and final verification of data accuracy were developed or performed solely by the author. The author takes full responsibility for the accuracy, reliability, originality, and integrity of the submitted work.

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ВІД ІНДИВІДУАЛЬНОЇ ПРИДАТНОСТІ КАНДИДАТІВ ДО ФОРМУВАННЯ ЕКСПЕРТНОЇ ГРУПИ В РЕІНЖИНІРИНГУ СКЛАДНИХ СИСТЕМ

Вступ. У реінжинірингу складних систем експертів залучають до аналізу станів *AS-IS* і *TO-BE*, уточнення вимог, формування проєктних альтернатив, оцінювання ризиків та вибору варіанта перетворення. Зазвичай увага зосереджується на тому, як отримати судження експертів, перевірити їх узгодженість і сформувати підсумкову оцінку. Питання про те, чому до групи включено саме цих фахівців, часто залишається поза межами формальної процедури. Методи *Delphi*, *AHP*, *MCDA*, *SHELF* і класична модель Кука починають застосовувати тоді, коли учасників експертизи вже визначено. У задачах *expert finding* і *reviewer recommendation* навпаки оцінюється відповідність між кандидатом та об'єктом експертизи. *Reviewer assignment* доповнює такі оцінки правилами розподілу, обмеженнями щодо навантаження та врахуванням конфліктів інтересів. Проте реінжиніринг складної системи не зводиться до призначення рецензента на окрему публікацію або заявку. Для такої задачі потрібна група, члени якої разом охоплюють предметні напрями, компетентності та функційні ролі, визначені умовами проєкту.

Мета роботи. Розмежувати оцінювання індивідуальної придатності кандидата і формування складу експертної групи, представити формальну постановку їх послідовного використання в задачах реінжинірингу складних систем.

Методи. Проведено порівняльний аналіз двох груп підходів: методів отримання та опрацювання експертних суджень і методів пошуку, рекомендації та призначення експертів. Складові задачі та зв'язки між ними описано засобами системного аналізу, формалізації й теоретико-множинного подання. Специфі-

кація вимог до експертної групи охоплює цільову предметну область, необхідні функційні ролі, професійні компетентності та обмеження щодо її складу. Початковими даними є множина можливих кандидатів, з якої необхідно сформувати групу відповідно до встановлених вимог.

Результати. Аналіз засвідчив, що індивідуальна придатність і відповідність групи не є тотожними характеристиками. Оцінка кандидата показує, наскільки його професійні дані відповідають конкретній предметній області та поставленій задачі. Однак проста сукупність кандидатів із найвищими оцінками може не містити фахівців для виконання всіх необхідних ролей або залишити частину компетентностей без належного представлення. Окремої перевірки потребують інституційна залежність, конфлікти інтересів і професійні зв'язки між учасниками. Тому оцінювання кандидатів розглядається як попередній етап, результатом якого є індивідуальні оцінки їхньої придатності. На наступному етапі з початкової множини кандидатів формується група, яка має відповідати визначеній специфікації вимог. Така постановка не передбачає включення всіх вимог до одного рейтингового бала. Предметна придатність характеризує окремого кандидата, тоді як рольове та компетентнісне покриття, чисельність, незалежність і представництво характеризують склад групи загалом.

Висновки. Перехід від індивідуальної оцінки кандидата до складу експертної групи потребує окремої формальної процедури. Рейтинг кандидатів може використовуватися як її вхід, але не замінює перевірку групових вимог. Запропонована постановка встановлює межу між оцінюванням окремого фахівця та формуванням групи з урахуванням предметних, рольових, компетентнісних й організаційних вимог. Надалі вона може бути доповнена моделлю розрахунку предметно залежної придатності та процедурою вибору складу групи відповідно до заданих обмежень.

***Ключові слова**: придатність кандидата, експертна група, склад групи, відбір експертів, реінжиніринг складних систем, експертне оцінювання, системи підтримки прийняття рішень.*