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Dmitry Gubanov · Nikolai Korgin
Dmitry Novikov · Alexander Raikov

E-Expertise: Modern
Collective Intelligence

Springer

Dmitry Gubanov
Nikolai Korgin
Dmitry Novikov
Trapeznikov Institute of Control Science
Russian Academy of Sciences
Moscow
Russia

Alexander Raikov
Trapeznikov Institute of Control Science
Russian Academy of Sciences
Moscow
Russia

Russian Presidential Academy of National
   Economy and Public Administration
Moscow
Russia

and

Analytical Agency "New Strategy"
Moscow
Russia

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Introduction

Today, the heads of federal and municipal authorities, the managers of corporations, industrial enterprises, and organizations (*Principals*) face a wide variety of aims and tasks. Furthermore, they operate under the complexity of existing problems, the diversity of subordinate departments and employees, dynamic or even uncertain requirements and conditions applied by an external environment. All these factors dictate that a Principal should have a subtle intuition, possess adequate information, and original techniques for efficient decision-making.

Any Principal disposes of limited time and resources including financial, cognitive, and intellectual resources. It seems often impossible for a Principal to comprehend a current situation in detail, to acquire and process all incoming information. Sometimes, a Principal finds difficulty in explaining his informational needs to subordinates. In other situations, full revelation of the Principal's aims may appear undesired, but the sense of discomfort causes inconvenience, and he needs competent advice. For hundreds or even thousands of years, a crucial role in management and decision-making has been performed by *expert* procedures. They proceed from acquiring and processing of the opinions of some *experts*, i.e., connoisseurs and specialists in corresponding subject domains. Historically, the term "expert" is associated with many other notions (an adviser, an assistant, a consultant, a foreteller, a prophet, a sage, a vizier, a master, an authority, a wizard, a pro, a dodger, a sorcerer, a magician, an extrasensory individual, a mentalist, to name a few).

Expertise represents both a field of scientific research [9, 24, 58, 80, 81, 91] and a field of practical activity. In the recent 50 years, thousands of expert organizations have been established worldwide. Since the early 2000s, this field demonstrates formation of a new phenomenon, *e-expertise*, which employs modern decision-making and information analysis technologies, data communication, and transmission networks. Due to the high complexity and responsibility of managerial decisions, a Principal frequently addresses the opinion of experts, professional communities, elite clubs, and influential public organizations. However, this leads to several effects, the so-called *expertocracy*. Following the development of informational community, we observe certain transformations in the existing management system; state authorities gradually become *transparent* (*responsibility management*), and management processes involve more and more

subjects of civil society (*crowdsourcing*). In such conditions, decisions of state authorities are strongly dependent on expert assessments and opinions of civil society representatives. A Principal should consider the opinion of civil society (expressed by experts through dedicated information analysis technologies and network technologies). Experts legitimize lobby for the interests pursued by subjects of civil society including science intensive small- and medium-sized business companies.

The phenomenon of e-expertise gains particular importance in the context of distributed *situation centers*. They render technological, informational-analytical, and expert-analytical support of a Principal and his team in decision-making in various situations including unforeseen ones. Situation centers "compress" the period of decision-making by special methods of conducting meetings and organizing collective expert procedures with networked experts.

E-expertise bases on the following conventional definitions.

Expert activity—*Expertise* is a study of a certain object or subject, a situation, issue or topic, which requires special knowledge and results in a motivated report. Alternatively, expertise can be viewed as a method and process of assessing or identifying some properties, factors, obstacles, and tendencies in the development of a problem situation based on experts' involvement.

Expert appraisals (*assessments*) are judgments of high-level specialists and professionals in the form of content, qualitative, or quantitative estimation of an object or subject to-be-used in decision-making.

There exist *individual* and *collective* expert appraisals. Individual expert appraisals are generated by one highly skilled professional. For instance, a lecturer independently estimates the progress of a student, a physician diagnoses a patient. Nevertheless, in complicated cases (a nontrivial diagnosis or student expulsion), a collective opinion becomes vital—a council of physicians or a board of examiners solve the problem.

An expert is a specialist in a subject domain, a management connoisseur, a person informed of some event,

- possessing necessary flair, knowledge, and experience;
- being able to analyze and comprehend incoming information;
- being able to penetrate deeply into a problem situation and to assess a corresponding object or subject of expertise within his competence and awareness;
- handling necessary technologies, being able to assess their applicability in a specific situation of decision-making and provide appropriate recommendations and opinions;
- having definite rights and duties to a Principal;
- bearing personal responsibility for his opinions and recommendations.

An expert can be also defined as

- a subject (individual or collective) with knowledge, a personal opinion, and experience regarding a specific activity;
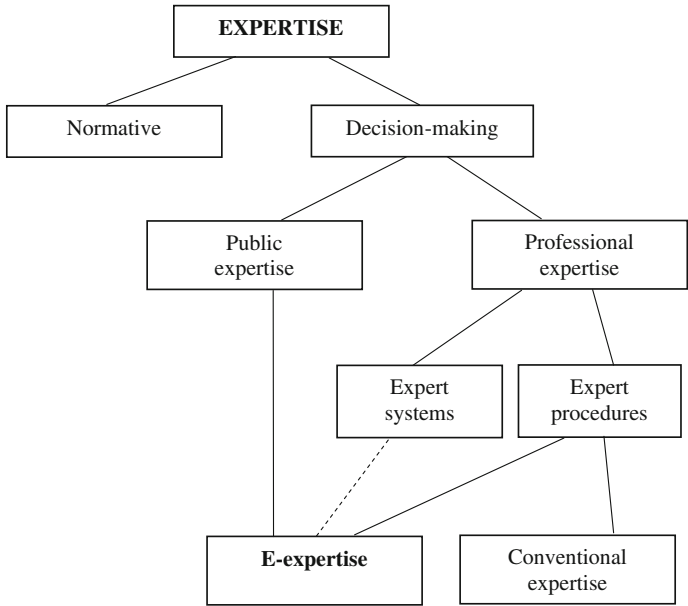
Fig. 1 E-expertise as a type of expertise

- a natural person having considerable intelligence in some field (politics, economics, social sphere, an industry or region, a science, a technology, public life);
- a legal entity performing a deep expert study of a given subject according to an established procedure;
- a representative of scientific and educational institutions, municipal authorities, public associations, and other organizations invited by a Principal as experts.

Subjects (individual or collective) of expert activity include a Principal, an analyst, a specialist in expert technologies, a coordinator of expertise, a moderator, a subject supervisor, and experts.

Similar to any expertise, e-expertise has several primary *aims*, namely

- increasing the sustainability and capitalization of a company, improving the quality of products and services, ensuring competitive ability;
- enhancing the reasonability level of decisions owing to the opinions of experts;
- controlling and/or establishing the correspondence between the characteristics of an expertise object or subject and requirements (conditions, restrictions) applied by normative legal documents of different levels.

According to the two primary aims of expertise, it seems possible to discriminate between *decision-making expertise* and *normative expertise* (see Fig. 1).

The following types of *normative expertise* are separated out depending on the fields of a specific professional activity:

- construction expertise;
- medical expertise (examination);
- legal expertise;
- environmental expertise (including nature management objects);
- product quality expertise;
- patent expertise (examination);
- insurance expertise;
- project audit, financial audit, etc.;
- appraisal of real/movable property, business, intellectual property, nonmaterial assets, and so on.

This book *par excellence* considers decision-making expertise in political, economic, social, and industrial spheres. There exist two types of expertise, *viz.*, public expertise and professional expertise. The latter comprises two large fields (see Fig. 1) known as *expert procedures* and *expert systems*. Actually, expert systems form an independent and intensively studied branch of artificial intelligence. They are not discussed in the book.

Expert procedures differ in methods of expertise organization, expert data processing, etc.; for a detailed discussion, readers are referred to Chap. 2. We pay most attention to *e-expertise*, see Fig. 1. This term is an equivalent of "networked expertise." Throughout the book, both conceptions are used as synonyms. E-expertise bases on *information and communication technologies, as well as information analysis, decision-making, and artificial intelligence technologies.*[1] Today, e-expertise technologies are intensively applied to conduct public expertise, report expertise, and event expertise. The reasonability of using network technology represents a challenge for specialists in artificial intelligence (multi-agent systems, distributed decision-making systems—see dashed line in Fig. 1).

A subject (topic) of expertise concerns various properties of material and nonmaterial objects, events, phenomena, and processes in the past (retrospective expertise), present, or future (expert forecasting and strategic planning, prediction or even prophecy). Here are some examples illustrating the whole diversity of possible subjects (topics) of expertise: the areas of investments, a multi-stage technology of quality function deployment, the technical state of buildings and installations, the consumer properties of a product, a draft version of a legal act, a regional economic development strategy, the development prospects of an industry, the forecast of a research work or a research project, the opinion of a social group, the forecast of an election campaign, crisis forecasting, etc.

Generally, the topics and conditions of normative expertise are regulated rigorously. Contrariwise, *expertise* for making managerial decisions is initiated by a Principal or subjects of civil society.

In the context of e-expertise, the present book also operates on the following notions (see [67, 81, 88, 91, 101]).

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[1] This work does not analyze networked expertise as a type of normative expertise, where an object represents a network (e.g., a computer network).

Polling of experts is interviewing them by an open or closed set of questions, e.g., in the form of questionnaires; special estimation scales and rating systems (semantic, fuzzy, graduated ones) can be assigned to each or some questions.

Trust is subject's hope that other subjects (individuals and/or organizations) interacting with this subject will come up to his expectations.

Report of an expert is a document (particularly, an electronic document) defining the progress and results of investigations conducted by him; the written contents of investigations and final conclusions regarding the issues explored by an expert; a type (source) of evidence.

Moderator (or *facilitator*) is a specialist performing several tasks: (1) coordination of collective expert procedures, (2) checking of agreements' execution by experts (in accordance with their user statuses), and (3) policing of expert information submission.

Public expertise (*in legislature*) represents certain procedures of verifying the compliance of draft laws and state authority decisions with existing standards and interests of society, rights and liberties of a man and citizen; these procedures are initiated and performed by state authorities or civil society institutions.

Networked (*electronic*) *strategic meeting* is an expert procedure mode under the chairmanship of a Principal, which serves for consentient elaboration of goals, formulation of problems, and choice of actions.

Networked (*electronic*) *expert community* is a group of legal entities and/or private experts representing different sectors of a society and rendering expert services; a networked expert community employs information and communication technologies that provide equal opportunities for all experts (regardless of their location) to participate in its activity.

Subject supervisor is an authorized representative of a Principal being responsible for problem statement and preparation of a generalized expert report.

Networked (*electronic*) *expert brainstorming* [58] is an expert procedure mode, which supports networked brainstorming under the supervision of a moderator. This mode is intended for rapid generation of nonstandard ideas and proposals.

Networks—Networks have been known from the earliest times. For instance, recall road networks in Ancient Rome, postal networks in the Middle Ages, railway networks, telegraph, or telephone networks. A new type of networks improved communication among people *ergo* promoted further progress. We give an example from the modern world. A global city can be comprehended as the concentration of intersecting "roads." Moscow pretends to the status of a business and financial center as the heart of communications, intersection of financial and other "roads."

As any phenomenon, the development of networks has been demonstrating positive and negative sides. Many scientists predict the forthcoming appearance of a new "informational (networked) society," with power seized by global networks and transnational corporations. They will control people, and everybody will have to fulfill their requirements. Moreover, such viewpoints have even yielded a new term, the so-called *netocracy*. It signifies a new form of society management, where the basic value consists in *information* and structures used to generate, store,

process, and transmit information (rather than material resources such as currency, real estate, etc.). Besides information in its conventional interpretation, the process of society management essentially depends on various (public and nonpublic) institutions and electronic organizations, as well as on the collective unconscious. Actually, the last factor is revealed through spontaneous and purposeful mechanisms of e-expertise.

The intensive development of network institutions based on information and communication technologies highlights the problem of *intellectual property*. Any information allocated in the global network gets expropriated and becomes public. The related difficulties (in the first place, due to existing imperfections of the legal base) are clear. And expertise provides a relevant attribute in their solution.

Modeling of networks and conceptual expert models (hierarchical and cognitive ones) employ the well-developed apparatus of *graph theory*. Complicated objects and phenomena can be easily described by a set of elements and connections among them. A graph represents a set of nodes (elements) and a set of edges (connections, arcs) among them. Graph theory gives a convenient framework to model and cognize the structure of systems having different nature. Owing to visual methods, this framework seems intuitive and comprehensible for everybody (especially, for those having little to do with mathematics). In politics or economics, nodes correspond to factors characterizing a studied situation (inflation rate, product quality, competitive ability, public image, etc.), whereas arcs show the mutual influence of factors (strengthening, weakening, etc.). This approach was reflected in cognitive modeling methods [10]. Probably, among other formal conceptions, graph theory has mostly contributed to popularization of mathematics and application of mathematical methods in practice. Many researchers even treat graph theory as a universal tool of good communication between different scientific disciplines. On the other hand, in the recent decade, various network structures have been attracting the growing interest of theoreticians and practitioners (particularly, in the field of management).

Among network resources, the gradually ascending role belongs to *online networks* (social networks, expert networks, etc.) intended for communication support, opinions exchange, and data acquisition. However, they have recently become the objects and tools of informational control and the scene of informational contagion. In this context, we should mention the framework of graph theory and *game theory* as well.

Of course, online networks have certain benefits and shortcomings. The Internet was designed as a faster means of data transmission, but received further development mostly in the field of data acquisition. Nowadays, we browse the World Wide Web for necessary information (instead of visiting public libraries or bookstores). This seems very comfortable. On the other hand, a modern schoolchild, undergraduate or postgraduate student would hardly go to a public library to read or look into something important. Consequently, fewer people know about the things inaccessible through the Internet. Perhaps, in the foreseeable future, mankind will digitize all existing archives, books, and journals, and completely pass to electronic publications. But this is not the case today. The

Fig. 2 The interaction of basic participants of "conventional" expert activity
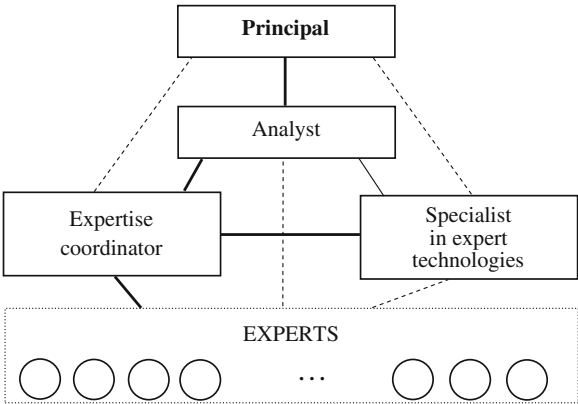
current generation of schoolchildren, undergraduate or postgraduate students lose touch with hard-copy materials and even the culture of their ancestors.

In the sense of information sources, an appreciable difference of any online social network from the Internet consists in the attitude of an individual to information provided by such network. Generally, the Internet provides anonymous information or information from well-known people (journalists, politicians, etc.). They are trusted owing to high rating or reputation gained. In a social network, a recommendation to watch some movie or purchase some product is made by "friends," i.e., people *trusted* not for their reputation or rating, but for personal relationships. In most cases, friends are not experts in products, yet enjoy more trust. In other words, a *social network* represents a source of personalized information (in contrast to Internet). Furthermore, a social network is a means of *communication*. Any individual appreciates the opinion of other people (including recognition, sympathy, and compassion). A social network is a means of support or even safety. Simply share your anxieties in a social network and receive "understanding."

The above-mentioned features apply to expert activity. Online expert networks serve for rapid acquisition and analysis of numerous opinions, organization of interaction among experts, generation of nonstandard decisions, and so on.

E-expertise (networked expertise)—The appearance of e-expertise is predetermined by three major factors: (1) accelerated changes in life conditions, (2) the development of group decision support systems, and (3) advances in information and communication technologies. Modern network information technologies (in the first place, Internet) organize communication of experts and an expertise coordinator. Moreover, they make a new method of expert data processing and collective expert decision-making.

Figure 2 illustrates the interaction of different participants within "conventional" expert activity.

Fig. 3 The simplified
scheme: A Principal and
experts
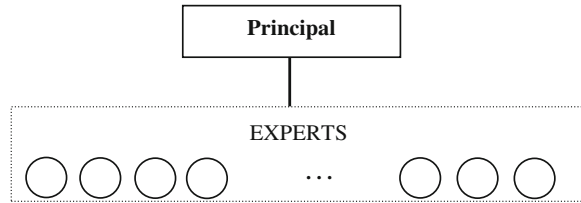
The block "Experts" in Fig. 2 comprises natural persons (individual experts) or legal entities (*expert organizations*). These sources of expert information employ specific responsibility, questionnaires methods, rating assignment methods, etc.

Undoubtedly, simpler schemes of interaction may exist in particular situations. For instance, consider the one in Fig. 3; a Principal acts as an expertise coordinator, an analyst, and a specialist in expert technologies. Such situations should be avoided, though.[2] E-expertise with very many participants requires the presence of an analyst to "translate" expertise results to a Principal.

Any participant of expert activity (a Principal, an analyst, a specialist in expert technologies, an expertise coordinator, a moderator, a subject supervisor, experts) can possess a complicated structure. As a customer and ultimate user of expertise results, a Principal may represent an individual or a collective authority; the institution of analysts may have a hierarchical structure; specialists in expert technologies may be natural persons or legal entities, etc.

Concerning fundamentally new capabilities, networked expertise excels the prevalent bureaucratic system of councilors (that "filter" and "dose" the incoming information of a Principal, see Fig. 4) in the following aspect. A Principal directly addresses any expert, a professional or expert community, a target public group, as well as easily organizes public expertise (see Fig. 5).

The novelty is not just that a Principal "breaches the front" of numerous advisors and accesses the "original information." E-expertise allows improving the quality of management by creating necessary prerequisites of stability and purposefulness in decision-making processes [88, 112]. In addition, expert procedures acquire new properties in principle. They guarantee appreciable reduction of risks in decision-making, require smaller costs under higher complexity, as well as accelerate formation of a "trust space" among experts. Figure 6 shows the scheme of an expert procedure, which incurs considerably greater costs without network usage.

At the same time, it seems incorrect to contrast "conventional" expertise with e-expertise. Actually, they are mutually supplementing and demonstrate some disadvantages and benefits (see below).
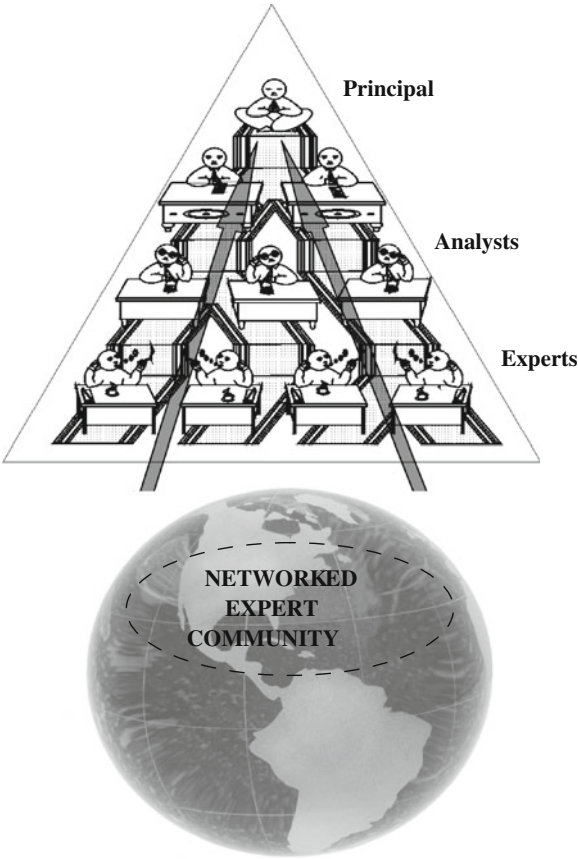
An example of comparing "conventional" expertise and e-expertise concerns the limited time and cognitive capabilities of a Principal.

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[2] A possible exception is the following "expertise." A manager conducts a meeting with his deputies.

Fig. 4 "Common" expertise
in decision-making
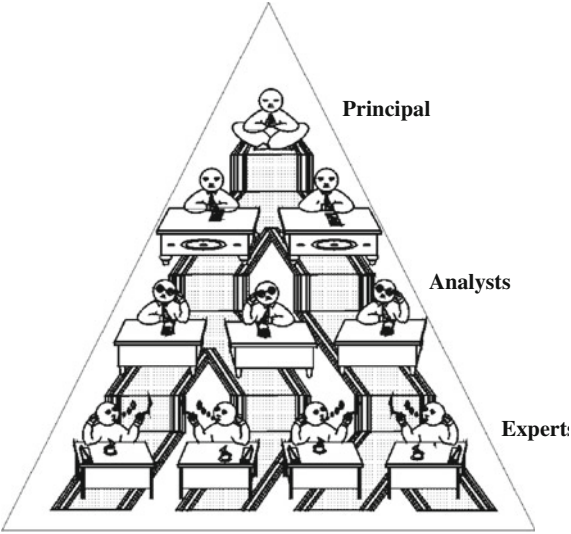
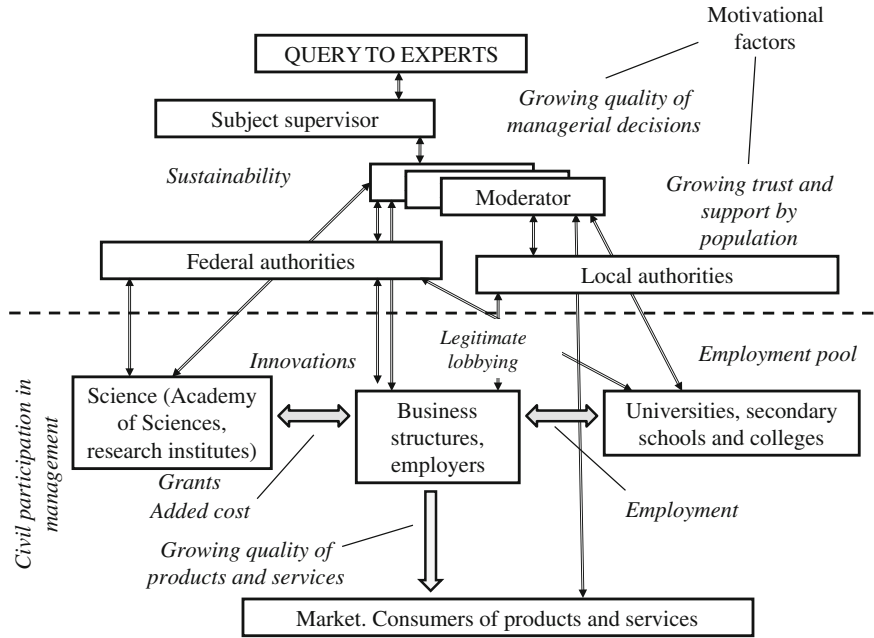**Fig. 5** E-expertise in deci-
sion-making

Fig. 6 Multiple factors considered in e-expertise

Ideally, a Principal should operate reliable and exhaustive information on any processes in a managed system (a state or a region, an enterprise, etc.).

However, the head of a large organization may have no detailed information about activities performed by an employee at a certain instant (more specifically, the former could and should not possess such information). Similarly, an army commander knows nothing about the location of a specific soldier during combat. And the need for *aggregation* (reduction) of *information* arises immediately. This function is performed by experts (as *information sources*) and analysts (as *converters of expert information* into a compact and transparent form for a Principal). Unfortunately, aggregation inevitably causes the risks of information misrepresentation due to objective reasons (bulky data, existing uncertainties) or subjective reasons (individual interests of experts and/or analysts). As is well known, the sustainability of a managed system goes down as management hierarchy grows. To improve such sustainability, a Principal must be able to acquire necessary (qualitative and quantitative) information about objects at any levels as soon as possible [88]. The stated task seems realizable only with the assistance of networked experts.

Different technologies of e-expertise provide the feasibility of addressing primary information (dialoging with experts, as well as expert, professional and public organizations). This improves the decision-making of a Principal in the sense of performance, objectivity, timeliness, and efficiency. Furthermore, such

approach reduces the risks of misrepresenting the "real picture" by the corps of analysts and councilors of a Principal. This does not mean that a Principal would frequently utilize the original information (perhaps, he would not do it at all). But a Principal must have such feasibility in order to improve the sustainability of a managed system (using special expert procedures).

E-expertise possesses the following *advantages* (see [105] for the discussion of solutions generated by large groups):

- timeliness, accuracy, and the complete coverage of a problem;
- the representativeness of experts' opinions, as granting the most adequate reflection of interests pursued by intelligent and elite clubs, public, professional, and other groups;
- the feasibility of involving many experts such that each expert is a specialist in some subject domains (the feasibility of incomplete preferences' aggregation);
- the feasibility of direct communications and electronic collaboration [115] among experts;
- the development of management tools for nonfinancial motivation of experts (including estimation scales and rating systems);
- the presence of self-organization effects in an expert community, the appearance of "collective intelligence" (sometimes, researchers also adopt the terms of "local synergy of intelligence," "teleportation of ideas," and so on), including autonomous formation of experts' reputation;
- the feasibility of documenting and real-time processing of different communication aspects that reflect a sense of actions (connect-analysis);
- transparency, openness, responsibility, and democracy (see Sect. 1.3 of the book);
- the feasibility of activating special mechanisms of information processing (they implement the principle "Ten fools may generate a genuine idea!").

We have repeatedly mentioned that e-expertise incorporates potential obstacles to-be-overcome. In the first place, the matter concerns the loss of direct communication when experts meet virtually.

Second, the number of individual communications among experts may appear superfluous. A group of experts may comprise members with insufficient qualification or knowledge of a specific situation. Opinions of very many experts would hardly converge to a "common" aggregated assessment.

Third, there exists the problem of expert *finding*. This depends on the analysis method of expert data selected in given expertise (see Chap. 3). Another associated problem lies in rational grouping of experts (see Chap. 4).

And finally, analysts, coordinators, and specialists in expert technologies (of course, experts proper) can be interested in certain expertise results. The *problem of data manipulation* arises naturally (some subjects with individual goals exert a strategic influence on expertise results). The data manipulation problem is analyzed in Chap. 5.

The Structure of the Book

Chapter 1 ("E-Expertise") discusses the role of e-expertise in decision-making processes (Sect. 1.1). Next, the procedures of e-expertise are classified (Sect. 1.2), their benefits and shortcomings are identified (Sect. 1.3), and the efficiency conditions are considered (Sect. 1.4).

Chapter 2 ("Expert Technologies and Principles") provides a comprehensive overview of modern expert technologies. A special emphasis is placed on the specifics of e-expertise. Moreover, the authors study the feasibility and reasonability of employing well-known methods and approaches in e-expertise.

Chapter 3 ("E-Expertise: Organization and Technologies") describes some examples of up-to-date technologies to perform e-expertise.

Chapter 4 ("Trust Networks and Competence Networks") deals with the problems of expert finding and grouping by information and communication technologies.

Chapter 5 ("Active Expertise") treats the problem of expertise stability against any strategic manipulation by experts or coordinators having individual interests.

The Appendix provides supplementary information and some draft documents:

   I. Typical statute of networked expert community;
  II. Typical regulations of networked expert community formation within the structure/for the demands of federal authorities;
 III. Assessment criteria for expert analysis organizations (think tanks);
 IV. Assessment procedure for expert ratings;
  V. Professional ethics code for networked expert communities;
 VI. Security problems.

The authors suggest several ways of perusal. A reader interested in the general conception of networked expertise can be confined to Chap. 1. To accumulate necessary information about networked expertise organization, one may terminate reading after Chap. 3. As a matter of fact, Chap. 2 represents a brief navigator over expert technologies. Finally, Chaps. 4 and 5 can be studied independently.