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INTELLIGENT DATA SYSTEMS TO AID DECISION-MAKING AT TENDERS FOR OIL AND GAS FIELDS DEVELOPMENT

In the last few years the world oil and gas industry has experienced a rapid development growing more strongly than many other industry branches. Modern oil and gas industry aims at the extraction of natural resources at an increasing scale. The growth of oil production is conditional upon developing new exploration fields to create auspicious investment conditions, stabilize national social and political life using and implementing state-of-the-art technologies. It is efficient and vital for oil and gas companies today to contract different companies and their competences and resources in the development of fields, oil and gas extraction, transport and refining. It allows incorporating cutting-edge know-how in extracting natural resources by means of implementing new scientific and technological solutions aimed at further leveraging profitability based on inter-company cooperation thus opening opportunities for economic and social development and improvement but also environmental protection and quality of life. The search for a suitable partner / contractor to perform the necessary duties is difficult and laborious, and usually realized in the form of a tendering process.

The complicated nature of organizing tenders requires creating new means and instruments which are designed to improve the choice efficiency and reduce the term of decision making. As evidenced by world experience from other industries the most prospective decision in this field are made using Intelligent Data Systems.

This article deals with structure of intelligent information systems aiding decision-making using the case of an electronic tender competition. In this paper we provide a new approach for tendering in the oil&gas industry.

Keywords: tender procedure, system aiding decision-making, conflict situation, intelligent data analysis, oil and gas industry, purchase innovation.

JEL classification: M10, M11, M15, O31.

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Literature review

The concept of using computer aided tools for decision making was first published in 1963 (Bonini, 1963). However Bonini's work and the majority of subsequent articles are mostly descriptive and advisory in nature, there are relatively few illustrative examples and conceptual works. In the early 1970s, a wide range of terms was used to describe a system that helps decision-makers at various levels of management. Scott Morton (1971) is a representative of the first group of researchers who used the term "decision support system" (Eom, 2006). Since then, many studies in the field of decision support systems (DSS) have been steadily growing.

DSS research can be broadly divided into 1) papers devoted to application development, 2) work on the creation of the theory of DSS and 3) study recommendations for the use of DSS. At the same time the practical aspects of DSS are based on the results of scientific research on DSS. It is therefore important to systematize and analyze the widespread and application of DSS to monitor progress in this area periodically as well as elaborating needs for future research.

Papers devoted to the integration of decision support systems can be broadly divided into theoretic works of DSS (Morton S. and Michael S.,1971; Csaki P. et. al,1995 etc.) and study recommendations for employing them (Eom, 2006; Oyediran, 2011 etc.), but there is virtually no deep analysis of actual cases related to corporate and non-corporate DSS implementation.

Decision support systems are a subset of computer-based information systems (CBIS). One of the major decision support system applications are tender procedures which are very complex and uncertain by nature involving the coordination of many individuals with different priorities and objectives (Mohemad and Hamdan, 2010) . The first objective is making transparent decision and establishing healthy competitive tendering (see, for example, Mohemad and Hamdan, 2010; Alias and Mohamad, 2009). The tendering process is modelled by a generic architecture called Decisioning for Decision Support in Process–D2P that represents decision making processes at a high level. The decision making process is modeled modelling to analyse, study and support the tendering process (Mohamad and Warboys, 2004). Some scholars aim at giving reviews on current practices of DSS technology for tendering processes (see Mohemad and Hamdan, 2010; Mohamad and Man, 2010). They describe technology systems such as web-based information systems, process standard from Jabatan Kerja Raya Malaysia (JKRM), intelligent Web-based decision support systems and applications of Web-based tendering processes (see Bharati, 2004; Mohamad and Man, 2010; Mohamad and Hamdan, 2010; Mohamad and Papamichail, 2006; Mohemad and Hamdan, 2010). More recently tendering processes were designed and implemented applying intelligent agents, which are emerging technologies in DSS, and have been recognised as a flexible and efficient methodology to facilitate the development of DSS (Alias and Mohamad Noor, 2009; Taghezout et. al, 2009).

Due to the importance of tendering management a new research stream focusing on tender evaluation using intelligent agent systems has begun to emerge. Designing intelligent agents requires a systematic analysis of the agents' environments (Alias and Mohamad Noor, 2009). The combination of Web services and software agents provides a promising computing paradigm for efficient service selection and integration of inter-organizational business processes (Taghezout N. et. al, 2009). Eventually all these technologies are used to facilitate the understanding and communication of electronic tendering processes to stakeholders such as construction managers and contractors (Mohamad Noor and Papamichail, 2006). The main advantages of web-tender technologies are the widespread adoption of PCs and mobile communication systems and the Internet, interactive computing, application of computing to semi-structured problems, use of computers by managers and others, cloud computing (Alias and Mohamad Noor, 2009).

Advancing the application of information technology in tendering is a major international research and innovation endeavour for both scientific establishments and industry (Mohamad and Warboys, 2004). Current practices of general tendering processes as applied in the most regions, e.g. USA, Europe, Middle East and Asia are comprehensively discussed (see, for example, Mohemad and Hamdan, 2010; Oyediran and Akintola, 2011).

Today's oil and gas industry needs a common information technology (IT) reference architecture for use by upstream organizations, system integrators (SIs) and solution providers (SPs). Microsoft is currently working to develop a coherent reference architecture that will enable a better integration of upstream applications through the composition of common application components. A single architectural approach will encourage the simplification and unification in the upstream sector. It will also give SIs and SPs a common environment in which to design and build solutions, while allowing upstream operators to design architectures as a requirement for potential vendors (Microsoft).

Rincon and Perez (2004) and PricewaterhouseCoopers (PWC 2008) report examples of using computer technologies in tendering processes. They consider e-Procurement a new paradigm in procurement which acts as an information hub to support business planning and decision making. It improves the performance of routine tasks like transaction processing, monitoring and enforcement of regulatory compliance, increases transparency, eliminates middlemen overhead cost, improves competition amongst suppliers and eases management reporting. Overall, doing business electronically is found to have a profound impact on the way today's construction businesses operate — streamlining existing processes, with the growth in innovative tools, such as e-Tender, offering the construction industry new responsibilities and opportunities for all parties involved (see PWC, 2008; Kajewski et. al, 2001).

The implementation of an automated e-Tendering process (system) enhances the overall quality, timeliness and cost-effectiveness of a tender process and provides a streamlined method of receiving, managing, and submitting tender documents than the traditional paper-based process.

However scholars also identified a range of challenges and perceptions that seem to hinder the uptake of this innovative approach to electronic tendering. A central concern seems to be that of security – when industry organizations have to use the Internet for electronic information transfer (Kajewski, 2001 et. al).

As evidenced literature review the main purpose of tenders is to arrange competition on terms which are attractive for the participants. On the basis of literature review we can summarize that the main criteria of attractiveness (effectiveness) are:

- minimal cost (price) of purchased resources,
- compliance with quality requirements for purchased resources,
- regular timely delivery of purchased resources,
- flexible settlements procedure while paying for purchased resources.

However, tender competition does not always allow maintaining the optimal price/quality ratio, obstructing purchase of products (works, services) ideally compliant with the consumer requirements, and does not always eliminate the possibility of work with poorly qualified or unconscientious specialists, or providing steady and sound relations between the bid holder and successful tender.

Finally we conclude that despite the fact that there is a lot of research devoted to the investigation of using DSS in tender procedures a serious lack of methodologies of implementation in the oil&gas industry taking into account national and sectoral specifics remains. Consequently we provide our own methodology for tendering on the example of oil&gas sector in Russia.

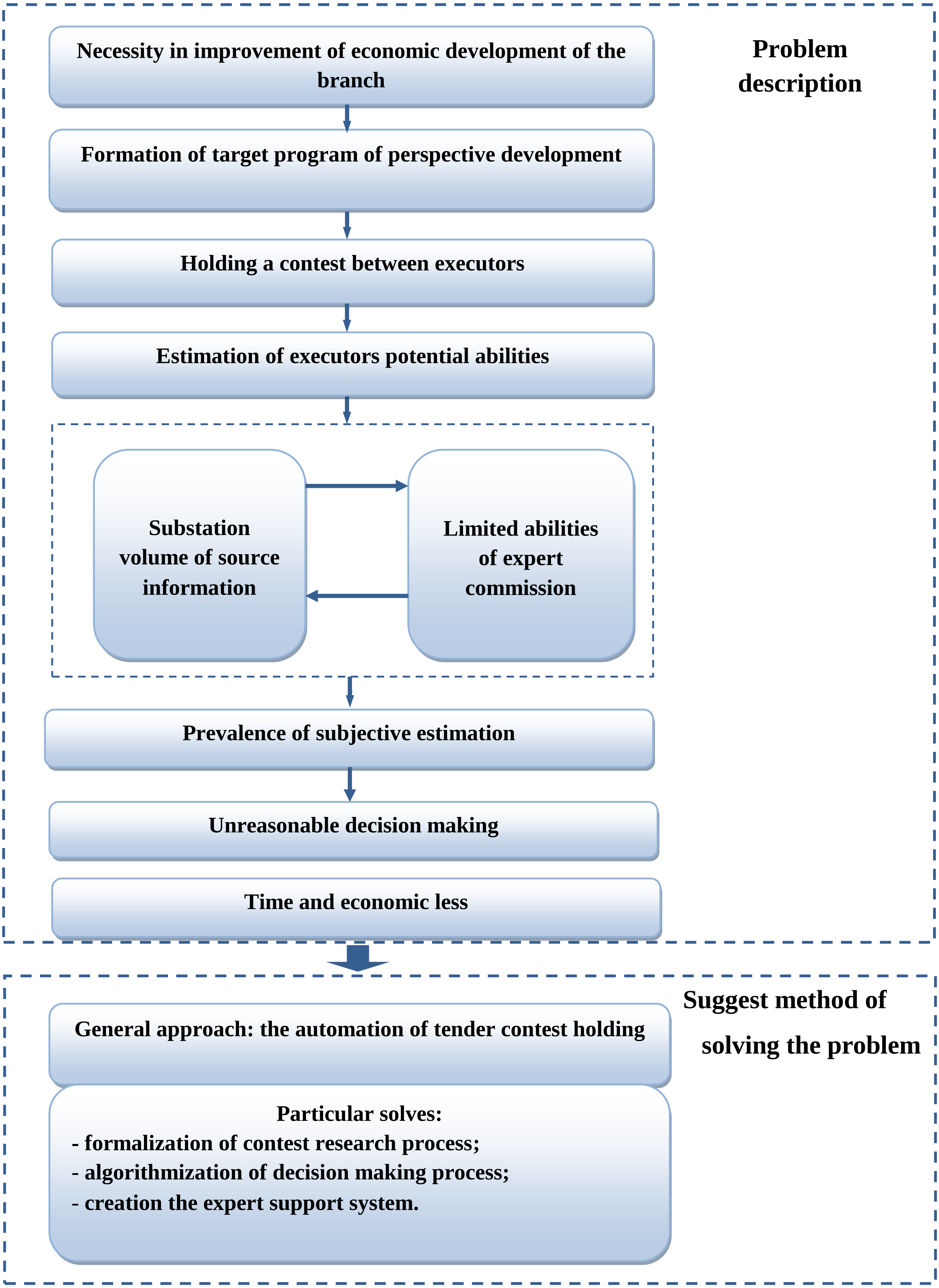
The complicated nature of organizing tenders requires creating new means and instruments designed to improve the choice efficiency and reduce the complexity of decision making.

The literature **review leads to the following** research questions. The analysis of existing tendering approaches reveals major problem associated with these and outlines possible ways to overcome them.

First external challenges include the necessity for improvement of the economic development of the industry, the formation of target programs of perspective development, the holding of contests between executors and the assessment of executors' potential capabilities (figure 1).

Figure 1 systemizes the challenges occurring during purchasing contests which's impact is not limited to the actual contest results but extends to the companies and executors' eventual performance.

Figure 1. The scheme of research problem



Second a method is proposed to meet this challenge which aims at improving the procedures of carrying out a tender contest by process automation.

Methodology

We propose to introduce computer assistance to tendering procedures, i.e. to substitute intellectual and manual labor of the bid holder meant to choose an appropriate contractor with the automated system aiding decision-making (SADM). Choosing the successful bidder through procedures of tender for oil and gas fields imposes high level of responsibility for the decision-maker on the bid holder to the tenderers, the decision is time-restricted and demands unconventional thinking. Such situation can be described as conflict (disputed).

It is typical for the conflict situations arising from tenders related to oil and gas field development that the bidders tend to become prejudiced and try to please the client rather than find the common ground with him. In other words, they play up to the client rather than demonstrate their real potential. It hampers impartial assessment of the bidders. To find the true best successful bidder the bid holder should have clear, well-founded, impartial understanding of which company to prefer. Making the decision about the best fit company under stressing conditions such as conflict (competition) is usually up to a certain person — director or manager.

Bharati (2004) finds the following basic principles of creating and using SADM in conflict situations:

- providing the bid holder with all the necessary information possibly available;
- option to perform prompt search of data on the bidders;
- generating alternative possible solutions;
- providing predictive assessment of results of realizing possible alternatives;
- continuous evolution of the system due to advancement of its capabilities

The generic structure of intelligent data SADM includes four basic functional groups of elements:

- intelligent interface;
- database;
- intelligent database;
- problem solver.

The intelligent interface is a complex of hardware and software instruments effectively connecting the intelligent system with human user and ambient environment while organizing data exchange in course of the system operation. The so-called pop-up dialog window presenting information requested by user in form of diagrams, tables, mnemonic diagrams, text etc. can be an example of intelligent interface for choosing the successful bidder.

The database consists of hardware and software instruments allowing to write and store in the system memory and search for basic information units of the given structure, i.e. data and factual information about the operating environment. The database is based on exact values of elements of reality (source and temporary information), including information on the problem currently processed by the system. This information is inserted into the system from outside through the intelligent interface and form, basically, a parametric model of the system's operating environment for the present moment. For example, a database for choosing the successful bidder can describe the current conditions of similar competing companies (technological level of manufacture, personnel qualification, the conditions of transport infrastructure (roads, pipelines, ports etc.).

An intelligent database includes a complex of relatively long-term data providing insight into the regularities specific for the domain where the system is used (axiomatic information) and its methods of solving various problems (heuristic information) according to the current level of knowledge about reality (operating environment of the intelligent system). The complex of information stored in the intelligent database forms a procedure-oriented model of the intelligent system operating environment and allows operations of task-oriented data transformations using the database contents to solve the given problem (Bhargava, 2007). The intelligent database can include, for example, various standards for oil and gas companies, general information about bidders, information and individual knowledge of experts and specialists working in the oil and gas industry. The format of data stored in the knowledge base is given by the expression of axioms, i.e. the procedure model "If average annual cost of R&D performed in the last 5 years amounts to 50 mln. roubles, the company is profitable"; "If a company has 10 years of experience in oil and gas fields development, this company is reliable"; "If a company has specialized software programs for natural deposits development, the company is strong", etc.

The problem solver is the key element of the intelligent system. It is a complex of hardware and software instruments providing search capabilities and creating instructions for solving the given problem. The solver contents is made of procedures reflecting the general strategy of management decision-making, and specifically mechanisms of problem-solving specific to the domain in question and used by specialists (experts) working in it. These processes form, basically, the search and control algorithm of the intelligent system, or else the system's knowledge of itself (metaknowledge) and allow creating the solution tree for pursuing a goal based on information and data. The solver contents for choosing the successful bidder can be exemplified by heuristic description of a bidder in form of process instructions, such as: "IF… THAN…». For example: "IF the company is profitable THAN it qualifies for the tender"; "IF the company is reliable THAN it qualifies for the tender"; "IF the company is strong THAN it qualifies for the tender", etc.

The solver contents can also include procedures allowing for possible implementation of teaching and learning (adaptation in the broad sense of the term) in the intelligent system (interactive and offline mode), i.e. obtaining new information and correcting current information and problem-solving strategies according to the working conditions at both stages of creating the system and its operation. It is therefore possible to describe the problem solver as a model of reasoning performed by a professional specializing in the given field, including the ability under difficult circumstances to discard the search directions with the least potential, narrowing down the options in search of solution for the given problem.

The problem solver contents can include models of reasoning by analogy, by association, common sense etc., usually involved into problem-solving strategies in the state space, space of alternatives or inference used by specialists in planning their activities or solving certain problems (Kajewski et al., 2001).

Therefore, the problem-solving process designed to define the successful bidder takes the following form:

$$\mathbf{U = \varphi(x, zx),}$$

- where x is description of potential of the bidders,
- zx is the list of requirements for the oil and gas companies participating in the tender,
- U is decision/choice of a certain contractor,
- φ is the algorithm of the bid holder defining whether a company qualifies for the work or not.

In such formalized representation vectors x and zx represent contents of the database and the intelligent database respectively and are essentially a model describing the bidders and requirements applied to them.

Algorithm (φ) is a control model in form of programs for processing the given descriptions (x, zx) allowing on the one hand to take into account the contents of the problem to be solved, and on another hand to generate decisions choosing the successful bidder (U).

Programs of processing descriptions are proposed to be formed based on heuristics used by expert managers in their daily activities. These heuristics reflect certain regularities in the process of choosing the successful bidder and take into account the nature and specific features of reasoning by experienced specialists such as a bid holder.

The structure of a tender vividly reflects the investigated problem area and enables to allocate automation the elements of this process (Figures 2, 3). Solutions based on the results obtained by the SADM may inherit a potential distrust in these results by the bidders and tenderers. The expert shell “Explanatory Expert System” is suggested for contest organizers to refine the solution obtained.

Figure 2. Present decision making scheme

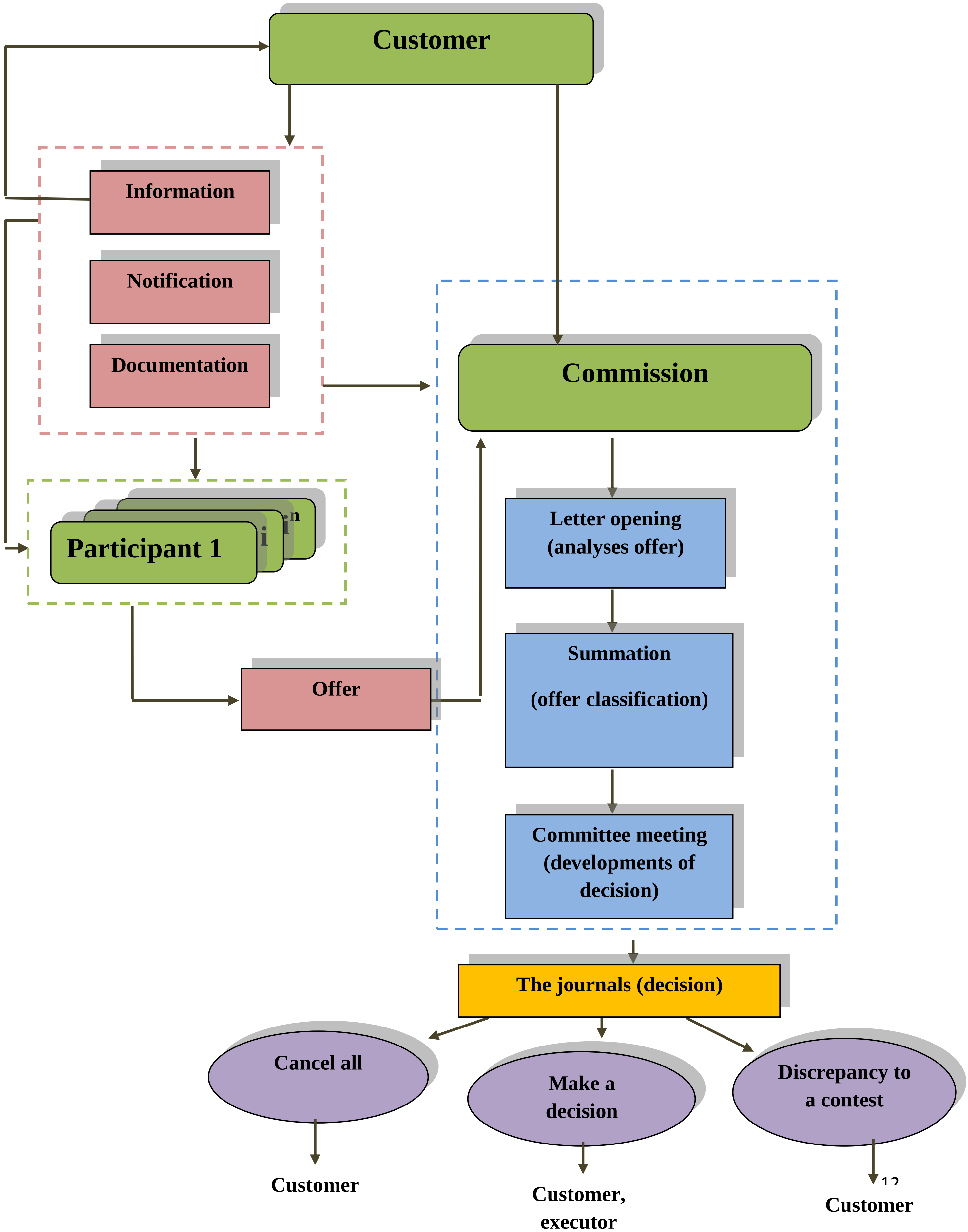
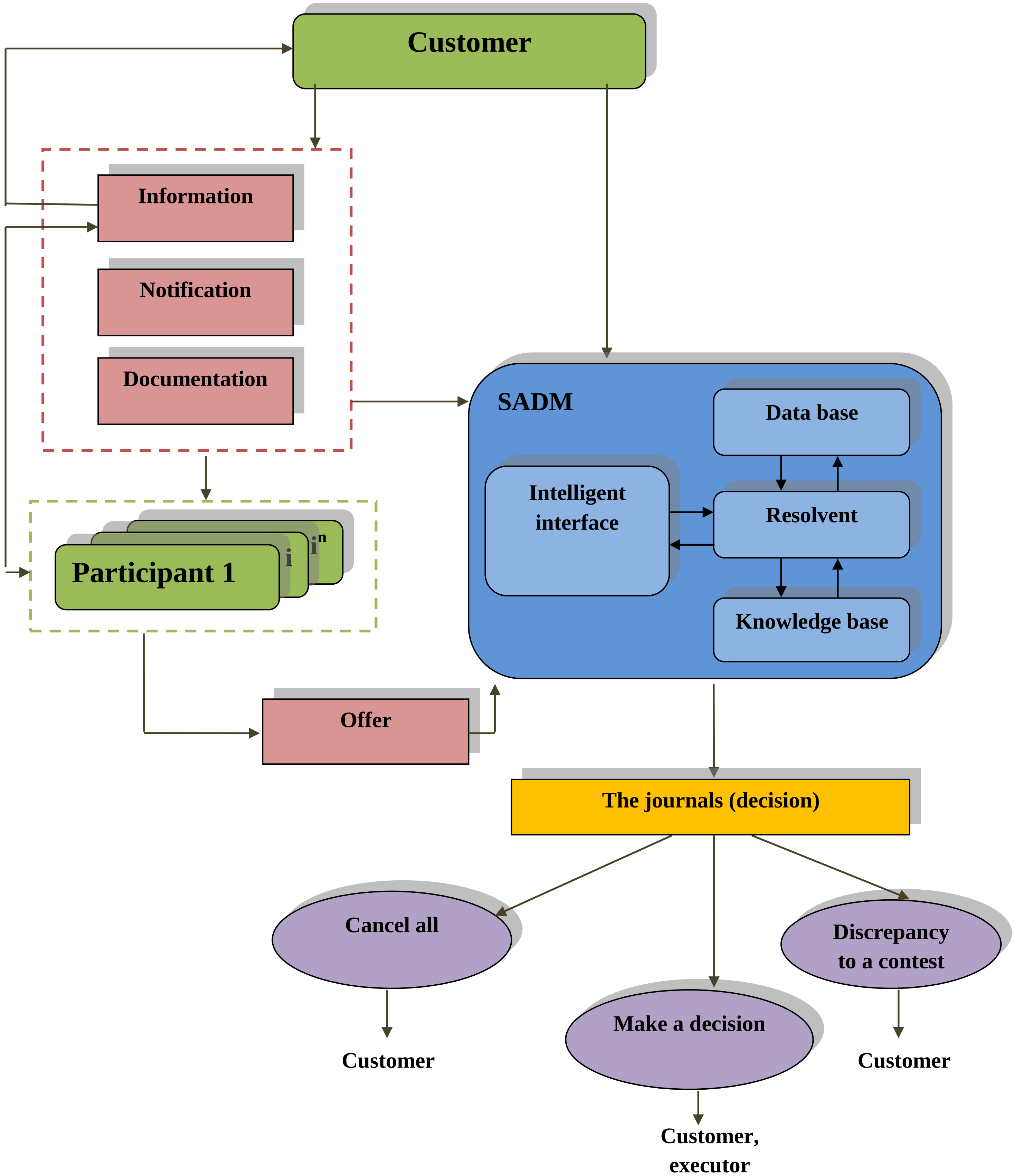


Figure 3. Proposed decision making scheme



Conclusion

The use of computer technologies in the form of intellectual systems, SADM, during a tender competition, has the potential for significant cost reductions hence increase of profit margins. There is preliminary evidence that profit margin can rise by 10–30 % on average. Moreover SADM shows non quantifiable effects which impact the quality and transparency of decision making in the tendering process. Firstly there is a more systematic and structured documentation of all relevant information and documents, secondly any information or document can be changed and updated real time, the possibility of unintended manipulation of any information is limited. Thirdly information are by definition and in principle available at almost any place simultaneously and can be processed by more than one person at the same time. At the same time these advantages are challenged by human behavior especially in the introductory phases of SADM. The transparency of the decision procedure which is the advantage of SADM implies a loss of power for the by then dominating knowledge and information holder. Neither should the power of these people be underestimated nor their motivation to limit and hamper the introduction of SADM.

Eventually it can be concluded that implementing intelligent data systems to aid decision-making allows significant time saving and improves the probability of choosing the most suitable company in managing a conflict situation such as choosing the successful bidder.

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