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New Goal-Oriented Approach to Assess Main Virtual Organization's Elements Integrated with Model-Based Methods

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Abstract

For a sufficient understanding of the status of the virtual organization (VO), assessment from viewpoints is required. The evaluation of the VO includes the evaluation of the entire VO, the assessment of partner organizations in VO, the evaluating of projects in VO, the evaluating of the progress of VO projects, the evaluation of the VO improvement in different periods, the assessment of capabilities, the assessment of a service-group, and etcetera. Understanding an accurate evaluation of the VO is an impressive factor in more effective VO management and helps VO achieve better to the VO mission and objectives. This research represents a new goal-oriented procedure for service-oriented (SO) VO assessment. This method can assess VO from the different types mentioned above. This method acts as part of COBEAM (collaborative enterprise architecture method) and works consistently with many goal-oriented service-oriented concept-based methods.

Keywords: Service Oriented Virtual Organization, Virtual Organization Integration, Virtual Organization Management, goal-oriented assessment, Knowledge Management.

1 Introduction

The concept of VO is considered an alternative to establishing cooperation between independent partners such as organizations, human resources, and information [1] [2]. In recent years many innovations regarding the development, improvement, and management of VO and its combination with other methods which are using in enterprise architecture (EA) have been propounded. The foundation of VO is collaboration due to achieve the mission of the whole VO and the goals of its partners. An example of such organizations is the project of crisis management to organize in time and suitable enough for citizens, when natural disasters take place, war, and such like issues.

To achieve that purpose several organizations such as municipality, Red Crescent, constabulary, healthcare organization and etcetera should collaborate in an integrated manner and share their services in an integrated way.

Obviously, assessment and management of cooperative organizations requires an integrated architecture of methods, regarding to relation between components of VO, and based on an incorporated modeling. Such an architecture due to attaining main and complementary characteristics of VO should consider many cases such as: goal-orientation [3], dynamism [4], collaborative infra structures [4] [5], communication and cooperation between participants [4] [6], cooperation between autonomous and heterogeneous partners [7] [8], unpredictable environment [8] [9], knowledge intensive environment [8], agility [10] , Avoiding information overflow [11], performance in inter-organizational connection [2] [12] [13], development of trust [14] [15], common understanding [15,16], resource selection [17], effectiveness [18] [19], Decision making about partners

[4] [15] [20] [21], separation with integration [4] [19] [22], integration of business processes [4] [15] [16], data and knowledge-base (KB) integration [20] [23], and setting priorities based on organization mission [2] [4] [15].

To understand the current state and accurate assessment of the VO, first, well-defined modeling of all VO elements should be done. Then, by using a goal-oriented method, and based on the designed models, the priorities of VO elements will be identified. Finally, based on the detected priorities and the current status of the VO, the assessment procedure will be carried out.

Assessing VO elements such as services, service groups, projects, and partners, from the first phase to the end, prevents not useful investigations and helps to reach better to the goals of VO. Consequently, an integrated approach based on the mission of the organization, and goals in an integrated manner with consistent models of VO, seems to be one of the necessities for VO success.

One of the current necessities of virtual organization's management is the existence of an integrated solution based on the mission and objectives of VO including the capability of generality. Generality says that each partner corresponds to its main elements and based on important parameters from its viewpoint and VO mission, could identify the basic elements. Unfortunately, today's VO management methods suffer from the following challenges and limitations:

- Considering relations between main elements in each partner organization, and the whole VO [16];
- Conflict analysis and tracing for distinguishing needed services, especially with many requirements in VO;
- Data-driven and flexible architecture and method to cover all phases of SO VO management;
- An integrated KB to store VO best practices with an integrated understanding;
- A suitable mission-oriented assessment method for assessing services, projects, and partners based on VO priorities in SO VO [16] [24] [25];
- Saving the assessment results, for the next decision makings [24] [25]; and
- Not limiting partner organizations to adhere to a particular framework, method, and language.

In this research, an integrated approach based on VO mission and corresponding modeling for VO namely the VO Mission-Oriented EA analysis method (VOM-M) has been introduced. This method is based on:

- SO VO;
- A customization of the mission-oriented EA assessment method (MOEAAM); and
-Collaborative ontology-based EA models (COBEAM).

This research is organized in the following way: Section 2 presents related work. Section 3 motivates COBEAM Architecture; section 4 introduces VOM-M Method. Section 5 presents the AC component in VOM-M, Section 6 presents an analysis method of applicability and an evaluation of the AC, and section 7 concludes and gives ideas about future work.

2. Related work

This section summarizes related work, going from the broad field of VO modeling, assessment, and management. Management of VO is very complex. This management needs an integrated and flexible method to cover the main phases of VO to reach the mission and main goals of VO.

EA provides a set of principles, methods, models, and tools for analyzing, designing, and redesigning elements and identifying the relations and linkages among these elements. Therefore, EAs enable the company to be represented in a holistic and integrated perspective, to achieve the business objectives, and facilitate decision-making [20]. In recent years, several EAs have been proposed. Several studies have explored how different EA frameworks (including TOGAF) can be used to achieve strategic alignment. However, these studies do not provide prescriptive guidelines to achieve this alignment in real-life settings.

Emerging business and IT trends, such as Service-Oriented Architecture (SOA), may impact EA frameworks, methodologies, governance, and tools. However, the phenomenon of EA evolution is still poorly understood. Although both EA and SOA have matured, there is a lack of understanding of the relation among them, which has resulted in a marginal realization of their combined benefits. New paradigms, such as SOA, emerge and change the enterprise, and recent architectural elements and relations may need to be considered.

The existing approaches do not consider external influences on the EA planning process or changing conditions in an organization's environment. To better management of Service Oriented (SO) EA, knowledge management (KM) is needed. High information quality helps to allocate resources better according to value creation, and strategic goals, and it speeds up decision-making processes. Some research shows that the higher the integration degree is in the organization, the higher the efficiency of the new product development will be, and the products created are more in line with market demand. KM consists of preparing integrated modeling, priority detection, assessment, and Decision making. One of the important parts of KM is benefits management. The benefit management process is required for the active management of, and continuous alignment between, project outputs, outcomes, benefits, and organizational strategy [23].

Another important case in KM and benefits management for organizations is priority detection in organizations' entities.

In EA, the effectiveness is determined by the degree to which the outputs of EA implementation can help the enterprise attain its intended goals [24]. Besides, EA function effectiveness is: "the degree to which organizational objectives are attained through the outputs of the EA function" [24] [25].

There is the ineffectiveness of the EA implementation methodology that is used to support EA implementation due to the complexities; these complexities come from EA implementation management processes, models, methods, and strategy [24]. Consequently, EA projects may be faced with a lack of support in the following part of EA: requirement analysis, governance and evaluation, a guideline for implementation, and continuous improvement of EA implementation [24].

In most of EA implementation management's methods, the design of a transition plan is used between TO-Be and As-Is architecture. Some important factors for this case are effective communication, optimal alignment, continuous improvement, appropriate governance mechanism to detect project progress, selected effective process, effective agile collaboration, value-driven, consistency, adaptability, abstraction levels, and flexibility [24]. Each of the existing methods only addresses one or more of the factors mentioned above.

We checked 160 papers for reviewing existing transition planning methods, from 1999-2022. Through EA, the process of sharing information between organizations will be more efficient. The organization is still unable to translate the proposed EA solution provided by existing EA frameworks/methodologies according to its own organizational needs [25]. But many organizations especially those in public sector agencies are having difficulties in implementing EA due to the inflexibility and complexity of the business and IT structures [25] [26].

Some existing methods will only evaluate and manage a specific attribute, such as [27]. Some studies present evaluating methods of service evaluation, using AHP (Analytic Hierarchy Process) and fuzzy AHP, but are not suitable for VO assessment and management [26] [28] [29] [30]. Nuralizadeh et al., have presented a method to assist the EA implementation process by proposing an EA implementation capability and priority assessment model. But this method is not suitable for SO VO [26]. Some researchers such as Prothivi Bhattacharya, and Azevedo et al. have designed a conceptual modeling strategic alignment and information technology based on TOGAF [31] [32] [33]. But this research does not provide a quantitative method based on this conceptual modeling. Simona Kidiene has presented a multi-criteria opportunity assessment method [34]. But this method is not designed to be compliant with SO VO.

OMAVE is another approximately formal domain modeling and partner selection approach for collaborative designing in VEs. This approach has presented a rule-based system for this case [35]. But this method makes it difficult to understand and use.

Therefore, in short, we need a systematic and consistent method for designing and managing a transition plan for VO, including the following cases:

- Service Orientation
- Based on SO VO characteristics
- Value-driven and presenting priorities of VO elements
- Effectiveness
- Agility
- Based on integrated and ontology-based models of VO
- Generic model presented that can fit other organizations
- Adaptability
- Presenting level of abstraction and different needed viewpoints
- Project progress detection
- Presenting quantitative needed calculations
- Easy to understand and use
- Saving the results as best practices in a knowledge-base

In this study, we present a systematic method that includes the above items. We named this method VOM-M.

3. Description of COBEAM

In section 2, the existence of an integrated architecture, including the main components for managing the VO, was introduced as an important requirement. To help with this challenge, we have made COBEAM an integrated architecture to cover the main required components of the VO life cycle. In COBEAM, consistency, agility, the capability of alteration, and expansion are considered necessities of VOs. COBEAM consists of three parts:

Collaborative Ontology-based EA Framework (COBEAF), shared knowledge base, and VOM-M.

COBEAF provides an ontology-based modeling framework for SO VO recognition and modeling. In COBEAM, a shared KB is designed to store all gained information about the VO. The models designed by COBEAF are also stored in shared KB. Storing and updating information is done by a dispatcher /updater component. In this manner, at each stage of the VO life cycle, the necessary information can be obtained from shared KB.

By presenting different viewpoints and different levels of abstraction, COBEAF provides a better understanding and focus on the required data by each shareholder.

In COBEAM, we have established the Measure class to store detected priorities and prepare required values for more accurate assessment, management, and decision-making. The Measure class was designed and modelled in the conceptual and logical models, as illustrated in Figures 2 and 3. This class was created for SO VO management, based on mission and goal-oriented approaches, and stores results from values in an integrated manner. A schema of the Measure class related to the COBEAF component is illustrated in Figure 1.

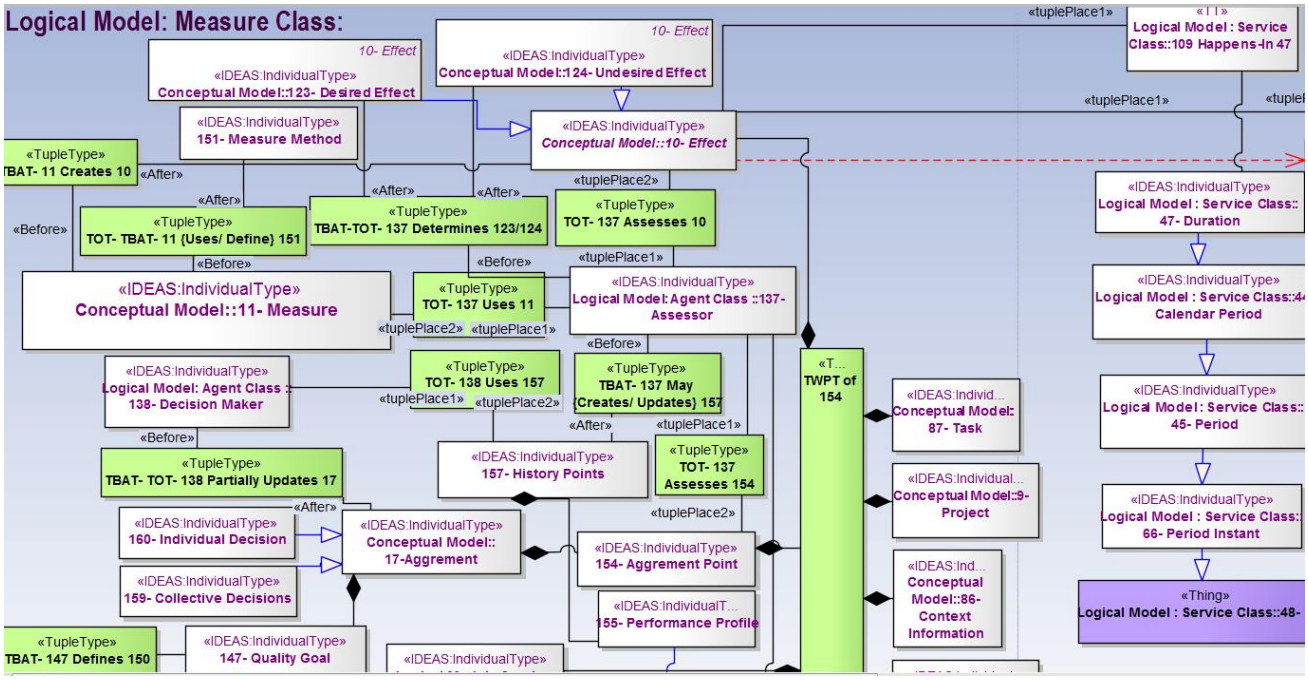


Figure (1): Sample of logical model of measure class of COBEAM architecture

4. Description of VOM_M

The component of VOM-M, as part of COBEAM, performs the task of identifying the priorities of the VO components, assessment of them based on VO goals, and making accurate decisions about the VO. The VOM-M component is illustrated in Figure 2. All elements in VOM-M can act at different levels of abstraction. VOM-M structure and the default layers for VOM-M are illustrated in Figure 2. PC acts as top-down, and AC acts as bottom-up in VOM-M layers.

One of VOM-M's positive characteristics is that, based on the level of required accuracy, and the amount of budget and time spent, it is possible to customize the levels associated with each element of VOM-M.

VOM_M consists of the following main components:

- Prioritization component (PC): responsible for determining the importance of any element in the VO and prioritizing these based on the organization assignment.
- Assessment component (AC): responsible for VO assessment on different granularity levels of the elements, including partners, projects, and progress of any project at different time milestones. This component uses outputs of the PC component as one of the assessment parameter values for assessment at a larger granularity level of the elements.
- Decision support system component (DSSC): This component decides on the selected problem description in four parallel methods. Comparing the results of a decision with different methods for one issue makes it possible to increase trust in the decision's correctness.
- DSS assessor component (DSSAC): compares the decision results from the mentioned methods for one issue, making it possible to increase the reliability of and confidence in the decision correctness.
- Knowledge-based updater component (KBUC): adds new COBEAF models and amounts of VOM_M components calculations to the knowledge base.

Complete descriptions of the AC, DSS, and DSSAC will be provided in separate articles.

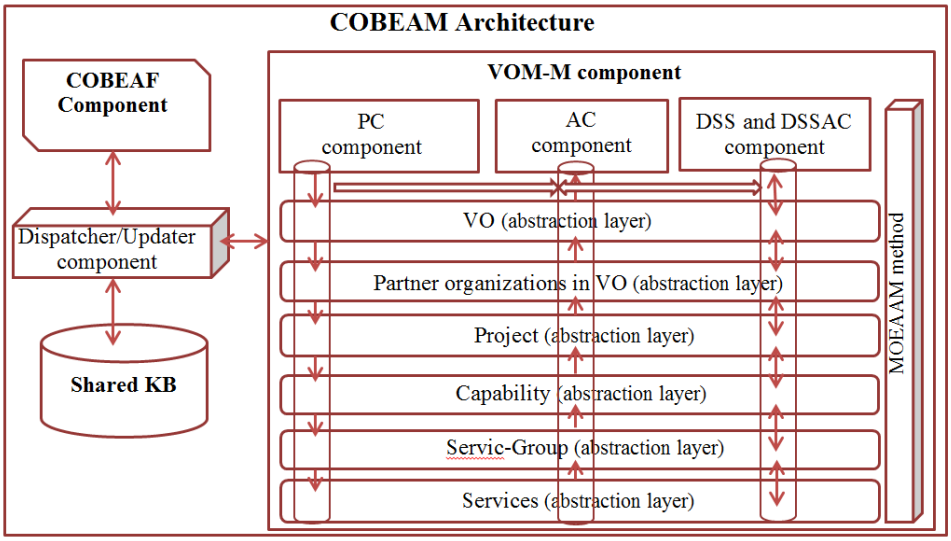


Figure (2): VOM-M as a part of COBEAM

5. Assessment components (AC) description

The AC component receives priority values from the PC component. As illustrated in Figure 3, the PC component prioritizes the VO components using extended MOEAAM [18] [19]. This component operates based on the relations defined in COBEAF.

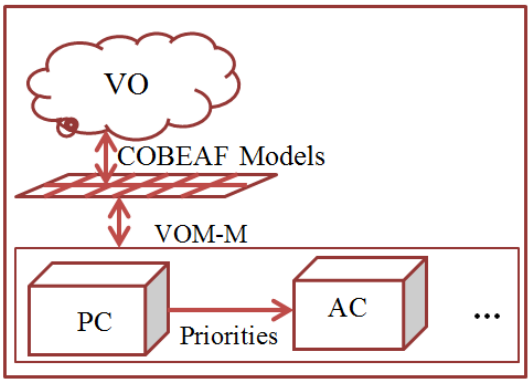


Figure (3): AC gets priorities from PC

Description of the PC method and COBEAM architecture have been mentioned in the related papers from this research [18] [19]. The AC receives PC results as each element value. After that, voters vote about the quality of the lowest layer elements. In COBEAM, for the Assessment of elements of VOM-M, formula 1 has been designed.

$$(1)\quad QualityPercentage_i \equiv \frac{\sum_1^n (Weight_j \times Vote_j)}{100}$$

The "Quality Percentage$_i$" is the final calculated score for element "i", "Weight$_j$" is the allocated weight for Voter$_j$, "Vote$_j$" is the value of the vote allocated with Voter$_j$ to the elementi, and "n" is the number of voters. Finally, the assessment of VO elements is done with formula 2.

$$(2)\quad Score_j \frac{\frac{\sum_1^n (Effect_i \times QualityPercentage_i)}{100} + QualityPercentage_j}{2}$$

The result of the evaluation of each component is" Score$_j$". In the formula number 2," Score$_j$" is the calculated quality score for component$_j$, "Effect$_i$" is the effect percentage of the child node$_i$ for father node$_j$.

Formula 1, and 2 should be done from down to the top of the layers mentioned in Figure 2. These calculations should be done until the highest level.

Finally, the result scores for each goal show the percentage of the achievement of each goal related to the VO's mission.

For progress assessment of the project, these calculations could be done at different milestones of time. The number of milestones is related to the needed precision of progress control. More milestones of progress assessment mean more overhead calculations.

The comparison of the richness percentage of each goal between milestones helps to understand project progress.

By checking the quality score result for each element, and the element provider ID, we can understand the quality of collaboration of each partner. Since the partner's collaboration results may affect each partner's score, to check each partner's quality score, it is better to consider the collaboration tree and the partner's quality scores. For this case, such a tree as Figure 4 can be used. In this tree, children nodes are needed for the father's node to reach to father's responsibility.

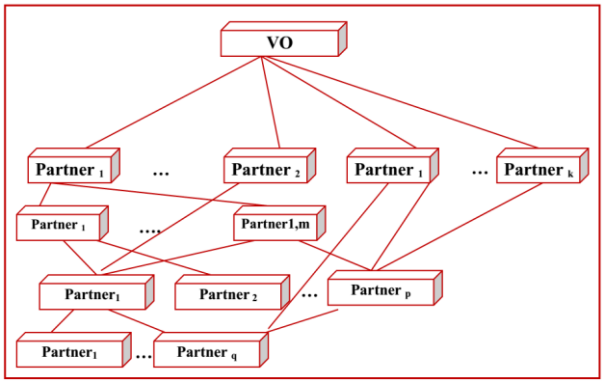
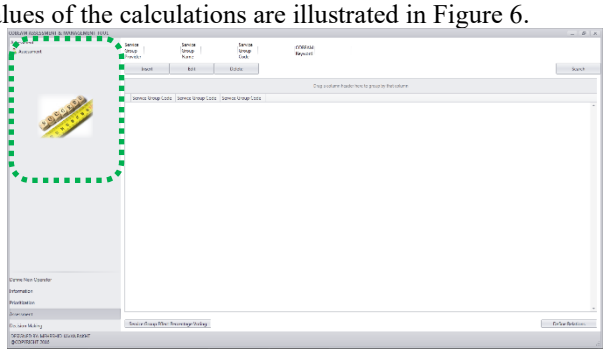


Figure (4): Partner influence tree

6. Checking the usability and validation of AC in the VOM_M

For the study of usability and validation of the "AC" component in VOM_M, two online projects in "air pollution prevention" and a project of "Virtual medical services" has been used in the method. Then the layers of the goals and other components are identified and listed by experts and the related values were initialized. Maintaining the integrity of information and calculations done for all components manually is difficult. For this purpose, COBEAM software was designed and made for saving all information while saving data and simplifying calculations. An interface of the software designed for the atomization of AC calculation has shown in Figure 5. A portion of the centric values and final values of the calculations are illustrated in Figure 6.



Figure(5): An interface of the software has designed for atomization of AC calculation

The AC section designed in the software, including exclusive sections of "ID" components, in the proportion of the formula provides automatic calculation and data input, communication definition, and voting. A small part of the results of the calculations related to the "AC" has shown in equation 3.

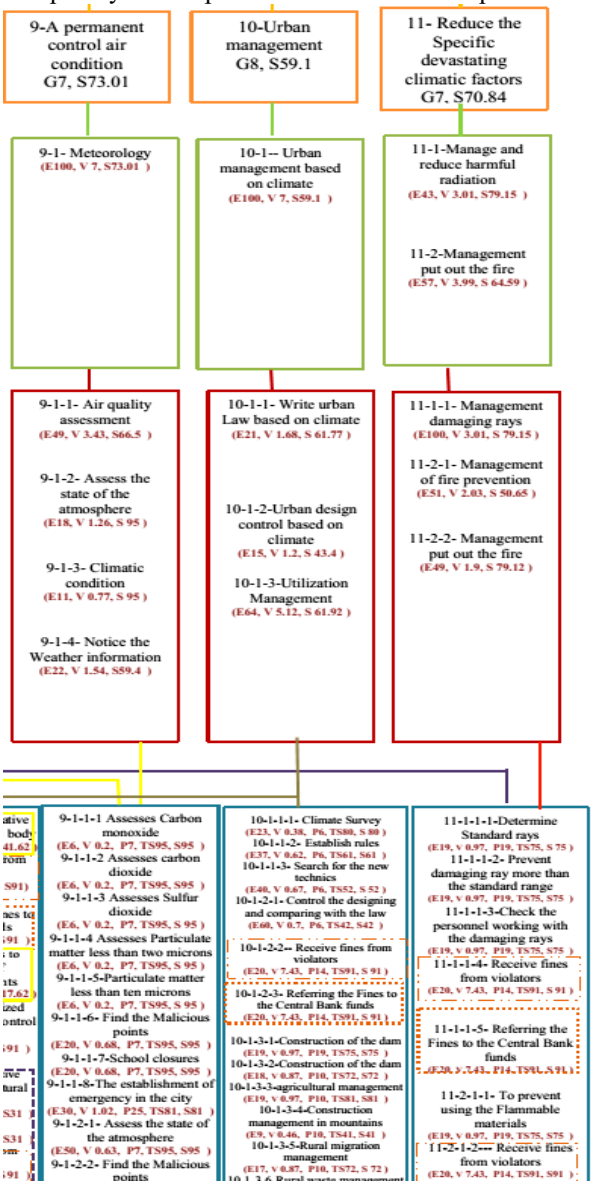
(3)

(E27, V 0.340, P22, TS19, S18.99)

In equation 3, for the "i_{th}" element" E" is the percentage of effect of element "i", "V", is the final calculated value for the element "i", and "p" is the "provider partner" of that element. "TS" is the current temporal score of element "i", and "S" is the final score of the element "i".

The important results were compared with the study's intuitive studies and experts' opinions. For example, "standardization of fuel", and "car industry management" services have given low scores in this project. This means that these two issues are flawed and should be addressed to improve them.

To check "AC" more, the voter's weights and also the value of goals have been changed and the value related to each element, from the lowest level of the layers, was reviewed, calculated, and changed. The results of AC calculations were completely compared with the expected results.



Figure(6): A small part of AC's results has calculated for "air polution preventation" project

7. Conclusion

As mentioned in the abstraction part of the present article, one of the most important challenges in VO management, is

the lack of a flexible and integrated method based on the VO mission. AC component in COBEAM as a goal-oriented and priority-oriented approach provides the assessment results as scores for each element for achieving the VO mission and goals. AC acts in an integrated manner with other parts of COBEAM.

One of the needed specifications of the mentioned method is its capability to be extendable and reusable in different projects. Given the SO concept and based on the needed time and budget determined, regulating the number of VOM_M layers for VO management is possible.

The AC component has solved these problems. For the consistent, flexible, and reliable design of VOM-M's layers, these layers were designed based on the concepts modeled in COBEAM in an ontology-based manner.

To check the goodness of VOM-M, we designed a software known as COBEAM software. The calculations for the two "air pollution prevention" and "virtual medical services" projects were calculated by using AC in the COBEAM software. All the resulting quantities were following the intuitive views of the experts. Then we deliberately changed values and weights at the highest level. Final values were calculated and compared. The resulting changes were quite reasonable.

One of the future works for completing AC is adding the component with colour-score cards, consistent with the results of COBEAM software. Also changing the layers in COBEAM tools is the other necessity that should be added to the made tools. Additionally, checking more and more case studies makes AC More reliable. Using more detailed probability formulas and fuzzy logic can complete assessment formulas with more precision.

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