

## Cultural Intelligence Decision Support System for Business Activities

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**Abstract**— With the rapid growth of globalization, cross-cultural business activities are on the rise. These activities are of increasing importance for individuals and organizations. As a result, culture has become a decisive factor in the success of cross-cultural business. In today's global marketplace, individuals and organizations must be culturally intelligent. The concept of cultural intelligence has been introduced in the literature on global management. Researches on cultural intelligence have provided a new perspective, and, hence, have presented a new way to alleviate cross-cultural business challenges. However, these researches mainly rely on questionnaires to find solutions to the problems of cultural intelligence in cross-cultural business. To date, no research on cultural intelligence has been empirically computerized. This study aims first to create a new cultural intelligence computational model in order to process the soft data in cross-cultural business activities. This will enable individuals and organizations to make better decisions in cross-cultural business activities. Second, this study will implement the model in a system called the CIDSS through the use of artificial intelligence techniques. The purpose of the CIDSS is to allow individuals and organizations to make intelligent decisions in culturally diverse business activities and to solve the intercultural adaptation problems faced in a variety of authentic cross-cultural situations.

**Keywords** - Cross-Cultural; Cultural Intelligence; Business Intelligence; Decision Making; Soft-Computing.

### I. INTRODUCTION

The globalization of productive forces is rapidly increasing. In order to face this new reality, individuals and organizations must form global strategic alliances to deal with worldwide competitors, suppliers and customers. When confronted with cultural diversity, some individuals and organizations are able to adapt successfully to the new cultural business environment [1], while others are not. What is the decisive factor for these opposing responses? How can good decisions be made in culturally diverse business environments? What skills can be improved to enable cultural adaptation? [2]

In recent years, researchers have shown great interest in globalization and intercultural management. Cultural intelligence has, therefore, been presented as a new phenomenon as a means to answer the above questions [3]. Organizational psychology and human resource

management have paid a great deal of attention to cultural intelligence since its introduction. These fields of study have yielded valuable results that apply to the real business world.

However, since Earley and Ang put forward the concept of cultural intelligence in 2003, there has been no research model on cultural intelligence with business intelligence technology, and most current studies pertaining to cultural intelligence do not integrate any artificial intelligence computational aspect [4]. In addition, traditional business intelligence has encountered two challenges: the first involves determining the means of adapting to cultural diversity; the second pertains to the measures required to treat soft data for decision making. Our claim is that when cultural intelligence is applied to individuals and organizations in the fields of business, it should be computationally modeled.

This research attempts to offer effective solutions to the aforementioned problems. It is the first attempt to create a new computational model of cultural intelligence implemented in an intelligent system called the CIDSS (Cultural Intelligence Decision Support System), to resolve cross-cultural business problems. The main reason to create such a system is that, in the real business world, there are not enough qualified cultural experts to help users make better business decisions, and these experts may lose some of their effectiveness after long consecutive hours of work. Moreover, the sphere of application has been confined to cultural experts and researchers. From a user's point of view, the system appears as if an efficient team of top cultural experts is always working together with him/her. This system has the potential to achieve better performance results than human experts.

There are three goals behind such a system, when helping individuals and organizations to cooperate more effectively with people from different cultural backgrounds: 1) to assist individuals and organizations in their business decision-making processes involving cultural affairs; 2) to assist people in improving their use of a specific form of intelligence based on their capacity to understand, to reason correctly, and to adapt to culturally diversified situations [5]; and 3) to facilitate the work of researchers and to equip them with more effective tools in their studies on cultural intelligence.

This paper consists of six sections. In Section I, we state the research question and research objectives. In Section II, we briefly discuss the concept of cultural intelligence and its dimensions. In Section III, we introduce the relationship between business and cultural intelligence. In Section IV, we present an overview of the system's architecture, we identify the main modules in the architecture, and we explain how these modules work. In Section V, we discuss the fundamental cultural intelligence soft-computing model inference techniques that are applied in the architecture. Finally, in Section VI, we present the contributions of this research.

## II. CULTURAL INTELLIGENCE AND ITS DIMENSIONS

In the research literature, researchers have different opinions regarding the concept of cultural intelligence. Earley and Ang presented cultural intelligence as a reflection of people's ability to collect and process information, to form judgments, and to implement effective measures in order to adapt to a new cultural context [6]. They also indicate that cultural intelligence should predict performance and adjustment outcomes in multicultural situations, when an individual is faced with diversity. Earley and Mosakowski redefined cultural intelligence as the ability of managers to deal effectively with different cultures [7]. They suggested that cultural intelligence is a complementary form of intelligence, which may explain the capacity to adapt to cultural diversity, as well as to operate in a new cultural setting. Peterson interpreted cultural intelligence in terms of its operation [8]. He believes that the concept of cultural intelligence is compatible with the cultural values of Hofstede and their five main dimensions, i.e., individualism versus collectivism, masculinity versus femininity, power distance, uncertainty avoidance, and short- and long-term orientation [9]. Brisling et al. defined cultural intelligence as the level of success people obtain when adapting to another culture [10]. Thomas explained cultural intelligence as the ability to interact efficiently with people who are culturally diverse [11] [12]. Ng and Earley presented cultural intelligence as the ability to be effective in all cultures [13]. Johnson et al. defined cultural intelligence as the ability of an individual to integrate a set of knowledge, skills and personal qualities so as to work successfully with people from different cultures and countries, both at home and abroad [14].

Researchers in the field of culture also use different dimensional structures to measure cultural intelligence. Each of these researches is associated with conceptual models. These structures seek first to explain the attributes that enable people to develop their abilities in various cultural contexts, and then to determine how people can improve these capabilities. Earley and Ang presented the first structure of cultural intelligence, which integrates the following three dimensions: cognition, motivation and behaviour [5]. While Thomas agrees with Earley and Ang that there are three dimensions to cultural intelligence [12], he does not share their point of view regarding what these three dimensions should be. He therefore advocated another tridimensional structure. His belief is founded on the theory of Ting-Toomey, which states that the structure of cultural

intelligence should be based on the skills required for intercultural communication, that is to say, knowledge, vigilance and behaviour [15]. Vigilance acts as a bridge connecting knowledge and behaviour, which is the key to cultural intelligence. Tan believes that cultural intelligence has three main components: 1) strategic thinking about culture; 2) dynamics and persistence; and 3) specific behaviours [1]. Tan stressed the importance of behavior as being essential to cultural intelligence. If the first two parts are not converted into action, cultural intelligence is meaningless.

Ang and Van Dyne [5] suggested a four-dimensional cultural intelligence structure. This structure is based on the general intelligence structure of Robert and Douglas [16]. Ang and Van Dyne used the framework of Robert and Douglas, which divides cultural intelligence into metacognitive cultural intelligence, cognitive cultural intelligence, motivational cultural intelligence and behavioral cultural intelligence. This structure has been widely used in the following cultural researches and studies.

## III. BUSINESS AND CULTURAL INTELLIGENCE

We believe that cultural differences have a greater impact on business efficiency than previously thought. Cultural backgrounds influence how people think, act and interpret information during business activities. Business is becoming increasingly globalized, and partnerships are a means to gain a competitive advantage. Thus, the potential for success or failure depends on the ability of organizations and leaders to make appropriate decisions within a framework of cultural diversity. Businesses and leaders must understand and become proficient in intercultural communication. In this regard, cultural intelligence offers strategies to improve cultural perception in order to understand the culturally motivated behavior of individuals and organizations. Many articles address the importance of cultural intelligence [17] [18] [19] and culture in the context of international business [20] [21] [22]. Huber indicated that the performance of an international business, in terms of efficiency and effectiveness, is determined by the quality of its organizational intelligence [23]. Ang and Andrew [24] specified that organizational intelligence is the cultural intelligence of businesses. Cultural intelligence in business is based on the research on psychology concerning the cultural intelligence of individuals, as well as on the views of the organizations. Cultural intelligence permits businesses to collect a set of resources and to develop their capabilities. Ang and Andrew suggest that, when organizations venture into foreign territories, cultural intelligence is a necessary predictor of organizational performance. The involvement in international trade offers significant advantages and challenges to the business development of a company. A business may be successful at home because of its cultural sensitivity. However, this does not guarantee that it will be able to attract international suppliers, partners and customers. If the business does not learn to adapt to cultural differences, it risks losing and missing business opportunities. A business approach that is culturally inappropriate may be detrimental

when doing business abroad. Knowledge and sensitivity toward other cultures result in increased business success. Consequently, cultural intelligence is of the utmost importance when engaging in business practices.

#### IV. CIDSS COGNITIVE ARCHTECTURE

Sternberg and Detterman [16] determined that general intelligence has four dimensions, i.e., metacognition, cognition, motivation and behaviour. Cultural intelligence should also include these four dimensions. We believe that the diverse structures of cultural intelligence should be considered collectively in order to integrate the elements required to respond to the cultural knowledge acquired. Therefore, we built the cultural intelligence architecture of the CIDSS based on the specific four-dimensional cultural intelligence structure of Ang and Van Dyne [5]. It represents a comprehensive overview of the multi-aspects of the researches on cultural intelligence.

The architecture of the CIDSS uses both the symbolic and the connectionist approaches of artificial intelligence. The CIDSS respects the cognitive concepts of Ang and Van Dyne [1] regarding the theories of global cultural intelligence, as well as other important aspects, such as the Hofstede’s theory of the five dimensions of culture [9]. The CIDSS also relies on engineering concepts in its solutions when designing and implementing software. It offers learning mechanisms which emulate human intelligence. The CIDSS is a distributed and modular architecture. It relies on the functional “consciousness” mechanism for much of its operation [25]. Its modules communicate and offer information to each other.

The CIDSS can be considered as a cognitive agent with an eleven-step cognitive process. This agent recognizes business-related information in natural language from its environment. By using its cognitive cycle, the agent influences its environment by offering a recommendation to the users. The following describes these steps, which correspond to the numbers inside the rectangles in Fig. 1.

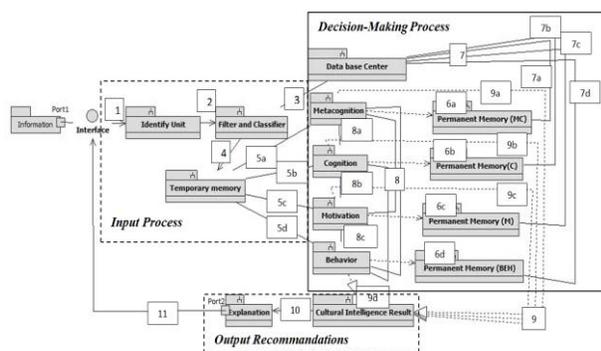


Figure 1. Architecture of CIDSS

**Step 1:** The business information is in natural language and expresses a problem, a question or a requirement of the user. It is input through the user interface. The information enters the *Identify* module, which identifies the information used to determine what the user requires.

**Step 2:** The business information goes to the *Filter and Classifier* module. In this module, the information is classified. Useful information is filtered from non-useful

information. The useful information is culturally analyzed in the following steps.

**Step 3:** To perform this classification, the module is associated with the *Cultural Intelligence Database Center*. This center has the necessary data required by the system, such as countries, religions, languages and laws.

**Step 4:** The classified business cultural data are ready to be sent to the *Temporary Memory* module. This module keeps the data temporarily and, at the same time, interacts with the other modules.

**Step 5:** Modules *5a-Metacognitive*, *5b-Cognitive*, *5c-Motivational* and *5d-Behavioral* collect the business cultural data belonging to them in the *Temporary Memory*.

**Step 6:** Each module depends on the consultation of its own *Permanent Memory*. These permanent memory modules are 6a for metacognition, 6b for cognition, 6c for motivation and 6d for behaviour. Each permanent memory represents a complete and specific cultural database that is used by its associated module to analyze the business cultural information stored in the *Temporary Memory*.

**Step 7:** *7a*, *7b*, *7c* and *7d* analyze the business cultural information. If data are missing, *Permanent Memory* modules go to the *Cultural Intelligence Database Center* to assist in the cultural analysis of the respective modules.

**Step 8:** After the analysis has been completed in each module, the four modules interact with each other to adjust their respective cultural decisions. This interaction enables each module to make a complete and effective decision before continuing to the next step.

**Step 9:** Following the interaction among the modules of the different dimensions of cultural intelligence, the four modules in steps 9a, 9b, 9c and 9d send their final cultural decisions to the *Cultural Intelligence Result* module. In this module, the decisions of these four modules are generalized and offer significant information to the user.

**Step 10:** The *Explanation* module justifies and explains in detail using natural language understandable to the user why these decisions were presented.

**Step 11:** The explanations are sent to the *User Interface*.

#### V. DESIGNING AND IMPLEMENTING THE CIDSS

##### A. The Cultural Intelligence Model

Business intelligence generally has two types of data: the first type consists of traditional crisp values, or numbers; the second type is uncertain, incomplete and imprecise. This information is presented in a manner that reflects human thinking and is called "soft data." When we introduce the cultural concept to cross-cultural business activities, we usually use soft information represented by words rather than traditional crisp numbers. The traditional computational technique, known as "hard" computing, is based on Boolean logic and cannot treat business cultural soft data. In order to enable computers to emulate a way of thinking that resembles that of humans, we used a neuro-fuzzy technique to design the CIDSS. This soft-computing technique is capable of operating with uncertain, imprecise and incomplete information. It attempts to model a human-

like understanding of words in decision-making processes.

This hybrid neuro-fuzzy technique makes use of the advantages and power of fuzzy logic and of the artificial neural network. Fuzzy logic and the artificial neural network are complementary paradigms. 1) The *Fuzzy Logic* technique is used for three reasons. First, the cultural intelligence concepts are described in natural language containing ambiguous and imprecise linguistic variables, such as "this person has low motivation" and "that project is highly risky because of this religion." Second, fuzzy logic is well-suited to modeling human decision-making processes when dealing with "soft criteria." These processes are based on common sense and may contain vague and ambiguous terms [26]. Third, fuzzy logic provides a wide range of business cultural expressions that can be understood by computers. 2) The *Artificial Neural Network*: Although the fuzzy logic technique has the ability and the means to understand natural language, it offers no mechanism for automatic rule acquisition and adjustment. The artificial neural network presents a viable solution for processing incomplete and imprecise business cultural information. The artificial neural network can manage the new business cultural data input and the generalization of acquired knowledge. The hybrid neuro-fuzzy technique represents the essence of our soft-computing model.

In Fig. 2, we explain the neuro-fuzzy inference model, which is part of the *Main Cycle* in the CIDSS architecture, as shown in Fig. 1. Essentially, the hybrid neuro-fuzzy technique is a neural network with fuzzy inference model capabilities. The network can be trained to develop IF-THEN business cultural fuzzy rules and determine membership functions for input and output variables. The model is represented with a neural network composed of five layers in the CIDSS. It has four inputs: metacognition (MC), cognition (C), motivation (M) and behaviour (BEH), and one output: Cultural Intelligence.

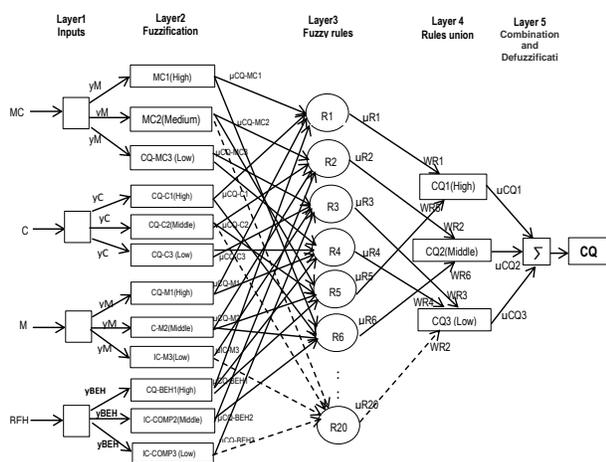


Figure 2. Soft-Computing Model of Cultural Intelligence

**Layer 1 - Input:** No calculation is made at this layer. Each neuron corresponds to an input cultural variable. These input values are transmitted directly to the next layer.

**Layer 2 - Fuzzification:** Each neuron corresponds to a business cultural linguistic label (e.g., high, medium and

low) associated with one of the input cultural variables in Layer 1. In other words, the connection of the output, which represents the inclusion value, specifies the degree to which the four input cultural values belong to the neuron's fuzzy set. The connection is computed at this layer.

**Layer 3 - Fuzzy Rule:** The output of a neuron at Layer 3 is the cultural fuzzy rules. Each neuron corresponds to one cultural fuzzy rule. The cultural fuzzy rule neurons receive inputs from Layer 2 (fuzzification neurons), which represent cultural fuzzy sets. For example, neuron R1 represents cultural Rule 1 (Rule 1: *IF metacognition is high AND cognition is high AND motivation is high AND behavior is high THEN Cultural Intelligence is high*). Neuron R1 receives input from the neurons MC1 (*Metacognition High*) and C1 (*Cognition High*). The weights (WR1 to WR20) between layers 3 and 4 are the normalized degree of confidence of the corresponding cultural fuzzy rules. These weights are adjusted when the system is trained.

**Layer 4 - Rule Unions (or consequence):** This neuron has two main tasks: 1) to combine the new precedent of cultural rules, and 2) to determine the output level (High, Medium and Low). The output level belongs to the cultural linguistic variables. For example,  $\mu_{R1}$ ,  $\mu_{R5}$  are the inputs of *Cultural Intelligence High*, and  $\mu_1^{(4)}$  is the output of the neuron *Cultural Intelligence High*.

**Layer 5 - Combination and Defuzzification:** This neuron combines all the consequential rules and computes the crisp output after defuzzification. The composition method "sum-product" [27] is used. It computes the outputs of the membership functions defined by the weighted average of their centroids. We apply, in this case, the triangle calculation in our neuro-fuzzy system, which is the simplest calculation of the fuzzy set as shown in Fig. 3. The calculation formula (see (1)) of the weighted average of the centroids of the clipped fuzzy sets *Cultural Intelligence 3(Low), 2(Medium) and 1(High)* are calculated.

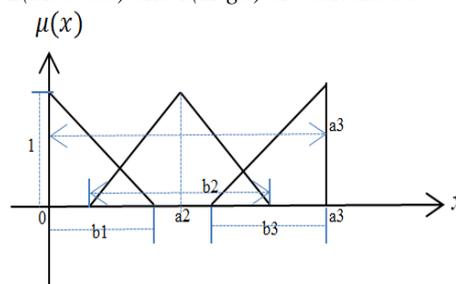


Figure 3. General Cultural Intelligence Fuzzy Sets

$$y (\text{Cultural Intelligence}) = \frac{\frac{1}{3} b_1^2 \mu_1 + a_2 b_2 \mu_2 + (a_3 - \frac{1}{3} b_3) b_3 \mu_3}{b_1 \mu_1 + b_2 \mu_2 + b_3 \mu_3} \quad (1)$$

where  $a_2$  is the center and  $a_3$  is the end of the triangle.  $b_1$ ,  $b_2$  and  $b_3$  are the widths of fuzzy sets which correspond to *Cultural Intelligence 3, 2 and 1*.

*B. Implementing CIDSS as an Expert System for Cultural Recommendations*

We would like the CIDSS to be capable of acquiring, extracting and analyzing the new knowledge of the cultural

experts. First, it should be able to: 1) express knowledge in a form that is easily understood by users, and 2) deal with simple requests in natural language rather than a programming language. Second, the CIDSS should act as would an efficient team of cultural experts who are able to make decisions and provide explanations in the decision-making process in culturally diverse settings. Hence, we integrated the model into an expert system. Fig. 4 illustrates the architecture of the CIDSS.

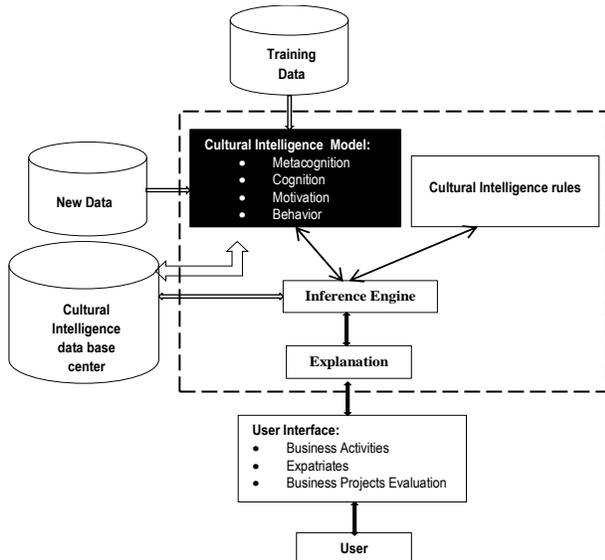


Figure 4. Deployment Structure of CIDSS

The CIDSS has three application domains (Business Activities, Expatriates Assignment and Business Projects Evaluation). The *Cultural Intelligence Model* in this structure is represented by a trained neural network. This structure includes four main modules:

1) The *Cultural Intelligence Model* contains cultural intelligence knowledge that is useful for solving business cultural problems. The soft-computing technique used in this model enables the system to reason and learn in an uncertain, incomplete and imprecise business cultural setting. It supports all the cultural decision-making steps in the system. This module connects with three different units: *New Data*, *Training Data* and the *Cultural Intelligence Database Center*. *New data* include users’ requests for solving a given problem that involves cultural business affairs. *Training Data* are a set of training examples. They are used for training the neuro-fuzzy network during the learning phase. *The Cultural Intelligence Database Center* predominantly contributes to the knowledge gathered from the data about different cultural aspects which have been collected from different countries.

2) *The Cultural Intelligence Rules* examines the cultural intelligence neural knowledge base and produces neuronal rules which are implicitly “buried” in the CIDSS network.

3) *The Inference Engine* is the core of the CIDSS. It controls the flow of business cultural information in the system and initiates inference reasoning from the

knowledge base in the *Cultural Intelligence model*. It also concludes when the system has reached a decision.

4) *The Explanation* clarifies to the user why and how the CIDSS has achieved the specific business cultural results. These explanations include analyses, advice, conclusions and other facts required for deep reasoning.

The CIDSS possesses generic cultural intelligence and is not specific to a particular culture (such as the United States or China). The system shows great capabilities of cultural adaptation by modeling the human decision-making process in situations characterized by cultural diversity. Furthermore, due to its elaborate cultural schemas and analytical abilities, the system can help users identify and understand key issues in cultural judgment and decision making. It also gives them the corresponding explanations.

Fig. 5, Fig. 6 and Fig. 7 present an example of three outputs of the *Expatriate Assignment* application domain of how the CIDSS can help a user make decisions by taking into consideration his/her inputted request. The CIDSS prototype system follows the decision-making cycle process shown in Fig. 1. The input data are specific business questions in natural language from the users. The system provides two outputs as answers to the question. Output 1 (Fig. 5) gives a general decision to answer the question put by the user.

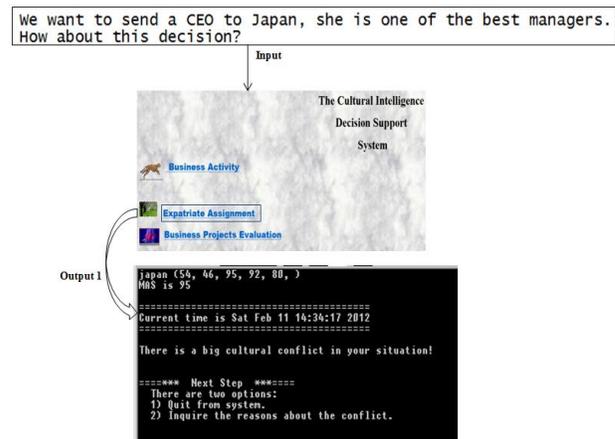


Figure 5. Example of CIDSS Prototype System (Output 1)

Output 2 (Fig. 6) gives more detail explanations which clarify to the user why the system reached this decision.

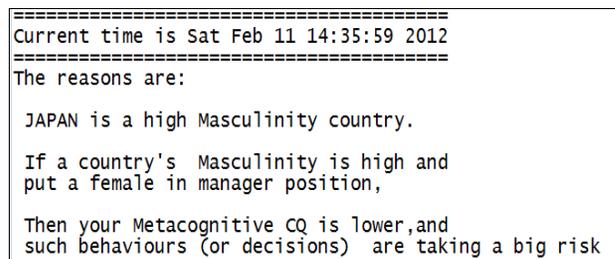


Figure 6. Example of CIDSS (Output 2)

Output 3 (Fig. 7) gives useful suggestions for self-improvement to the user whenever cultural intelligence is required.

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=====
Current time is Sat Feb 11 14:36:27 2012
=====
Your the newest results are :
5.5.
*****
      In the future training,
      the Systems suggest you that
      you should pay more attention to the following aspects
      to improve your CQ ability:

A)In Metacognitive
  1) the cultural knowledge applying to cross-cultural interactions.
  2) the cultural with five dimensions.
  3) the accuracy of cultural knowledge with people from different cultures.

B)In Cognitive
  1) the cultural values and religious beliefs of other cultures .
  2) plan how Im going to relate to people from a different culture before you meet them.

C)In Motivational
  1) confident socializing with locals in a culture that is unfamiliar to you .

D)In Behavioral
  1) vary the rate of your speaking when a cross-cultural situation requires it .
    
```

Figure 7. Example of CIDSS (Output 3)

Three cultural experts have validated our computational cultural intelligence model, as well as the CIDSS prototype system. This validation ultimately reflects the consistency between the real world and the artificial CIDSS system. The CIDSS prototype system was also tested with two hundred people. Based on the results of the validation, the cultural experts compared the CIDSS results with their own. These experts concluded that the cross-cultural business decisions recommended by CIDSS are similar to the ones suggested by a human expert.

## VI. CONCLUSION

Cultural intelligence is the human ability to capture and reason properly in culturally diverse settings. Cultural intelligence can be measured with four dimensions. Thus, we build a cultural intelligence model based on a soft-computing technique so as to integrate these dimensions and to embody an expert system called the CIDSS. The CIDSS acts as an intelligent expert assistant which helps users make better decisions in cross-culture business activities; it also enables users to solve cultural problems that would otherwise have to be solved by cultural experts. This paper shows how the CIDSS can be used as a "culturally aware" system which assists both individuals and organizations in the decision-making process. It enables users to be more efficient and "intelligent" as they develop their cultural skills. The contribution of our research is, first, to fill that gap between cultural intelligence and artificial intelligence. Second, it improves the application of cultural intelligence theories in the field of cognition. The research focuses on modeling four cultural intelligence dimensions that are an interdependent and integrated body. As a result, the theories are more complete, more efficient, and more precise in their applications. Third, we added to the field of artificial intelligence by computerizing cultural intelligence. As a result, new research topics and directions relevant to this research have arisen, and the range of computational intelligence possibilities, such as soft-computing in business decisions, training and expatriates assignments,

has been expanded. Fourth, our research is groundbreaking as it simplifies the work of the researchers by freeing them from heavy, complex, repetitive tasks, which were normally carried out manually in cultural intelligence studies. The algorithms and techniques used in this research may offer some enlightenment as to how they can be applied to other branches of business intelligence in order to improve model design and system performance.

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