Multi-Criteria Business Intelligence Approach

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Abstract. Multi Criteria Business Intelligence approach (MCBI) aims to enhancement Business Intelligence Applications (BIA) by applying Multi-Criteria Decision Making (MCDM). MCBI approach contributes to improve Business Intelligence Decision Support System (BIDSS) for BIA. Also MCBI approach presents a standard method to evaluate and select business decisions. The recommended business decision is the suitable and optimal choice to implement. The proposed model for MCBI approach that consists of five major components. The first component is business objectives, problem definition and main goals. The second component is a business heterogeneous data treatment which gathering from different resources and related with different areas. The third component is a unified business intelligence databases. The fourth component is a business intelligence processing. The fifth component is a evaluating the business decisions to select the suitable and optimal solution.

Keywords: Multi–Criteria Business Intelligence (MCBI), Business Intelligence Applications (BIA), Multi–Criteria Decision making (MCDM), Business Intelligence Decision Support System (BIDSS), Decision Support System (DSS), Data Warehouse (DW), Spider Data Warehouse (SDW), Analytic Hierarchy Process (AHP).

1 Introduction

This study presents MCBI approach to make better decision to enhancement BIA model by applying MCDM its impact on quality and evaluation processes for business decision in Business Intelligence Decision Support System (BIDSS). MCBI approach have many criteria and alternatives that effect on business decision making processes and business DSS and we could defined MCBI as "a set of models, descriptions and analysis methodologies that systematically exploit the available data to retrieve information, knowledge and advice useful in supporting complex decision-making processes according to many criteria and alternatives. Where MCBI approach produce from the integration between BIA, MCDM methods. This paper is divided into seven sections. Section 2 presents surveys and literature reviews for previous work in BIA and MCDM. Problem statement and definitions are presented in section 3. Section 4 presents research plan and methodology. The integration between BIA and MCDM presents MCBI Model in section 5 by using AHP method. Section 6

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presents the deployment and implementing for MCBI model: deployment and implementing for MCBI model: BOVIS case study. Finally, conclusion and future work are presented in section 7.

2 Survey and Previous Work

In this section we discuss the previous work that related to BIA and MCDM methods. As well as, we are explore methodologies, methods and applying techniques that allows to making integration between BIA and MCDM. BIA defines as "a set of mathematical models and analysis methodologies that systematically exploit the available data to retrieve information and knowledge useful in supporting complex decision-making processes [3]. MCDM could be define as well as a set of methods to help the decision makers to describe, evaluate, rank and select alternatives according to several criteria"[2,11]. DSS define as " a computer program application that analyzes business data and presents it so that users can make business decisions more easily [1,3]. BIA needs to make many analysis and mining processes by using Multi-dimensional Data Warehouse (MDW), On-Line Analytical Processing (OLAP), mining processes such as classification , clustering , association, statistical mining and regression to make prediction to increasing the effectiveness and efficiency of decision making processes for BIA [3]. Business DW and data marts collecting data from different resources to store in databases to extracting, transforming and loading these data by using ETL tools [3]. Figure 1. Illustrates the main components of a BIA.

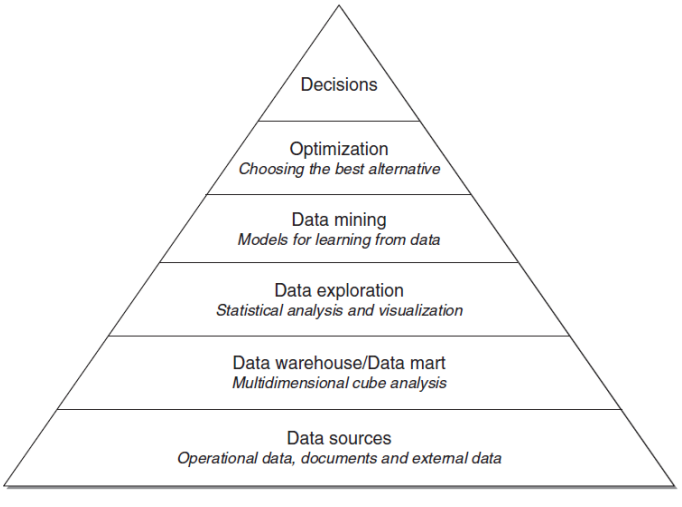

Fig. 1. The main components of BIA, Source: Vercellis, 2009

MCDM can define as "making the right decision, at the right time, for the right property" [2, 3, 11]. Analytic Hierarchy Process (AHP) is one method of MCDM methods to find the best alternative according to their needs by using preference table technique [2, 11]. Figure 2 illustrates the structure of the AHP method.

3 Problem Statement and Definition

The central research question will be "How can we better make standard decision to enhancement BIA model by applying MCDM its impact on quality and evaluation processes for business decision in BIDSS?" This study wish to find answers for some questions as the following:

- What are the main factors that might effect on processes of a new integrated model?
- How to covers the problems of heterogeneous and incompleteness of data?
- What is the new architecture of synthesis model for MCBI approach?
- How to make development for cattle wealth by using MCBI approach.

4 Research Plan and Methodology

MCBI model have both qualitative and quantitative approaches. In the qualitative part of the study, purposive sampling is used to search on literatures which enhancement the decision of new BI model. In the quantitative part of the study, the use of survey questionnaires and quantitative analysis of the data will further enhance the significance of the research findings. Data is collected by many of questionnaires and in-depth interviews from BOVIS project database, documentations and stakeholders [8]. MCBI system aims to produce recommended decisions to make investment and development for the productions of cattle and buffalo wealth to satisfy the sufficient requirement from red meat in new Egypt.

5 The Proposed Model for MCBI Integrated Approach

The proposed model for MCBI approach is integration between BIA and MCDM methods to enhancement BIDSS for BIA by using AHP method.

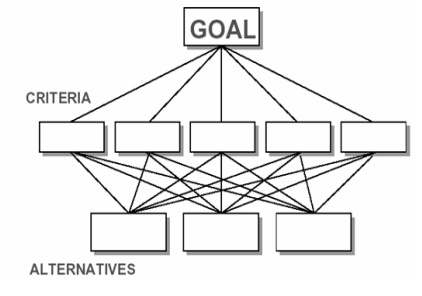

Fig. 2. AHP flow method, Source: Vincke, 1992

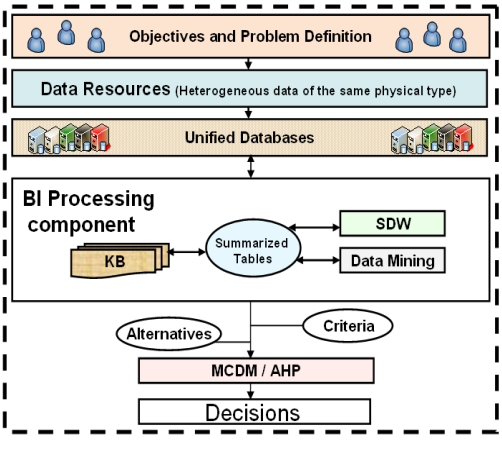

Fig. 3. Components of MCBI model

This integration model finds a standard methodology to evaluating and selecting an optimal business decision through the five components of MCBI model which as shown in figure 3. The technology that used to implement MBCI approach based on the client/server technique through internet communication technology. The software technology that used is web2 and Structured Query Language (SQL) databases infrastructure to implement MCBI model. Business intelligence decision making processes depend on the amount of information and knowledge which extracting from analytical processing from a huge amount of business data by mining classification and visualization methods to make better business decisions.

6 Deployment and Implementing for MCBI Model

A case study in the area of cattle production has been adapted to prove the concept of applying MCBI in national development as the following sub-sections.

6.1 Component of Business Objectives, Problem Definition and Main Goals

The main goal in this case study are producing a recommended solutions to development the cattle investment in Egypt according to fund, cattle heads, regions … etc, to satisfy the sufficient requirements from red meat by using MCBI approach.

6.2 Component of Heterogeneous Data Treatment

Data are not complete and need to other gathering data from different related areas by interviews, surveys, statistics and reports. Business data collect from different resources but have the same physical data type in different formats for the content. The gathering data it should be unified and complete integrity. Data are specific and have relative connection between business areas such as time, region, cattle… etc [9].

6.3 Component of Unified Databases

Unified business databases are complete and integrity databases which have all related data with business intelligence processes [9]. BIA databases have a summarized database that has summarized tables and facts which produced from business intelligence data warehouse or mining prediction processes. Table 6 Illustrates N-dimensional summarized tables for MCBI system.

6.4 Component of Business Intelligence Processing (PIB)

Business intelligence processing (BIP) component prepares information, knowledge and facts from DW, data mining and knowledge base system or from both of them.

6.4.1 Data Warehouse

Business DW is multi-dimensions DW which based on the technique of galaxy DW to produce a SDW. The dimensions of SDW are related areas with BIA to extracting facts to development cattle investment projects. This development will be satisfied a requirements of food security in Egypt as shown in figure 5. The SDW which express of these dimensions in cattle wealth investment projects as the following: (1)Cattle {(pc, fc , buff, mc) , (male, female) , …}. (2) Time (year, moth, day, hour, sec). (3)Region {(…….), Land (…..)}. (4) Water {…}. (5)Plant {…}.(6) Population of Egypt {…} . (7) Industrials {…}. (8) Transport and communications {physical () , other media(...)}. (9)Effective science {political (….), Economic (...), social (…), Management (…), Education (...)}.(10) Energy{}. Figure 4. Illustrates Spider DW for MCBI model of Investment Cattle production Projects.

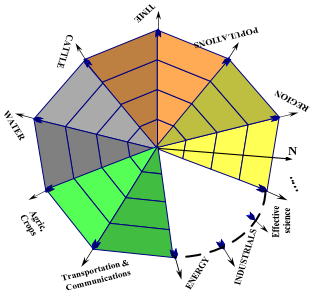

Fig. 4. SDW for Cattle investment Projects by using MCBI approach

6.4.2 Data Mining

The outputs of BIP collect in summarized tables which have criteria, alternatives and facts that produced from SDW and predicting results of mining processes [9,10].

We apply Bayesian statistical classification to perform probabilistic predictions to make optimal decision. Where X are active investment project, belongs to class C, have hypothesis H, and probability for hypothesis holds observed data sample X are P(H|X). Where $P(H|\mathbf{X})=\frac{P(\mathbf{X}|H)P(H)}{P(\mathbf{X})}$ $P(C_i|\mathbf{X})=\frac{P(\mathbf{X}|C_i)P(C_i)}{P(\mathbf{X})}$ (1)

The current investment projects not suitable and not sufficient to satisfy the expected results such as local productions from requirements of a red meats and business developments for cattle wealth. Table1 expresses the cattle experts' vision for the new development and investment cattle projects in new Egypt [6,7,8,9,10].

Where P_i are the type of project based on the number of cattle heads, where $1 \le i \le 8$ according to survey of development cattle production project in Egypt and satisfy

$$P_1 \subseteq P_2 \subseteq P_3 \subseteq P_4 \subseteq P_5 \subseteq P_6 \subseteq P_7 \subseteq P_8 \ , P_m = \bigcup_{i=1}^{m-1} N_{p_i} P_i \ , \qquad 2 \le m \le 8 \qquad (2)$$

Where N_{pi} is project number of project type P_i, the number of cattle heads for project of type P_m are $N_h(p_m)$, where $\forall P_m, N_{h_{mim}}(p_m) \le N_h(p_m) < N_{h_{\max}}(p_m)$ (3)

The total number of investment cattle projects is p, where $P = \sum_{i=1}^{n} N_{Pi}$, $1 \le n \le 8$ (4)

Total numbers of investment cattle projects in Egyptian are $P = \sum_{i=1}^{27} \sum_{j=1}^{8} a_{ij}$ (5)

Where a_{ij} are number of cattle projects of type *j* in governorates *i.*

6.4.3 Knowledge Base

Knowledge base (KB) collects from experts as a cases saved in storage files [1, 3]. PIB collects facts in summarized table to evaluating a business decisions according to criteria and alternatives to make investment for related areas. The total numbers of fattening and dairy cattle are 444738 heads from four types of projects P1,P2,p3 and P4 shown in table 2 additional to a new others [4, 5, 6]. The total numbers of registered cattle and buffalos in BOVIS project are 2357418 heads [8].Table 3 illustrate the requirement form red meat/ Egyptian person at 2010 [5,6].

Table 1. The new structure for cattle heads in investment projects

INVESTMENT PROJECTS	Category	Project	Heads density	Head average. No.	No. projects	Heads No.
	SMAL	P1	h<10	4	37500	.15M
		P2	10<=h<25	10	15000	.15M
		P3	25<=h<50	25	6000	.15M
		P4	h>=50	50	6000	.3M
	LARGE	P5	500<=h<1000	500	300	.15M
		P6	h>=1.000	1000	600	.6M
		P7	h>=10.000	10000	150	1.5M
		P8	h>=100.000	100000	45	4.5M
	Total				65595	7.5M

Table 2. Survey for requirements Red meat[s]

year	red meats (Kg)/ person	Cattle No. (Million Head)	Buff No. (Million Head)	(Million Head)	Goats No (Million Head)	(1000 head)	Requires Red Meats (1000 tons)	Available Red Meats(1000 tons)	Import Red Meats (1000 tons)
2010	10.9	4.326	4.104	2.5	3	143	863	510	353

The Average % or weights for cattle types ratio in cattle projects as Pure cow (PC)=Foreign cow (FC)=10%, Mixture Cow (MC)=43% and buffalo (Buff)= 37% [4].Table 4 and table 5 illustrate cattle heads requirements to obtain the sufficient amount of red meat. The average net red meat/ one cattle (400 Kg x .5) = 200 kg. [4, 5, 6]. Figure 5 Illustrates the requirements of red meat mean with time and Figure 6. Illustrates the investment production for red meat with time.

Table 3. Red meat requirements

Year	E.P. per Million	Red Meats (1000Tons)	75% cattle (1000Tons)	M. Cattle Heads for markets
2010	79.5	866.6	649.9	3.25
		……		
2017	90	981	735.8	3.68

Table 4. Red meat requirements studies

Year	Real Red Meats%	Agri Study %	MCBI Study%	Mean%
2010	60	60	60	60
		……..		
2017	66	77.6	100	81.2

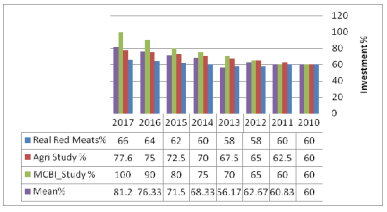

Fig. 5. Required red meat mean with time

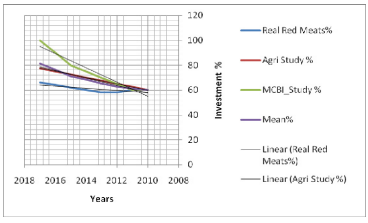

Fig. 6. Red meat investment with time

6.5 Component of Evaluation and Selecting the Optimal Business Decisions

AHP method evaluates the business decisions to select the optimal solution to implement. MCBI system determine the main criteria, sub-criteria and alternatives by business owner, mining techniques, SDW, expertise, etc. the structure of AHP method of cattle development MCBI system flow shown in figure 7.

Table 5. N-Dim. summarize tables
Source: adapted from Lala, 2009

Summary table type	Dimension of analysis
1-dimensional	Time
2-dimensional	Time and Area
2-dimensional	Time and Customer
2-dimensional	Time and Product
2-dimensional	Product and Area
2-dimensional	Product and Customer
3-dimensional	Time, Product and Area
3-dimensional	Time,Product,Customer
……	……..
N-dimensional	Time, Product,…etc.

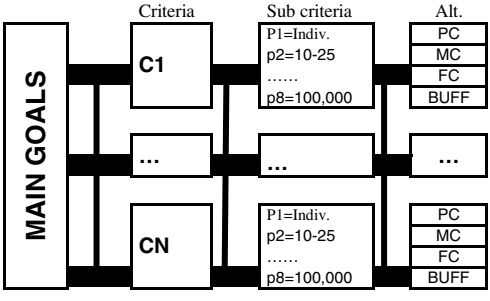

Fig. 7. AHP method for MCBI system

The normalization for main criteria matrix into weights as the following (Cattle = Crops = Water = Region=13.6%; Population = Time = 10.6%; Energy = Industrials = 7.6%; Transport and Communications = Other sciences= 4.6) as the total=100%. The normalization for sub-criteria matrix into weights as the following (P_1=P_2=P_3= P_5 = 2%, P4=4%, P6=8%, P7=20%, P8=60%) as the totally=100%. MCBI system has weight for 10 main criteria, 8 sub- criteria and 4 alternatives to calculate the ranking results which have 320 values (10 x 8 x 4 = 320 decisions). Then make a grouping for criteria which have a same weight to be 4 types and so for sub- criteria to be 5 types and alternative are 4 types. When applying AHP method produced as the following output values / decisions in table 7 to implement where the number of output decision are (4 ×5×4) = 80 results. MCBI system arrangements the output decisions which produced from previous evaluation process to select the implementing solution in table 8. The recommended solution is optimal and suitable choice to satisfying the investment conditions according to business criteria and alternatives. At the case of open fund, large investment and project type, the recommended decision is C1S1A1.

Table 6. Final result from applying MCBI/ AHP method

C1 S(1..5) A(1..4)			
M-C	S-C	Alt.	Result
13.6	0.6	0.43	3.51
	0.6	0.37	3.02
	0.6	0.1	0.81
	0.6	0.1	0.81
	0.2	0.43	1.16

Table 7. The arrangement results to select the optimal and suitable solution

Sample of Sorting solutions CnSnAn from 1 to 80			
C1S1A1	3.509	C1S1A1	3.509
C1S1A2	3.019	C1S1A2	3.019
C1S1A3	0.816	C2S1A1	2.735
C1S1A4	0.816	C2S1A2	2.35
C1S2A1	1.17	C3S1A1	1.961

7 Conclusion and Future Work

- BIDSS for BIA are enhanced by applying MCDM /AHP method to evaluate and select the optimal and suitable choices to implement. MCBI model add a new trend for BIA as a national investment based on the architecture of globalization. MCBI model treats a heterogeneous data of the same physical type format to have unified databases for different development areas. Business data using in analysis, mining classification, statistical prediction and visualization processes mining.
- In the future we hope to increase the effectiveness of MCBI model by using other features of data warehouses, data mining techniques and other MCDM methods.

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