On a New Modeling Process of the Decision-Makers' Needs

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Summary
The decisional information systems, compared to the traditional information systems, constitute, today, an essential support for decision-making in any enterprises taking into account the complex analysis (discovery requirements and analysis of the sources of data warehouses); the discovery of the requirements is a pinnacle phase in every project, and it is provided by the requirements' engineering. The modeling of needs allows decision-makers to limit the interpretations of needs and it, therefore, facilitates the confrontation of the needs of several actors, among themselves on the one hand, and with the data sources on the other. The modeling of needs offers, additionally, an explanation of the treatments. In the remainder of this paper, we propose in the first part, a state of the art of the modeling approaches' requirements, and in the second part we present a new modeling process of the decision-maker needs, and then we complete this work with the conclusions and a future work part.

Key words:
Business intelligence, decisional information systems, decision-maker needs' modeling, requirements engineering.

1. Introduction

In the development of Decisional Information Systems(DIS), there are two engineering branches, namely Requirements' Engineering (RE) and Engineering of the Developments of Decisional Information Systems (EDDIS). In this work, we will be interested in Requirements' Engineering, which is a science that focuses on the study of the requirements' discovery, and it is defined as a discipline that treats the phases of: elicitation, analysis, specification, validation and management of needs and constraints of building a system [1].
To formalize the decision-making needs (DN), the majority of the requirements' engineering approaches are based on two concepts: goal and scenario. Hence we find three types of approaches: Scenario-Oriented Approaches, Goal-Oriented Approaches and approaches generated by the duo: goals and scenarios at the same time.
In this paper, we propose a new modeling process of decision-maker needs, by using the following structure: Section 2 presents a state of the art of the needs' modeling, section 3 portrays our new modeling of needs, and section 4 contains conclusions and future works.

1.1. Motivations

Ignoring the importance of needs' modeling and, of generally, requirements' engineering, can cause several damages: budget overrun of projects, the exceeding of their deadline and even the failure of the developed BI system. The Standish Group led a survey on 800 projects which were conducted in 350 American companies, the survey, which was presented in two reports, entitled "Chaos" and "Unfinished Voyages", revealed that 31% of the projects were canceled before completion, this cost 81 billion dollars to US companies in 1995 [2]. As shown in "figure 1", the poor quality of the requirements' documentation represents 47% of the causes of the failure cited. This percentage is distributed as follows: the lack of the users' participation (13%), the badly expressed needs (or incomplete) (12%), the needs altered between the beginning and the end of the project (11%), the unrealistic needs (6%), and the unclear objectives (5%). this section, input the body of your manuscript according to the constitution that you had. For detailed information for authors, please refer to [1].

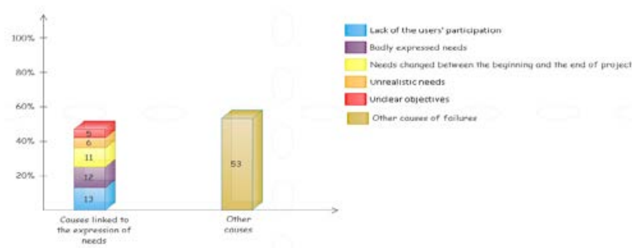

Fig. 1 The Standish Group study on causes of project failures [2].

Hence the motivations of this work are about the problems related to:

- The difficulty of needs' specification.
- The lack of distinction between the types of goals.
- The difficulty of the formalization and the treatment of goals.

2. State of the art

For the modeling of DN, the different types of DNE approaches define several stages, and a set of models that

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allow the collection, the formalization and the treatment of these decisional needs:

Table 1: Comparative study of the needs of representation models.

Methods / Needs representation	*Lujan-Mora and al., 2003*	*Ghozzi, Ravat and al., 2005*	*Mazon, Trujillo and al., 2005*	*Feki, BenAbdallah and al., 2006*	*Annoni, 2007*	*Gam El Golli, 2008*	*Bargui, Feki and al., 2009*	*Abdelhédi and Zurfluh, 2013*	*Sabri Aziza and al, 2015*
Goal models			×		×	×			×
Query models		×						×	
Table models							×	×	
Models based on relational schemas	×			×					

2.1 Modeling of the needs

For decision-maker needs' modeling, the Deci-sion-maker Needs' Engineering (DNE) approaches define several stages, and a set of models that allow the collection, the formalization and the treatment of these decision-maker needs, generally the representation models are classified into five categories of models “Table 1”:

- Goal models: Numerous studies are based on the "i *" goals' model [3], which is a modeling language; it is defined with the dependencies between various types of agents, in order to modelize situations where one of the agents depends on another to achieve a certain goal, or to carry out a task. Other works [4] propose a method for analyzing the decision-makers' needs using a goal model to represent the intentions and the implemented strategies to achieve a goal.
- Table models: The collecting of the decision-makers' needs in the table models is made via n-dimensional tables containing the concepts of: facts, dimensions, measurements, parameters, hierarchies and attributes. To collect the needs, we ask decision-makers to express them in a syntactic model[5]. Afterwards, the analyst-designer extracts and treats the multidimensional concepts and generates multidimensional schemas.
- Models based on relational schemas: The formalization of decision-maker needs, is made by several types of relational schemas, such as the Entity / Association model[6], the authors use an ideal schema for the formalization, from which we define a candidate schema for the treatment phase, it is on the basis of this schema that our conceptual schema is generated.
- Query models: Queries, in this kind of approaches, are the basis of the modeling of decision-maker needs. Initially, the expressed requirements are captured in natural language from which the analyst-designer formalizes these needs in the form of queries. The next phase of needs' treatment, in which we extract fact indicators (fact table and its measurements) and dimension indicators (dimension tables and their attributes) is done with a matrix of needs [7]. After this step, we define the first star schema extracted using the needs and we confront it with a second star schema which will be made using the data sources.
- Mixed models: In this category, two or more types of models are combine in order to collect, formalize and treat needs. For example, needs can be collected in the form of queries and subsequently formulated into goals and into decisions, the authors use an owner goals' model GDI (Goal / Decision / Information) to represent them[8]. In other works [9] to treat DN, a model of analytical requirements' specification is used (queries / tables) to extract fact tables and dimension tables.

2.2 Type of actors and goals

To study the methods of the DISE, a complete comparative study was established [10], in which we applied the four world’s framework, and this allowed us to study the various aspects of decision-maker needs’ modeling.

Table 2: Evaluation criteria according to the FOUR-Worlds Framework [Outfarouin et Abdali, 2015].

VIEW:	FACET:	ATTRIBUTES:	(Mazon, Trujillo and al., 2005)	(Soussi, Feki and al., 2005)	(Feki, Ben-Abdallah and al., 2006)	(Annoni, 2007)	(Gam El Goli, 2008)	(Abdelhédi and Zurfluh, 2014)	(Sabri and Kjiri, 2015)
Subject View	Approach	top-down	×	--	--	--	--	--	--
		bottom-up	--	--	×	--	--	--	--
		Mixed	--	×	--	×	×	×	×
	Coverage	Requirement	×	×	--	×	×	×	×
		Specification of the solution	--	--	×	×	×	×	×
		system	×	×	--	×	×	×	×
	Strategy	iterative	--	×	×	×	×	×	×
		Incremental	×	×	×	×	×	×	×
		Big bang	--	--	--	--	--	--	--
	User	Strategic	--	×	×	×	×	×	×
		Tactical	×	--	--	×	×	--	--
		System	--	--	--	×	×	--	--
		Data analysis	--	×	×	--	--	×	×
	Purpose of use	Prescriptive	×	×	×	×	--	×	×
		Descriptive	--	--	--	--	×	--	×
System view	Modeling level	Conceptual	×	×	×	×	×	×	×
		Logic	×	×	×	×	×	×	--
		Physical	--	--	×	--	--	×	--
	Mean (*)	Conceptual paradigm	4	1	1	2	4	2	1
		Logic model	1	1	1	1	1	3	1
		Requirements model	5	6	7	4	5	2	5
Development View	Learning	Reuse	--	×	×	×	×	×	×
		Capitalization	--	--	×	×	×	--	--
		From nothing	×	--	--	--	--	--	--
	Adaptability	Rigid	--	--	--	--	--	--	--
		Adaptive	×	×	×	×	×	×	×
	Procedure	Product	--	--	×	--	×	×	×
		Activity	×	×	×	×	--	×	×
		Process	--	--	--	--	×	×	×
	Prototype	Boolean	--	--	--	eBIPAD	--	SelfStar	ACED
		Automation	M	SA	M	SA	SA	A	A

(*) Mean comprises of three facets, and each of these facets can be defined by several attributes, we will refer to them by a number:

- Conceptual paradigm: {1. E/R, 2.Object, 3.Specific, 4.Undefined}
- Logic model: {1.Multidimensional, 2.Relational, 3.Object, 4.Semi-structured, 5.Undefined}.
- Model requirements: {1. Natural language, 2.Object 3.Classic model, 4. Request, 5. Goal model, 6. n-dimensional table, 7.Undefined}.

In this study we classified the types of approaches, and we distinguished between three types, two of which consider the discovery of the requirements as a primary phase of their approaches (top-down approaches and mixed approaches), we distinguished, also, between three types of actors [4] [11] [12]: Strategic, tactical and system. In the four worlds framework, the usage view focuses on fixed goals by the different services of the organization and on the decision-makers' intentions. These characteristics are captured by the three facets:

- Users facet, defined by three attributes: 1. Strategic users (leaders) 2. Tactical users (decision-makers of a specific service or profession) 3. system users (contain any user related to data sources).
- Purposes facet, it is characterized by three attributes that affect the construction process of a data warehouse (DW): 1. the discovery of decision-makers' requirements (treated with requirements' engineering), 2. The modeling of the multidimensional schema and 3. The analysis of the data to restore.
- Method's Goal facet, defined by two attributes: 1.descriptive (the reference of the DIS approach, here, is the external observer) or 2. Prescriptive (the process of a DIS method must have a user manual and descriptive demarche fixed beforehand)).

2.3 Summary

As we defined it in motivations' part, this study allowed us to identify a set of problems with the DNE approaches due to the quality of the modeling of decision-maker needs in BI projects. These weaknesses revolve around:

- The limits of the needs' design steps.
- The limits of the needs' formalization steps.
- The limits in the needs' treatment steps.
- The absence of a standard model to express the decision-makers' needs, which is very important regarding the disparity between the decision-makers and the analyst-designer's languages.

3. Our proposition

To document the system's needs extracted by using the goals and scenarios, we use the concept of the need fragment (NF) [13]. A need fragment is a pair of <goal, scenario> (figure 2); since a goal is intentional and a scenario is operational, we define a NF as "a way to achieve a goal through a scenario".

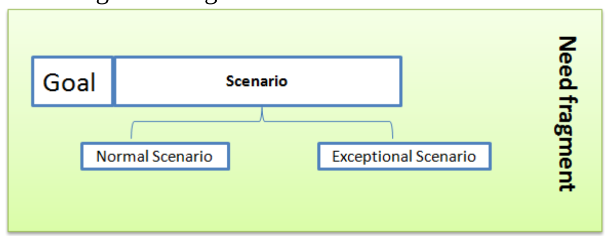

Fig. 2 Need fragment.

3.1 Modeling of the decision-maker need

To modelize a DN, we present the design that we have established:

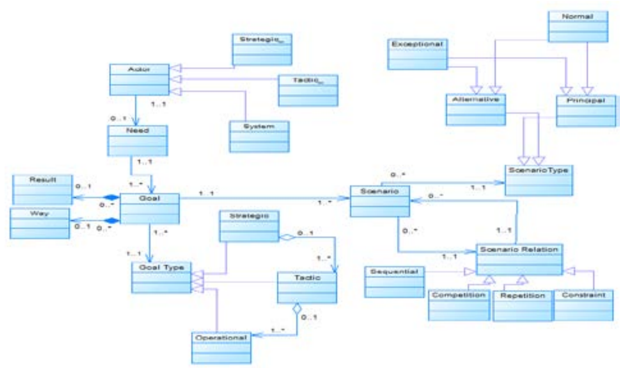

Fig. 3 Class diagram of the decision-maker need.

This design is characterized by adding, on the one hand, two types of scenarios: Main scenario (MS) and Alternative Scenario (AS), and for each of these two types we have two cases: Normal case and exceptional case.

These scenarios may have a relationship between them [13], it is a relationship that designates the scenarios' order of execution, which can be done in four ways:

- Sequential: Defines a precedence relation.
- Alternative: Represents two possible behaviors (if & else).
- Iterative: Used to iterate behaviors.
- Concurrency: Defines a behavior of competition between two scenarios.

On the other hand, we distinguish between three types of objectives: strategic, tactical and informational (or system), and we define a relationship between them. This relation is the basis of the matrix of goals' treatment in the following sections.

3.1.1 Levels of goal abstraction

In the decision-maker field, a strategic goal (level 1) does not offer an operational view and must be decomposed into tactical goals, this level (Level 2) does not yet give us the possibility to deduct our facts and our dimensions, thus we move on to the third level (level 3), which is operational, by dividing each tactical goal to a set of informational goals :

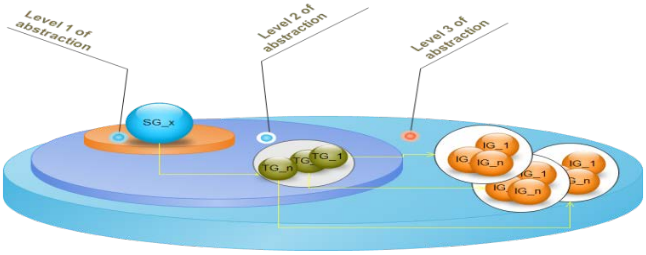

Fig. 4 Levels of abstraction of a goal.

Therefore, each decision-maker need (n) is de-composed into a set of strategic goals (SG) and each strategic goal i is presented as a set of tactical goals (1 to n), thus:

$$DN = \sum_{i=1}^{n} SG\ i \qquad (1)$$

Such as :

$$SG\ i = \sum_{j=1}^{n} TG\ j \qquad (2)$$

And for every tactical goal j of the strategic goal i, it is, itself, presented as a collection of informational goals (from 1 to m), we have:

$$TG\ j = \sum_{k=1}^{m} IG\ k \qquad (3)$$

To formalize the levels of abstraction of a decision-maker need, we define the following model:

Table 3: Goal classification model by level of abstraction.

Strategic goal x	Tactical_goal_x_1	Informational_goal_x_1_1
		...
		Informational_goal_x_1_m
	...	...
	Tactical_goal_x_n	Informational_goal_x_n_1
		...
		Informational_goal_x_n_m
....	..	...

3.1.2 Treatment of the decision-maker goals

Earlier works define the relationship between goals as a composition: "AND", "OR" and "Refined by" [13] some other works define it with "AND", "OR", "Refined by" and "complemented by "[12], this relationship type does not give an exact and a solid criterion for the treatment of goals.

These works are, generally, based on the decision-makers' and the analyst's intentions which gives room to a major error interval. From a designer-analyst to another we find differences in the establishment of these relationships due to the ambiguity in the difference between "AND" and "OR", for that we define, as a means to link the goals to each other, a relevant criterion which is based on the structuring of the goal itself : any goal has a result to achieve (What) and a way to achieve it (how to reach it) the result (R) and the way (W), these two concepts always exist for all goals, therefore a study of all possible combinations will be conducted to extract the linked rules between all types of goals.

The designer-analyst can represent these links via goal relationships' Matrixes: Type {Strategic / Tactical / Informational} :

Table 4: The matrix model of relations between goals' Type {Strategic / Tactical / Informational}.

Type goals (TG)	TG 1	TG 2	...	TG n
TG 1		M/¬M	...	M/¬M
TG 2	R/¬R		...	M/¬M
...	...	...		...
TG n	R/¬R	R/¬R	...	

To treat this matrix, the assistance of a trade expert with the analyst-designer is desired. In the remainder of this section, we offer the goals' treatment rules (GTR) that we have established as:

A. Strategic Goals' Treatment Rules (SGTR)

SGTR1:

If Result(SG i) = Result (SG j) (as i # j) AND Canal(SG i) = Canal(SG j) then the analyst-designer must:

- Choose one of the goals to keep and delete the other.
- Add the tactical goals of SG to be removed to the other (SG) that we must keep, eliminating duplicates for each TG.
- Add the informational goals of SG to be removed to the other (SG) that we must keep, eliminating duplicates for each IG.

SGTR2:

if Result(SG i) = Result(SG j) (as i # j) AND Canal(SG i) # Canal(SG j) then the analyst-designer must:

- Concatenate the two strategic goals into a sole global one.
- Merge the tactical goals of the two strategic goals, eliminating duplicates for each TG.
- Merge informational goals of the two strategic goals, eliminating duplicates for each IG.

SGTR3:

If Result(SG i) # Result(SG j) (as i # j) as Result(SG i) ∩ Result(SG j) = Result(SG j) OR Result(SG i) ∩ Result(SG j) = Result(SG i) then the analyst-designer must:

- Keep the strategic goal that have the most general result.
- Merge the tactical goals of the strategic goal to be removed with the tactical goals of the strategic goal to be kept, eliminating duplicates for each TG.
- Merge the informational goals of the strategic goal to be removed with the informational goals of the strategic goal to be kept, eliminating duplicates for each IG.

SGTR4:

If Result(SG i) # Result(SG j) (as i # j) as Result(SG i) ∩ Result(SG j) = ∅ OR Result (SG i) ∩ Result(SG j) = Result less than Result(SG j) and less than Result(SG i) then the analyst-designer must:

- Keep both strategic goals.

B. Tactical Goals' Treatment Rules (TGTR)

TGTR1:

If Result(TG i) = Result (TG j) (as i # j) AND Canal(TG i) = Canal(TG j) then the analyst-designer must:

- Choose one of the goals to be kept and delete the other.
- Add the informational goals of TG to be removed to the other (TG) that we must keep, eliminating duplicates for each IG.

TGTR2:

If Result(TG i) = Result(TG j) (as i # j) AND Canal(TG i) # Canal(TG j) then the analyst-designer must:

- Concatenate the two tactical goals into a sole global one.
- Merge the informational goals of the two tactical goals, eliminating duplicates for each IG.

TGTR3:

If Result(TG i) # Result(TG j) (as i # j) as Result(TG i) ∩ Result(TG j) = Result(TG j) OR Result(TG i) ∩ Result(TG j) = Result(TG i) then the analyst-designer must:

- Keep the tactical goal that have the most general result.
- Merge informational goals of the tactical goal to be removed with the informational goals of the tactical goal to be kept, eliminating duplicates for each IG.

TGTR4:

If Result(TG i) # Result(TG j) (as i # j) as Result(TG i) ∩ Result(TG j) = ∅ OR Result (TG i) ∩ Result(TG j) = Result less than Result(TG j) and less than Result(TG i) then the analyst-designer must:

- Keep both tactical goals.

C. Informational goals' Treatment Rules(IGTR)

IGTR1:

If Result(IG i) = Result (IG j) (as i # j) AND Canal(IG i) = Canal(IG j) then the analyst-designer must:

- Choose one of the goals to be kept and delete the other.

IGTR2:

if Result(IG i) = Result(IG j) (as i # j) AND Canal(IG i) # Canal(IG j) then the analyst-designer must:

- Concatenate the two informational goals into a sole a global one.

IGTR3:

If Result(IG i) # Result(IG j) (as i # j) as Result(IG i) ∩ Result(IG j) = ∅ OR Result (IG i) ∩ Result(IG j) = Result less than Re-sult(IG j) and less than Result(IG i) then the analyst-designer must:

- Keep both informational goals.

IGTR4:

If Result(IG i) # Result(IG j) (as i # j) as Result(IG i) ∩ Result(IG j) = Result(IG j) OR Result(IG i) ∩ Result(IG j) = Result(IG i) then the analyst-designer must:

- Keep the informational goal that have the most general result.

3.1.3 Formalization of the informational goals

Informational goals are expressed in a natural language, and they belong to the level 3 of abstraction, which is the operational level, the transition from this level to the extraction of facts and dimensions, to be included in the multidimensional model, is feasible.
To be understood by the actors of the DIS, at this level, the formulation of goals in a natural language requires a linguistic approach. One of these approaches has been developed by Prat [14] resumed and expanded in the work of Elgoli [4] and reformulated in the approach of sabri [12], and according to [4] the structure of a goal is made by a verb followed:

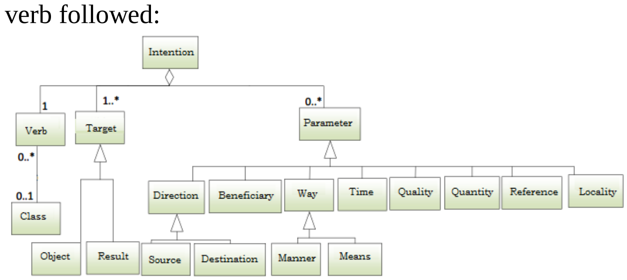

Fig.5 The linguistic meta-model of intention in UML notation [ELGOLLI, 2008].

To facilitate the extraction of the facts and the dimensions from this meta-model, we define a new formalization structure of the informational goals, dividing each one (informational goals) into two sections: the "indicators on the facts" section and the "indicators on the dimensions" section:

we have :

$$IGk = \begin{cases} \text{Indicators on the facts} \\ \text{Indicators on the dimensions} \end{cases}$$

From these indicators, the analyst-designer can extract the decision-maker data (<facts, measurement> ; <dimensions, attributes>) to build the multidimensional star schema, and this will be done directly from the formulated sentences under the form of informational goals, expressed by different DIS actors.

The section of the "indicators on the facts" allows us to determine the fact table and its measurements, this section is related to the section of the "indicators on the dimensions" that allows us to determine one or more dimensions' tables with its (their) attributes.

In comparison to the intention's linguistic meta-model of EL Golli [4], we find it very interesting to mention explicitly the "indicators on the facts" and the "indicators on the dimensions", which will simplify the discovery of the fact tables and the dimension tables hence the deduction of the multidimensional schema. For this we have redefined the structure of informational goals by introducing the concept of the "indicators on the facts" and "indicators on the dimensions".

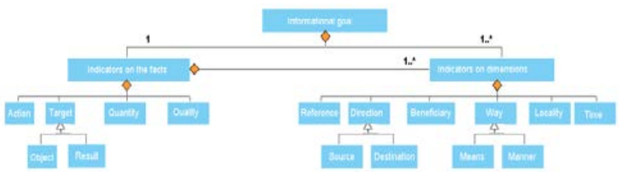

Fig.6 Linguistic meta-model for the representation of the informational goal.

The "Indicators on the facts" section contains the parameters that comprise the fact table, and the second section named "indicators on the dimensions" includes the parameters of the dimension tables:

A. "Indicators on the facts" section (IF)

As shown in "figure 6", this section consists of an "action", a "target" and other "indicators". Each indicator plays a specific role in regard to the action. In this structure, the action and the target are mandatory, and other "indicators" are optional:

- Action: It is usually in the form of a verb or a name that limits the boundaries and the semantic interpretations, and indicates the possible semantic functions for other indicators. (e.g., Rate (Action) ...., Increase (Action) .... Calculation of (Action) ....., analysis (Action) ...).
- Target: The target is a complement to the action concerning the entities affected by the goal. There are two types of targets: the object and the result. The object exists before achieving the goal and may, eventually, be modified or deleted by the goal, whereas the result is the entity resulting from the realization of the goal designated by the action (e.g., rate (Action) number of clients (Object)).
- Quantity: it measures the quantity of the object that should occur (e.g., Increase (Action) Price (Object) by 7% (Quantity)).
- Quality: This is a property that must be achieved or preserved (e.g., Stay (Action) the first telecom operator (Quality) at national level).

B. "indicators on dimensions" section (ID)

This section represents the dimension tables and is composed of a series of indicators which will allow us to build one or more dimension tables with its (their) attributes:

- Direction : Contains two types of directions named: source and destination, their role is to identify, respectively, the initial and final locations of the object:
- Source: Represents the starting point of the goal (source of information or physical location). (e.g., Establish (Action) the commercial plan (Object) from established market studies (Source)).
- Destination: Represents the ending point of the goal (to whom or what). (e.g., Provide (Action) sales dashboards (Object) for decision-makers (Destination)).
- Beneficiary: Expresses the person or group for whom the goal should be fulfilled (e.g., Ship (Action) the purchasing report (Object) for the CFO (Beneficiary)).
- Way: It consists of two parameters:
- The manner: Specifies how the goal can be achieved.
- The means: Specifies by what means (tool) the goal can be achieved.
- Locality: It positions the goal with regard to space (e.g., define (Action) the estimated production plan (Result) for the production unit (Locality)).
- Time: It positions the goal with respect to time (e.g., Sale (Action) every X brand products (Object) in seven months (time)).
- Reference: it is the entity according to which an action, of the fact table, is performed or a state is achieved or maintained (e.g., Adjust (Action) the SMS price (Object) to the minimum price of the competitors (Reference)).

To retrieve fact table and its measurements associated with the indicators on the facts, two types of indicators are to be considered:

- Indicators on the fact table: The name of the fact table can be inferred from the "Action" indicator and the "object" element of the "Target" indicator.
- Indicators on the measurements: These indicators constitute the measurements of the fact table: the

"Quantity" indicator which represents the "How many/much" of the things and the "Quality" indicator that represents the "How".

We define, in Table 5, the structure that will be adopted for the formalization of indicators on the facts:

Table 5: Formalization model of the indicators on the facts.

F.I / I.G	Action	Target		Quality	Quantity
		Object	Result		
IG i	What to do?	What?		How he is?	How many?

To infer the dimensions of the fact table, we have to extract them from the indicators on the dimensions, these indicators are split into two categories:
Indicators on the dimension tables only: "Time" represents a dimension table of dates, "Destination" and "Locality".
Indicators on the dimension tables and/or on dimensions' attributes: "Source" of the "Direction" indicator can take both roles (dimension table or its attribute) "beneficiary", "Means" and "Reference" which can be either a measurement or fact table (in another context) that is considered a dimension table for our fact table.
For the formalization of indicators on the dimensions of an informational goal, we define this model

Table 6: Formalization model of the indicators on the dimensions

ID / IG	Direction		Beneficiary	Way		Locality	Time	Reference
	Source	Destination		Means	Manner			
IG i	From what?	Aimed at whom?	For whose benefit?	Using what?	How to do it?	To what place?	For how long or on what date?	Compared to who / what

4. Conclusion

The modeling of decision-maker needs is one of the most important steps of the process phases of engineering decision-making needs, in this work we defined a new modeling of decision-maker need, based on the goal levels of abstraction, we defined some new more relevant axes of goal treatment with new treatment rules and a new formalization of the informational goals to facilitate the extraction of associated indicators on fact tables (with their measurements) and indicators on their dimension tables (with their attributes).

In future works, we will demonstrate the importance of our new modeling of needs, concretely, by applying it to the field of hospitals, and to make the job easier for decision-makers, we will develop a platform that implements this new modeling of needs in a new DNE process, for this reason some collaborations, in parallel with data warehouse professionals are planned to validate and evaluate the work and to study its applicability. In the case that you would like to paragraph your manuscript, please make use of the specified style "paragraph" from the drop-down menu of style categories.

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