# ADVANCED MODELS FOR INNOVATIVE DECISION SUPPORT SYSTEMS IN BROADCASTING SCHEDULE PLANNING & MANAGEMENT

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## ABSTRACT

The paper describes a set of advanced models to support strategic and operative decision in the television schedule planning and to analyze and to control related activities.
The research focus is to define support systems for modeling this complex scenario and its variables, and for permitting the elaboration and implementation of efficient strategies in the related management; in this context this kind of model is a critical to support marketing and advertising space allocation, broadcast planning, share parameter analysis and control, evaluation of the accuracy of the forecast activities and the effectiveness of implemented strategies.

Keywords: innovative decision support systems, broadcasting, schedule planning and management

## 1. INTRODUCTION

Broadcasting planning is a very complex framework, where simulation can introduce quantitative models able to provide a direct support in planning and controlling activities. In fact it is possible to consider the schedule of broadcasting stations as a bi-dimensional entity where products (programs, movies, news, soap operas, music, etc.) are organized in a time table and assigned to a channel.

Profits principally derive from selling of advertising time spaces during the product broadcasting, and obviously, in this context, profits deriving from the television market are the most significant.

The Rules and policies to maximize turnover derived by selling advertizing buckets need to evaluate many different variables, such as actors, concept and format parameters, channel characteristics etc. This introduce a very complex scenario and currently, quite often, the only tools available to obtain reliable analyses are based on experience and intuitions of decision makers.

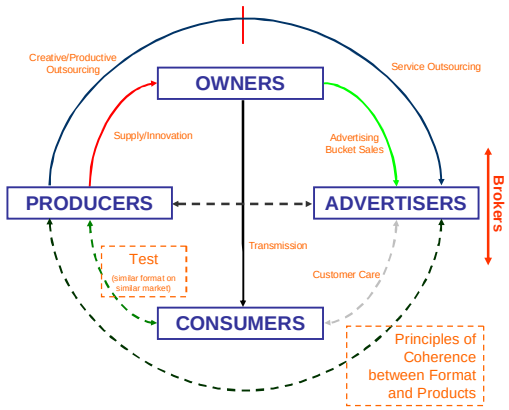



Figure 1: The Actors of the Broadcasting Planning

The actors of this process and their related activities are characterized by many interactions involving supplying, selling, buying and sharing of products and services. It is quite common that owners of broadcasting channels outsource the production of their formats or buy complete finished products in order to guarantee an high performance level of format selling; in fact currently this phenomena is increasing and producers are extending their investigations in order to capture and anticipate advertiser needs.

However buying of outsourced formats introduce a pretty new kind of problem for broadcast enterprises. In fact producers policies for selling of format is currently introducing the concept of stock management in this market sector. Currently formats are sold in a "container", it means that the channel owners in order to acquire a specific desired program have to buy also other products.

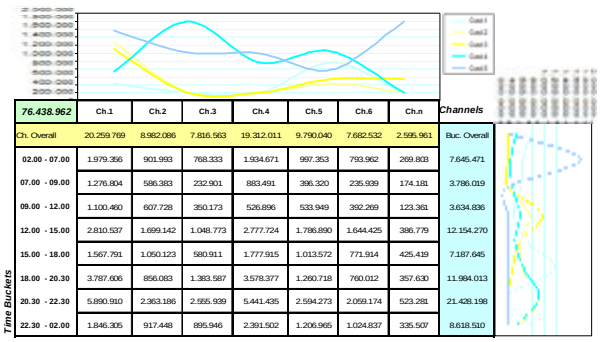
This triangulation among owners, producers and advertisers results to be efficient only if it is supported by effective information management; in fact it is required to have deep knowledge and understanding of all the interconnection among programs, advertisings and channels, so it is critical to evaluate the incidence of time buckets during the day not only in term of

audience share, but also in term of specific impact of commercials on the related consumers.

Based on these consideration in order to be competitive it is important to develop an efficient overview of the effects related to the interaction among different products and time-band/channels; by this understanding it becomes necessary to develop models able to define quantitatively the system behavior in order to optimize number of spectators for attracting advertising actors.

Therefore it is fundamental to define customer profile related to each specific period of the day, channel and program type; this is especially important for enterprise controlling multiple channels in order to properly tune their program management policies.

In this view, companies that want to promote their products by commercials or promotions are looking forward for buying spaces during the programs and time-bands where they expect to get more potential customers, in fact their choice is driven also by considering the specific characteristics of each broadcasting channel.



| 76.438.962 | Ch.1 | Ch.2 | Ch.3 | Ch.4 | Ch.5 | Ch.6 | Ch.n | Channels |
|---|---|---|---|---|---|---|---|---|
| Ch. Overall | 20.259.769 | 8.982.086 | 7.816.563 | 19.312.011 | 9.790.040 | 7.682.532 | 2.595.961 | Buc. Overall |
| 02.00 - 07.00 | 1.979.356 | 901.993 | 768.333 | 1.934.671 | 997.353 | 793.962 | 269.803 | 7.645.471 |
| 07.00 - 09.00 | 1.276.804 | 586.383 | 232.901 | 883.491 | 396.320 | 235.939 | 174.181 | 3.786.019 |
| 09.00 - 12.00 | 1.100.460 | 607.728 | 350.173 | 526.896 | 533.949 | 392.269 | 123.361 | 3.634.836 |
| 12.00 - 15.00 | 2.810.537 | 1.699.142 | 1.048.773 | 2.777.724 | 1.786.890 | 1.644.425 | 386.779 | 12.154.270 |
| 15.00 - 18.00 | 1.567.791 | 1.050.123 | 580.911 | 1.777.915 | 1.013.572 | 771.914 | 425.419 | 7.187.645 |
| 18.00 - 20.30 | 3.787.606 | 856.083 | 1.383.587 | 3.578.377 | 1.260.718 | 760.012 | 357.630 | 11.984.013 |
| 20.30 - 22.30 | 5.890.910 | 2.363.186 | 2.555.939 | 5.441.435 | 2.594.273 | 2.059.174 | 523.281 | 21.428.198 |
| 22.30 - 02.00 | 1.846.305 | 917.448 | 895.946 | 2.391.502 | 1.206.965 | 1.024.837 | 335.507 | 8.618.510 |

Time Buckets

Figure 2: Customer Profiles

In the past the scenario defining audience type and attendance on channels and time-bands was quite well defined among competitors; this situation changed after the growing success of cable tv and satellite stations (sat stations); in fact the development and diffusion of these new technologies opened new areas and policies of competitiveness.

For instance the born of channels aimed on well defined and restricted areas (i.e. one single sport, one kind of music, etc.) guarantees to specific advertisers a strictly selected field of potential customers, even if the absolute share could result to be lower respect other channels where the attendees are not really interested on their specific products; a very good example are channels related to cars for automotive companies, or fish and haunt channels for the companies involved in related production.

The changed in policies in programs production/acquisition and this new competitive framework stress the need for innovative efficient methodologies able to provide accurate analysis of all the system variables. Considering the high stochastic nature of these processes and the strong interrelations among the different factos, it is evident that simulation. In fact this innovative models require to consider many variables such as to Time Bucket Structure, Customer Profile, Attendance Profile, Format Structure, Channel Characteristics and the additional conditions and correlation among them, in order to provide an efficient and quantitative decision support systems.

## 2. STATE OF THE ART

Data related to audience profile are collected by various corporations; this information is composed by both public and private data and includes a wide range of data, involving timeframe, channels, customer age, cultural background, spending power, etc.

Several studies and researches have been focusing on channel performance analysis and audience evaluation in order to give an efficient and useful interpretation of these data based on models and technique for correlating them with desired goals.

For instance, A.Vanheuverzwyn and J. Chaskalovic approached the problem of confidence of audience indicators in radio broadcasting applying bootstrap techniques to define accuracy level for each considered indicator, station, day frame and target; they built models based on multiplicative structures for confidence interval, using data mining exploration to investigate potential dependencies of the confide interval regarding the other variables and recently they implemented neural networks to evaluate stability of the models ("Innovation in Estimation of a Reliable Approach for Radio Audience Indicators" , 2007).

Where many data are available and the problem is related to their correlation there were developed other models, implemented in ISL's *CLEMENTINE*, as a data mining toolkit based on AI techniques, that allows to identify patterns and business rules which elude traditional statistical analysis, OLAP (Online analytical processing) or visualization techniques.

Currently, a common main goal of researches is to elaborate efficient models to treat and aggregate massive data collections to extrapolate useful and significant information.

Several researches are currently focusing on identifying the significant variables and dependencies on these systems; by this approach it becomes possible to investigate scenarios and to forecast competitors results.

## 3. A CASE STUDY

Italy is the reference point for this research; in fact the proposed scenario is characterized by a small number of tv broadcasters collecting the majority of audience share; in this frame it exist an authority that provides reference figures for classification of spectators and data related to presence profiles during time ranges during the day.

Actually in the scenario few main competitors are operating on air channels, while cable tv have a very limited share in term of audience and advertising sales, so these elements are not significant in our case.

Otherwise the field of tv channel includes a small number of main competitors (6 channels cover 70% audience) and satellite televisions are conquering a growing up share of the market.

As anticipated a national society (named Auditel) provides info related to results of the competitors in terms of number and type of spectators distributed for channels and time frames, and collects these data with different time resolutions (i.e. each two minutes).

However these services are losing their incidence in strategic decisions for the higher complexity level of the competition and market, where now the number of spectators loses incidence on interests of advertisers by comparison with aiming of a specific consumer profile.
This fact, combined with the change of programs acquisition process, moving to strong outsourcing, determines the needs of innovation in decision support systems, devoted to guarantee more significant data, and more accurate knowledge of customer and format peculiarities; this requires to develop ad hoc simulation models able to allow what-if analyses and experimental analysis for investigating strategic policies changes.

## 4. SIMULATION MODELS

As anticipated in introduction, the proposed scenario requires to proceed in the identification of the variables and their definition for modeling these processes. Due to the high variability of market and products and to the strong influence of stochastic factors it is critical and very hard to model relations representing the interconnections among the different objects, variables and parameters.

Critical operations in strategies are identified in forecasting activities, format warehouse management, customer targeting and schedule planning.

*Forecasts*

Forecasting activities related to the estimation of appreciation level of a format by the spectators is currently mostly based on the experiences of decision makers and qualitative data; sometimes it is obtained also based on results of similar products on similar market, but it is currently increasingly the importance to have a good control on decision strategies by providing quantitative measure on these issues. In fact goal is not to provide models that guarantee very precise info about programs (this is a utopist crystal ball model), but it is required to obtain a statistical based support to evaluate policy performances as well as level of coherence between planning decisions and enterprise mission.

*Format Warehouse Management*

The production outsourcing for television concepts open issues in strategic planning, due to the fact that producers and brokers sell formats not one by one, but in "containers" including different programs. This is leading to the creation of television programs "warehouses" for broadcasters, and to develop stock management policies, cost and risk analysis and control procedures.

*Customer Targeting*

The more aggressive competition in this complex scenario requires a much more effective and efficient customer profile identification. This means that new models need to analyze and evaluate the proper target for advertisers in different channels/timeframes.

*Schedule Planning*

Success in a television program is related to the match of its format peculiarity with customer profile and channel audience target; the key for obtaining this results is the schedule planning. In fact to move a program into a different timeframe (from morning to afternoon) generates significant difference in term of results.
At the same time it is possible to operate otherwise by defining policies for changing customer profile in different time bucket/channel by attracting them with programs that better match their interests and expectations.

It is evident that the complexity of above mentioned phenomena requires development of specific models; in order to satisfy all these needs it is fundamental to reduce the complexity of the problem by subdividing the overall frame in different objects and entities.
The scenario proposed by the authors is concentrating on the 7 main competitors, corresponding to the 6 channels with wider catchment area and a meta-entity including performance of all the sat channels.

### 4.1. Entities and Variables

As anticipated the authors are presenting a new approach for creating models and methodologies to define, investigate and analyze the above described scenario. In particular entities and variables are proposed as following; it was identified different main classes for objects to create the scenario, and for each class their attributes are defined.

*Format Concept Object*

- Type of Contents;
- Star Power;
- Budget;
- Innovation Level.

*Customer Object*

- Customer Static Profile;
- Customer Dynamic Profile;
- Spending Power Profile.

*Calendar Object*

- Time Table Definition;
- Weather;

*Channel Object*

- Typology (Sat/by-Air);
- Referred Customers;
- Channel Mission Coherence Rate;
- Continuity Rate Between Time Buckets.

Innovative models are implemented to valorize attributes, identify and evaluate functions that interconnect different classes in order to develop an efficient decision support systems, based on analysis, aggregations and elaborations of the wide range of available historical data.

### 4.1.1. Format concept object

This represent the tv program object and it is characterized by the following attributes:

*Type of Contents Program Concept*

A set of variables is considered significant, in particular a coherence rate (0 ÷1) between the program concept and the following topics:

- economy;
- travels;
- culture;
- cooking;
- ecology;
- topicality;
- violence;
- information;
- interactivity;
- emotions;
- national Religion;
- others Religions;
- fear ;
- comedy;
- strain;
- national favorite sport;
- others sports;
- others.

This variable could be elaborated by Data Fusion algorithms to be further developed in next phase of the research.

*Star Power*

Star power is a score assigned to a program for evaluating number and incidence of actors/frontmen; this attribute is defined by creating fuzzy allocation matrixes (FAM) involving the following variables:

- National assigned awards:

1. Number;
2. Prestige;

- International assigned awards:

1. Number;
2. Prestige;

- Reward;
- Appearance:

1. Number;
2. Prestige.

It is possible to combine the different factors and to apply fuzzy rules for processing the FAMs.

*Budget*

Budget represent an important attribute of a tv program; it is proposed to define and evaluate this factor in term of amounts invested in production, marketing and distribution by defining fuzzy variables; in fact fixing the fuzzy membership functions and related ranges it is possible to extract meaning from the budget attributes in relation to its specific nature.

*Innovation Level*

The innovation levels are also to be defined in term of ranges of innovation considering budget invested and scores attributed by Subject Matter Experts (SME); this data are processed by *Fuzzy Logics* for providing an overall parameter estimator.

### 4.1.2. Customer object

The Customer represent the audience and its characterization it is defined by the following parameters:

*Customer Static Profile*

This attributes includes static attributes representing the characteristics of the audience (age, social status, etc)

*Customer Dynamic Profile*

These variables are defining the interest subjects on the different topics and preference on timeslots; in fact this parameters is both an input and output of the system: it is expected that SME will define reference timeslots and preferences and the models will check correlation among these hypotheses and overall results.

*Spending Power Profile*

This profile allows to correlate customer speding power on the different advertiser areas.

### 4.1.3. Calendar object

Calendar represent the object defining the timeslots composing the overall time table with the schedule of all programs, but includes also parameters related to weather for correcting historical data: i.e. bad weather during holiday period increase overall audience levels.

### 4.1.4. Channel object

The channel are defined as the frames where to broadcast the programs and among the attributes it is defined the channel typology as well as parameters provided by experts that define the channel profile;

these parameters (i.e. coherence) have to be estimated and validate by the simulation model.

It is critical to properly define, model and initialize each attribute in order to create an effective knowledge representation of the entities involved the scenario.

## 5. METHODOLOGIES

To be able to complete analysis it is necessary to identify interactions and dependencies between the objects. The authors are planning to develop ad hoc artificial neural networks to be used to correlate the overall data representing general share on the programs, channels, timeslots for the identification of parameters to be used in the simulation model.

In addition considering the large number of variables and the high quantities of available data it is expected that specific techniques need to be developed for processing the scenario; in this case the authors are looking forward for the combined use of different techniques; for instance Data Fusion methods are promising for correlating different info among time and sources, while Neural Networks methodologies are expected to be very effective to identify clusters of similar data and to correlate parameters; in addition in order to provide an understandable and significant description of so many parameters the variables definition have to take advantage of Fuzzy Logics models.

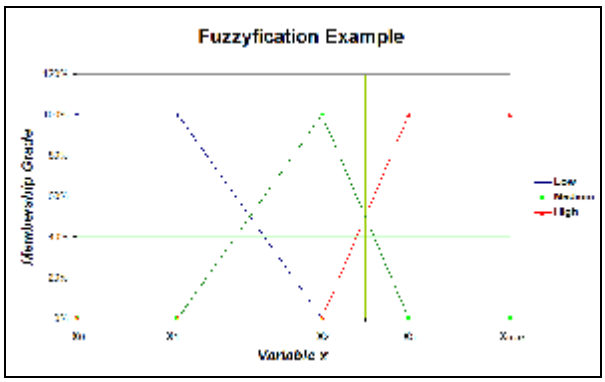



Figure 3: A Fuzzyfication Example

$$MV_{c-1} \equiv CV_c \equiv HV_{c+1} \quad (1)$$

- $MV_c$ =Minimum Value for the c-Cluster (Membership Grade = 0%)
- $CV_c$ = Central Value for the c-Cluster (Membership Grade =100%)
- $HVc$ = Higher Value for the c-Cluster (membership Grade = 0%)

This membership based on triangular functions overlapping 50% is pretty easy, however allows SME to quickly define the three reference values to be used to classify the attribute of a format: for instance the definition of budget for a variety program is fixed by defining these three levels, but the program is not discretely defined, while a membership grade is computed for each class (inexpensive, regular and very expensive) based on its specific production budget.

The fuzzy allocation matrices allow to combine different parameters in order to estimate their interrelations.

Data fusion algorithms are used to estimate the value of an attribute as combination of the different features measured along the time evolution.

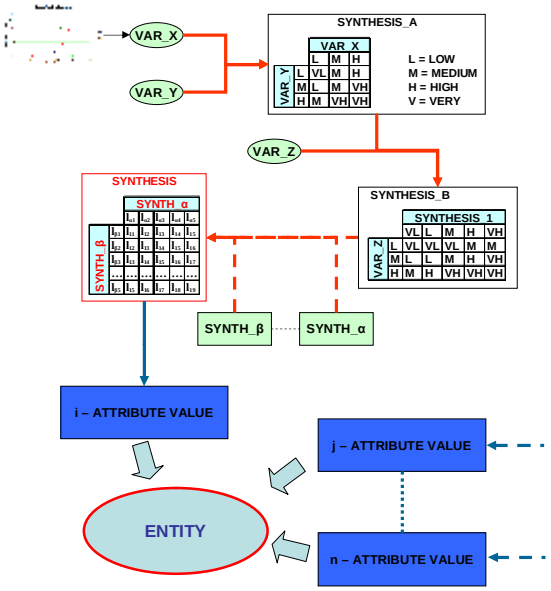



Figure 4: Data Fusion Architecture

In fact broadcasting scenarios are characterized by very short Life Cycles for the products, than is not usual to have enough historical data to elaborate forecasts, so Data Fusion methodologies can be applied to extract info by combining different data. In effect accuracy of forecast cannot be guaranteed due to the high influence of stochastic factors, but the comparison of these results with SME allows to better estimate effectiveness of decisions.

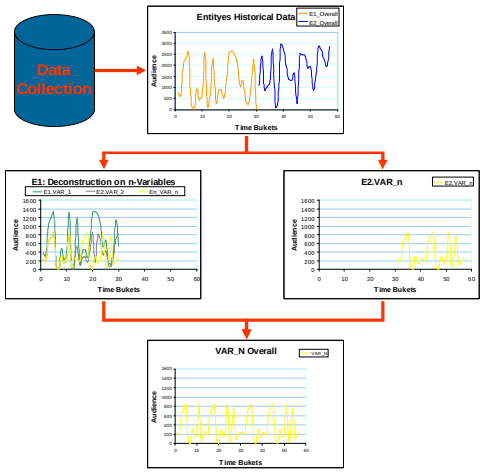



Figure 5: An application of Data Fusion Methodologies

Neural Models allows to check consistencies among elements estimated by SME and historical overall data; for instance it is expected to create the below proposed

scheme for correlating parameters of different objects, where not explicit rules (i.e. FAM) are known.

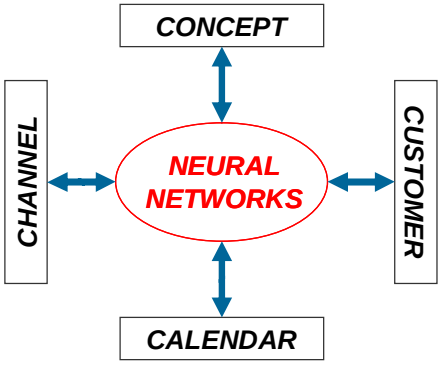



Figure 6: Correlation for Parameters of Different Objects

## 6. CONCLUSIONS

The authors proposed a first step forward in creating simulation models for tv broadcasting; the authors formalize the definition of general goals for these models in term of the definition of the schedule and creation/management of program warehouse; for this complex framework it is proposed a case study and the related object definition and attribute identification.

At this stage of the research models have been developed to support definition and measure of the attributes, while the authors are currently working for testing different integrated methods and techniques to be used for creating this new simulator.

The authors have collected data related to the scenario to complete preliminary test, however in the future it will be possible to present experimental results obtained by dynamic verification and validation of these models.

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