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Management Accounting Systems and Organisational Structure

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ABSTRACT. In this paper we present an empirical analysis to test whether organisation configurations and management accounting systems change simultaneously. Using the original application of the fuzzy logic methodology, we analyse the level of development and implementation of the management accounting system and the organisational configuration on a sample of 501 Italian firms. Even though we employ a cross-sectional approach, the results may be interpreted according to the life cycle model. Our findings show that the evolution of the organisational configurations is not always coherent with the relevance assumed by management accounting systems. In particular, we find a large group of companies with a simple organisational configuration and a well-developed management accounting system. We interpret the presence of this cluster dynamically as an intermediate stage of growth towards more complex forms of organisation.

KEY WORDS: organisational lifecycle, management accounting systems.

JEL CLASSIFICATION: M13, M40.

1. Introduction

The analysis of different management accounting systems (MAS) and of their relative variations observed in various companies is an essential issue in the managerial studies of the last few years (e.g. Bruns and Waterhouse 1975; Gordon and Miller, 1976; Otley, 1980; Duncan and Moores, 1989; Amat et al., 1994; Moores and Yuen, 2001). The increased complexity of the environment, of the company adjustment mechanisms, and of the company sensitivity to exogenous and endogen changes has led to the question about MAS consistency and about their relationship with the organisational schemes which form the basis of the company structure.

By following Simons' approach (1992) we can observe that, although in literature there are a few differences in the MAS definition, there are several common aspects, particularly, procedure formalities, their relation with information, and the relative diffusion, and focus on the business. After all, an organisational configuration is often interpreted as an archetype of different characteristics. In this regard Child's works (1972, 1977) are very enlightening. According to Child it is possible to identify any organisation within a certain configuration of contingent elements, typical of the context in which it operates. These elements refer to the market, to technology, to the range of activities and to the type of people operating in the company. In Miller's opinion (1981), in order to reach an internal coherence, organisations need to be interdependent and support each other in terms of strategy, structure and processes. Also Chenhall and Morris (1986) resume the organisational interdependence theme as one of the variable determining the MAS structure.

As is well known, in literature there are different types of organisational configurations; one of the most effective works in this regard is by Mintzberg (1979). He researched the consistency on the one hand between the environment and structure, and on the other between the elements of the organisational system; by following Miller and Mintzberg's (1983) and Mintzberg's (1983) approach, literature suggests a classification of organisational configurations with five evolution models (simple structure, mechanical bureaucracy, divisional solution, professional bureaucracy and adhocracy). Moreover the ability to

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identify different archetypes cannot hide the awareness about the existence of a continuum between the same, more suitable for seeing the complexity of the real world. For this reason, many analyses used a "dynamic approach" which makes it interesting to observe variations in the various organisations (see Kimberley and Miles, 1980; Miller and Friesen, 1983, 1984; Dodge and Robins, 1992; Dodge et al., 1994; Moores and Yuen, 2001). Moores and Yuen (2001) suggest a trend on this issue by exploring a MAS evolution processes through the various stages of an organisation life cycle and pointing out the differences in terms of MAS formalization level; according to Moores, an organisation adjusts to the changing context facts which express their placement in the company life cycle. Finally, according to a literature trend beginning from Gordon and Miller's work (1976), changes in the organisation affect the company MAS structure. In particular, management strategies, structures, and styles vary systematically during a company life cycle in order to preserve a consistency with the outside context. For this reason, a debate on the relationship between MAS and company life cycle, and on the consistency between organisation and MAS design is opportune.

This work is meant to fit into the debate on the existing relationship between MAS and organisational configuration through a non-traditional methodology to identify different MAS and various levels of organisational complexity. This method consists in processing context information identifying an MAS and certain organisation by using a fuzzy logic. This information was collected from a sample of 501 Italian companies that were asked to answer a questionnaire. The objective of this work is also to verify whether there are any recurring relationship between MAS and organisational configurations.

This work collects different information in order to identify, for each company, a set of MAS attributes; in particular, while identifying an organisational configuration, information classification aims at identifying the company size parameters (dimension set), delegation (decentralization set), characteristics of the production systems (production system set), and training activities (training set). According to a fuzzy logic, processing of the various sets of information refers to the collection method (i.e. selection), and to the type of information presentation (i.e. diffusion) The purpose of this information processing is to codify a decision system, as a tool to control the organisation and support the decision process.

Since the identification parameters of a MAS and an organisational configuration cannot be measured with numeric continuity, this work has used a fuzzy method in order to observe typical aspects such as the one this article deals with. Literature indicates the fuzzy approach as a tool used to solve complex problems that are not easy to formalize, or containing continuous spectrum data difficult to categorize through a traditional logic-mathematical system. When using a fuzzy technique, pre-determined relationships between data, seen from a cause-effect point of view, claim a main role from the data themselves. In particular, considering the relationship between MAS and organisational configuration, fuzzy logic enables to quantify continuously not only data expressed in numeric terms, but also situations expressed in terms of linguistic variables, such as, for example, the delegation level, organisation complexity, and the organisation size.

Note that the survey mapping performed on a significant sample of companies observes the company in a precise moment. This analysis, therefore, does not refer directly to the company life cycle; however, due to the sample size and the types considered, it is reasonable to interpret data dynamically: the identified points, i.e. the complexity couples of MAS-organisational configuration, could also be referred to a few companies observed in many different moments of their life cycle. This work identifies a relationship between MAS complexity and organisational configuration; more specifically, we identified high sample intensity areas and high rarefaction regions. According to Miller and Friesen (1984), results can be interpreted in a life cycle logic, and, therefore, can be interpreted dynamically: to the extent that the companies taken into consideration point out their position in a certain moment of the life cycle, then the areas the fuzzy logic has identified may be interpreted in the following way: birth, growth and maturity can point out the transfer from a limited organisational complexity and limited MAS complexity scenario (cluster 1), to a high organisational complexity and high MAS complexity scenario (cluster 3); companies with high organisational complexity and limited MAS complexity (cluster 4) can identify companies observed in a revival or decline phase. Consequently it is not unlikely for this latter cluster not to be so dense. This work also points out how the transition between the birth and maturity phase through the growth phase takes place when MAS complexity rather than the organisational configuration grows.

The paper is organized as follows. Section 2 shows our research framework and hypotheses. Then, we introduce our company sample highlighting its main descriptive characteristics. The paper goes on describing our methodology and the relative empirical results. Then we conclude by summarizing our findings and their limitations.

2. Research framework and hypothesis

The purpose of this paper is to find a relationship between organisation configurations and management accounting systems.

We define an organisation configuration, according to Moores and Yuen (2001), as a particular contingency of external variables (industry sector, technologies, etc.) and internal variables (processes, products, objectives). Organisational theory literature has recognized the presence of distinctive organisation patterns or archetypes. In particular, for the purpose of this work we will consider the organisation taxonomy of Mintzberg (1979) in five basic configurations: simple structure, mechanical bureaucracy, divisional solution, professional bureaucracy and adhocracy.

We define a MAS, according to Anthony (1965, 1978) and Deming (1968), as a set of tools involving the activities of information collection, classification and computing in order to help the strategic decision making process.

There exist relationships between these two issues. Among others, Miller (1981) considers the MAS as one of the internal variables determining the organisation configuration. Recently, Moores and Yuen (2001) studied the MAS-organisation configuration relationships in light of a life cycle perspective. They empirically verified that organisation configurations evolve according to the life cycle stage (birth, growth, maturity, revival and decline). Since MAS is one of the organisation influencing variables, it is clear that changes in MAS would induce changes in organisation configuration and *vice versa*. Furthermore, Miller emphasizes that a complementary alignment among these variables is an important factor determining performance.

Following this approach, our hypothesis is that organisation configurations and MAS would change simultaneously. In particular, we expect that the greater the organisation complexity, the higher the MAS evolution.

There are two possible ways to test whether such a relationship occurs. The first (longitudinal approach) considers the same company sample during different time-periods in order to verify whether changes in organisation configurations accompany changes in MAS (see among others Miller and Friesen, 1984). The second (cross-sectional approach) is to consider a company sample in a single time-period (see Dodge and Robbins, 1992; Dodge et al., 1994). In this case, companies showing differences in their organisation configurations are regarded as being in different phases of their life cycle. Therefore, they are expected to have different management accounting systems.

It is clear that the first alternative is more appropriate to test a dynamic relationship such as that implied in our research hypothesis even though there are some problems with time-varying comparisons. Nevertheless, the latter research framework may be more appropriate owing to the relevant size of our company sample.

After introducing our company sample, in Section 4 we define two variables measuring organisation configuration complexity and MAS relevance, respectively, in order to test our research hypothesis.

3. Sample characteristics

The survey was conducted by sending questionnaires to 2.603 firms operating in the Bergamo area[1] in Italy during 2001. These firms were selected from specific data bases such as Reprint, Kompass Italia, Business to Business and Servitec. This sample includes almost all the firms in the Bergamo area with more than 10 employees.

The questionnaire was structured in different sections in order to highlight the specific characteristics of the single functions such as R&D, Process Engineering, Accounting, Management Accounting System, Finance, Information System, Human Resources.[2] The 501 firms, which answered the questionnaire, form the object of this paper. The purpose of this section is to highlight some descriptive characteristics of the sample companies regarding management accounting system characteristics since it is not usual to have such a numerous sample. The next section will describe our research methodology.

The analysis of turnover shows that the majority of the sample (56%) is composed of firms having a turnover lower than 5 million euro. Firms having sales higher than 50 million euro compose only 5% of the sample. Table I shows the age of the firms in the sample divided into classes of turnover.

Generally, the sample includes small firms not only in terms of their turnover but also of the number of employees (see Table II): 70% of the firms in (Table II) have between 10 and 50 employees.

The smaller firms are in the wood industry sectors[3] (LEGN), furniture manufacturing (INDU), building sector (COST) and service sector (SERV). The firms operating in other sectors show a size close to the average dimension of the sample (Table III).

Going deeply into the MAS employed by our sample companies (Table IV), we find that 67% of the firms adopt a formal system of management accounting. The answers to this question depend on the typology of the firm, in terms of size and age: MAS plays a remarkable role in big companies. We would like to point out that firms having a turnover higher than 25 million Euros or a number of employees higher than 250 people use formal MAS more frequently.

TABLE I
Average beginning year of business classified by levels of turnover of the sample (Financial Year 1999)

Turnover (million Euro)	Average beginning year of business	Number of firms	Over the total number of firms %
< 5	1972	278	56
5–10	1972	96	19
10–25	1964	72	14
25–50	1956	32	6
> 50	1942	23	5
Total	1969	501	100

TABLE II
Classes of employees of the sample (Financial Year 1999)

Employees	Number of firms	Over the total number of firms %
10–50	352	70
51–100	71	14
101–250	59	12
251–500	14	3
> 500	5	1
Total	501	100

TABLE III
Firm Classification by field and by levels of turnover of the sample (Financial Year 1999). Please see Appendix A for field codes

Field*	Turnover (million Euro)					Total	Over total %
	< 5	5–10	10–25	25–50	> 50		
MACC	43	25	10	6	7	91	18
PRME	57	12	11	2	2	84	17
TESS	24	7	6	6	2	45	9
ELET	24	4	8	6	2	44	9
GOPL	17	13	8	4	0	42	8
INDU	25	4	1	0	0	30	6
CHIM	7	4	14	1	2	28	6
LEGN	23	4	0	0	0	27	5
MINE	18	4	0	3	1	26	5
CART	10	1	2	1	2	16	3
COST	5	6	4	0	0	15	3
ALIM	6	4	1	1	2	14	3
ABBI	9	3	0	0	1	13	3
META	3	2	4	0	1	10	2
TRAS	2	2	1	1	1	7	1
COMM	3	0	1	1	0	5	1
SERV	2	1	1	0	0	4	1
Total	278	96	72	32	23	501	100

TABLE IV
The diffusion of formal MAS for levels of turnover of the sample

Turnover (million Euro)	Diffusion of a formal MAS		
	Number of firms	Total	Over level of turnover %
< 5	166	278	60
5 – 10	66	96	69
10 – 25	52	72	72
25 – 50	28	32	88
> 50	22	23	96
Total	334	501	67

TABLE V.
Function carrying out the MAS, divided by levels of turnover. The percentages are computed over the number of companies using formal MAS. Multiple answers are allowed

Turnover (million Euro)	Functions Carrying Out the MAS										Firms using An MAS
	Specific function (%)		Accounting (%)		Strategic apex		Other functions (%)		Outsourcing (%)		
< 5	9	5	55	33	108	65	1	1	32	19	166
5 – 10	14	21	31	47	25	38	2	3	4	6	66
10 – 25	22	42	26	50	10	19	1	2	0	0	52
25 – 50	13	46	13	46	2	7	1	3	1	4	28
> 50	14	64	8	36	2	9	1	5	1	5	22
Total	72	22	133	40	147	44	6	2	38	11	334

TABLE IV.
Cost analysis techniques, classified by levels of turnover of the sample. Multiple answers are allowed

Turnover (million Euro)	Cost Analysis Techniques								Total firms
	Job costing (%)		Process costing (%)		Activity based costing (%)		Other methodologies (%)		
< 5	41	15	47	17	18	6	6	2	278
5 – 10	17	18	20	21	4	4	3	3	96
10 – 25	14	19	18	25	7	10	6	8	72
25 – 50	7	22	10	31	4	13	0	0	32
> 50	9	39	11	48	4	17	0	0	23
Total	88	18	106	21	37	7	15	3	501

The departments carrying out the MAS activities are essentially the administration (40%), the strategic apex (44%) and a specific function (22%). In this case, the figures depend on the turnover, the number of employees and the age of the firm, as shown in Table V.

The strategic apex carries out the MAS in small firms, with a turnover lower than 5 million Euros. In other dimensional classes there is a process of delegation of responsibility: the higher the turnover and the number of employees, the more important the role of the specific function in relation to the cost control. In particular, the specific function is almost always present in firms whose turnover is higher than 25 million Euros. Similar considerations can also be made in relation to the age of the company, since this variable is strongly correlated to the dimension.

The job costing and the process costing systems are the most common cost analysis techniques with a use of 18% and 21%, respectively (Table VI). Only 7% of the firms use activity based costing.

4. Research methodology

This paper widely uses the fuzzy logic methodology that was introduced by Zadeh (1965) as an approach to "handling vagueness, uncertainty and linguistic variables". Since fuzzy logic avoids the need for rigid mathematical modeling, it is well suited for many complex situations, which are difficult to describe analytically. Fuzzy logic has been used previously in a number of economic applications. For example, Basu (1984) introduced fuzzy analysing preference theory, Chen and Yu (1989) considered fuzzy isoquants in the theory of production, and Jozsef et al. (1992) used fuzzy mathematics in panel regressions. As far as we know, our paper is the first to apply this original approach in organisation and MAS theory; it is interesting to note how several organisation theoretical findings can be better expressed as qualitative linguistic variables. For example, Mintzberg (1979), describing the contingent factors affecting the organisation configurations, states that if the industry environment is "dynamic" then the organisation configuration will be "organic". The fuzzy logic methodology helps to define these fuzzy concepts and to handle them through "If-Then" rules.

The remaining part of this section will describe the three phases necessary to implement a fuzzy logic system and how we employ them to classify the organisation configurations and the MAS of the company sample:

(1) the definition of fuzzy membership functions or fuzzy sets;
(2) the definition of "If-Then" rules to combine the fuzzy sets;
(3) the so-called "defuzzification" of the solution fuzzy set.

4.1. *The definition of fuzzy membership functions*

In contrast to conventional probability theory, fuzzy logic uses linguistic uncertainty to describe real-world vagueness. It allows for characterizations of statements such as those described above. This is accomplished with an extension of conventional Boolean logic, that allows for intermediate values between the true and false Boolean values. Mathematically, multi-valued logic can be modeled with a modification of traditional set theory allowing for in-between values of memberships. By using continuous functions indicating the degree of membership, fuzzy sets can be represented in more detail. These so-called membership functions are defined more formally as follows:

Let the fuzzy set Y be defined in the conventional set $\mathrm{X} = \{x_1, x_2, \ldots, x_n\}$ and denote its membership function by m_Y. For example, Y may be the set of 'low company dimension' and X the set of 'company dimensions'. The function $m_y(X)$ indicates the membership degree in Y of elements in X. Hence, a real number in the interval [0,1] is associated with every element of $X : m_y(\mathrm{X}) : X \rightarrow [0, 1]$

Several membership function types may be used to map out an input variable. In this work, we use the well-known Gaussian distribution curve. The main advantages of this curve are its smoothness and the fact that it charts all possible X with non-zero values (see the example shown in Figure 2).

In our study, we use two different fuzzy systems: the first to classify the organisation configurations and the second to classify the management accounting systems (see Figure 1).

The former and more complex fuzzy system is composed of 23 first level input variables, 4 second level input variables and 1 output variable. A first level variable is a variable whose value directly depends on questionnaire answers. Conversely, a second level variable depends on both first level variables and on questionnaire answers. First and second level input variables produce the output variable that is the organisation configuration classification.

The latter fuzzy system is composed of only two first level input variables and one output variable that is the MAS classification. In Section 5 will describe the steps from the first level input variables to the second level input variables and then to the output variables.

We define membership functions for each of the 30 variables analyzed above. For example, the percentage of employees with a high school diploma or college degree over the employees total number ranges between 0 and 1 and it is transformed into a fuzzy variable by employing three different membership functions as shown in Figure 2.

In Appendix B we report its description for each variable and the names of the membership functions in which it is transformed. In reference to the latter information, the variable domain is equally divided into n-1 parts, letting n be the membership function number. If we assume that the variables domain ranges from 0 to 1, the first membership function peak corresponds to 0. Generally, the i-membership function peak corresponds to $(i-1)/(n-1)$. Thus, the last membership function peak corresponds to 1. Three is the most common number of membership functions used. The Low-Medium-High membership functions of Figure 2 are a typical example.

4.2. *Fuzzy Inferencing And Rule Composition*

After converting input variables into fuzzy sets, it is possible to introduce statements or If-Then

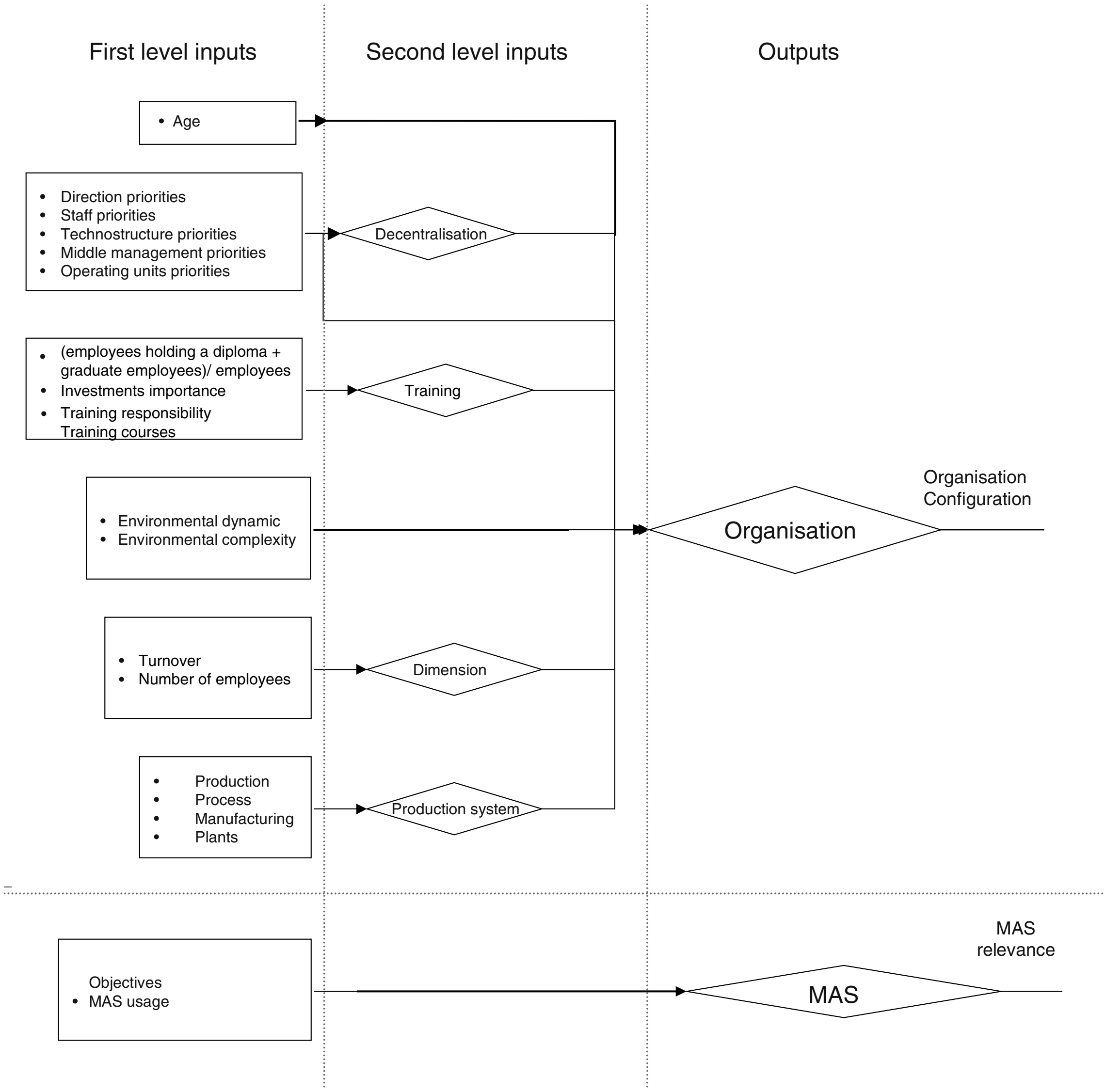

Figure 1. The two fuzzy systems used to classify the organization configuration and the MAS of the sample companies. The inference fuzzy systems are in rhombuses. First level variables come directly from questionnaire answers. Second level variables elaborate first level variables by using fuzzy systems. The two output variables, organization configuration and MAS relevance, are obtained from first and second level variables by using fuzzy methodologies.

rules linking fuzzy variables in relationships. Let us take as an example the fuzzy variable "dimension". This variable depends on turnover and number of employees and has three membership functions, "Low dimension", "Medium dimension" and "High dimension". Furthermore, both turnover and number of employees have three membership functions: Low Medium and High.

To assess the variable dimension, we employ five different rules, as shown in Table VII.

The fuzzy logic operators, AND, OR and NOT, generalize the Boolean operators. Let us take two fuzzy membership function values, X and Y. X AND Y is defined as the minimum membership function value between X and Y. One would easily verify that if X and Y can only

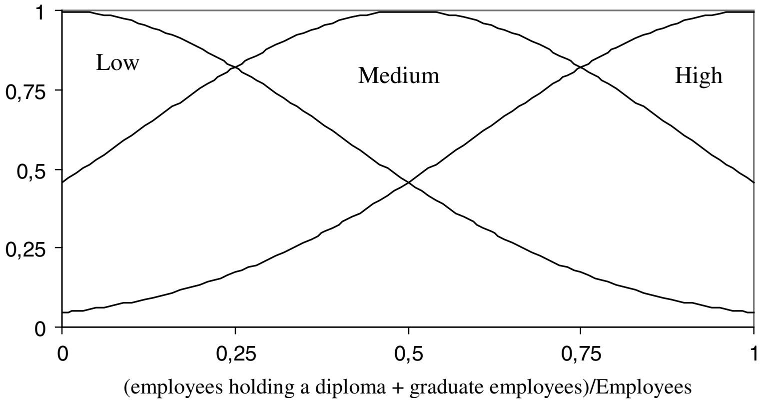

Figure 2. The percentage of holder of a diploma and graduate employees over the total number of employees is turned into a fuzzy variable by using three membership functions called 'Low', 'Medium' and 'High', respectively. For example, if the company holder of a diploma or graduate employees represent 50% of the total employees, this input variable belongs to membership function 'Low' with degree 45%, to membership function "Medium" with degree 100%, and to membership function "High" with degree 45%.

TABLE VII.
The set of rules used to create the dimension variable from the turnover and the number of employee variables. For example, the first rule states that if turnover is low and the number of employees is also low, then the dimension is low

Rule	Turnover	Logic operator	Number of employees	Dimension
1	Low	AND	Low	Low
2	High	AND	High	High
3	Not low	AND	Low	Medium
4	low	AND	Not low	Medium
5			High	High

be 0 or 1, the definition reported above corresponds to the Boolean definition of the operator AND. Analogously A OR B is defined as the maximum membership function value between A and B. NOT A is defined as the additive complement of the membership function value A.

The output of each rule is a fuzzy set. If there are more rules, then the respective output fuzzy sets will be aggregated into a single output fuzzy set.

In this analysis we employ the so-called max-min rule: we consider the minimum membership value (AND operator) within each rule and then we compose the rules using the maximum value for each rule. Dubois and Prade (1980) provide a very clear interpretation of the max-min rule. The rule systems may be regarded as a set of chains linking the preceding variables with the subsequent variables. Each chain is only as strong as its weakest link (min evaluation), while the strength of the relationship is that of its strongest chain (max evaluation).

Let us consider the first two rules of the fuzzy system 'dimension'. We evaluate the dimension of a company with 200 million Euro turnover and 300 employees. By applying the membership functions on turnover and number of employees, we discoverer that the turnover is High with a 75% degree, and it is Low with a 15% degree; whereas the number of employees is High with an 80% degree and Low with a 10% degree. By following the first rule, the dimension is Low with a 10% degree and from the second rule, the dimension is High with a 75% degree (AND operator). Since the dimension output membership functions are the same as those shown in Figure 2, the two rules bring the membership functions of Figure 3.

The consequent variable of a fuzzy rule assigns an entire fuzzy set to the output. If the preceding variable is only partially true, as in this case, then the output fuzzy set will be truncated according to the same rule. The composition of the fuzzy sets output is based on their maximum value for each value of the output range.

In Appendix C there is a "If-Then" rule complete list of the fuzzy systems shown in Figure 1

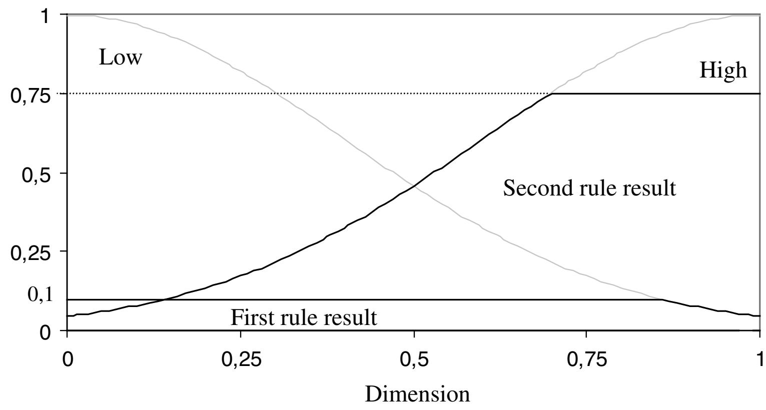

Figure 3. Fuzzy set results of first two rules indicated in Table VII, when the company turnover is 200 million euro and the company number of employees is 300. By applying the membership functions on turnover and number of employees, we obtain that the turnover is High with a 75% degree, is Low with a 15% degree, whereas the number of employees is High with an 80% degree and Low with a 10% degree. By following the first rule, the dimension is Low with a 10% degree, and from the second rule, the dimension is High with a 75% degree. The output sets are those indicated in the figure. Membership functions low and high are truncated at 10% and 75%, respectively and the aggregate membership function is set according to the maximum for each value in the output range (see Figure 4).

apart from the system 'dimension' which is described above in Table VII: decentralization, training, technology, production system, organisation and MAS. We use a total of 42 "If-Then" rules: 7 for decentralization, 7 for training, 5 for dimension, 4 for production system, 15 for organisation and 4 for the management accounting system.[4]

4.3. *Defuzzification*

The last fuzzy system step is to arrive at a single figure, which can be used for comparison purposes. There are different methods available for this operation. We employ the most widely used technique called 'centroid defuzzification' that is the weighted mean of the fuzzy region and is analytically defined as:

$$\frac{\sum_x Y(X) \cdot X}{\sum_x Y(X)},$$

where X is the domain value and Y is the correspondent membership function. Figure 4 shows how it is possible to pass from the fuzzy region to a single value. In the above reported example, the centroid corresponds to the value 0,67 which is the output of the fuzzy system "dimension". This value can be interpreted as the classification of the company dimension in the range [0–1]. It will then be used as an input variable of the fuzzy system "organisation" as seen in Figure 1.

5. Empirical results

In this section, we will show the fuzzy logic results referring to the organisation configuration and the MAS classification. As seen in the Appendix B, the organisation configuration variable has five membership functions, which may be classified in order of internal "complexity", as a proxy of configuration specificities, from the simple structure to adhocracy.

The complexity of the organisational structure of a firm is assessed by a numeric value, the output of the fuzzy system, lying in the range [0, 100]. In particular, the configuration of each firm is defined by the use of five linguistic and qualitative variables from Mintzberg (1979): simple structure, mechanical bureaucracy, divisional structure, professional bureaucracy and adhocracy. Since the membership functions are five, they have their peak at 0, 25, 50, 75 and 100 respectively (see Figure 5).[5]

The results of the fuzzy elaboration show that 40% of the firms own an organisational structure

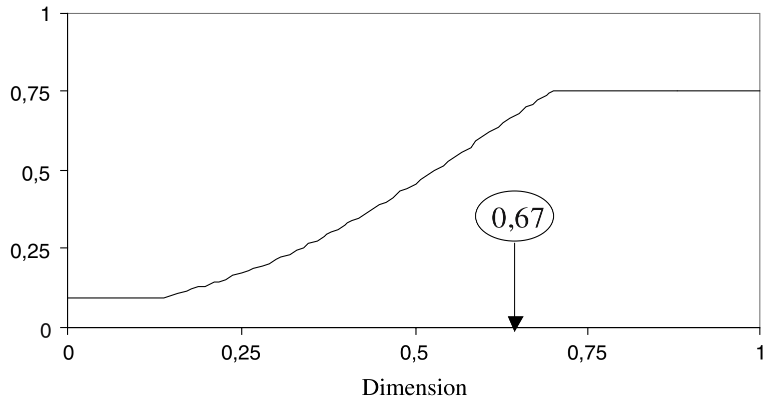

Figure 4. The defuzzification of the fuzzy region resulting from the example reported above. The methodology used, known as centroid defuzzification, evaluates domain values by using membership function values.

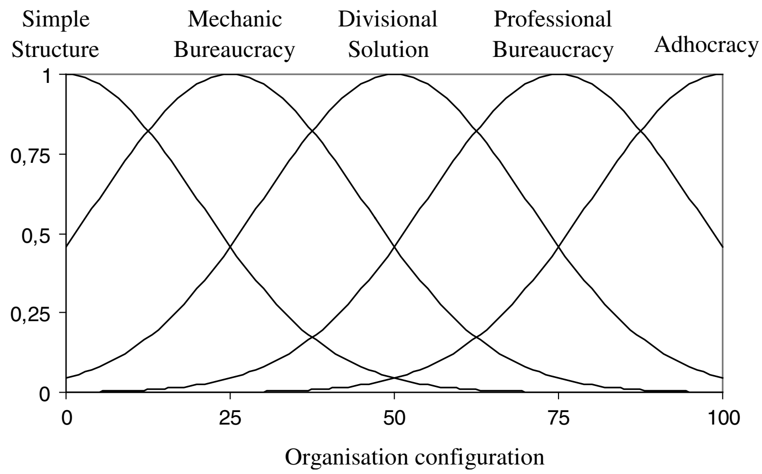

Figure 5. The variable Organization configuration is mapped out in five membership functions representing the five main organization configurations from Mintzberg (1979): simple structure, mechanic bureaucracy, divisional solution, professional bureaucracy and adhocracy. The ordering criterion is the organization specificity, from a simple structure to adhocracy.

close to the mechanic bureaucracy (around 25), whereas 20% lie between the divisional structure and the professional bureaucracy (between 50 and 75) as seen in Figure 6.

The firms are also classified by the level of implementation of MAS in five levels (low, limited, intermediate, advanced and high level).

The level of implementation of MAS is evaluated by a numeric value lying in the range [0, 100]. The results of this elaboration show that 30% of the firms in the sample employ a 'limited' MAS (around 25) and almost 50% use MAS classified as intermediate level (around 50) as shown in Figure 7.

Figure 8 shows the relation between the organisational specificity and the level of implementation of MAS: the dark color shows the areas with a high density of firms. It is possible to point out that the firms in the sample are divided into four clusters, labeled from 1 to 4: group 1 is composed of 208 firms (41,5%), group 2 of 165 firms (33%), group 3 of 103 firms (20,5%) and group 4 of the remaining 25 firms (5%).

The existence of a cluster of firms with low complexity organisations and lowly developed MAS (cluster 1) is predictable. The presence of a cluster of firms with high complexity organisations and highly developed MAS (cluster 3) is not

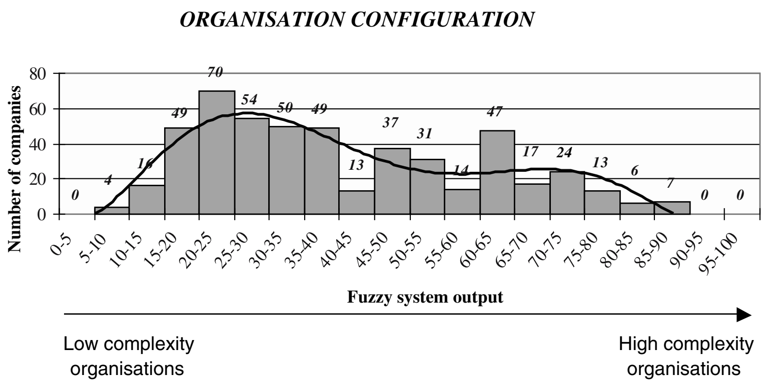

Figure 6. Results of the organisation configuration classifying the sample companies taken into consideration. The y-axis shows the number of sample companies with a given output value (x-axis).

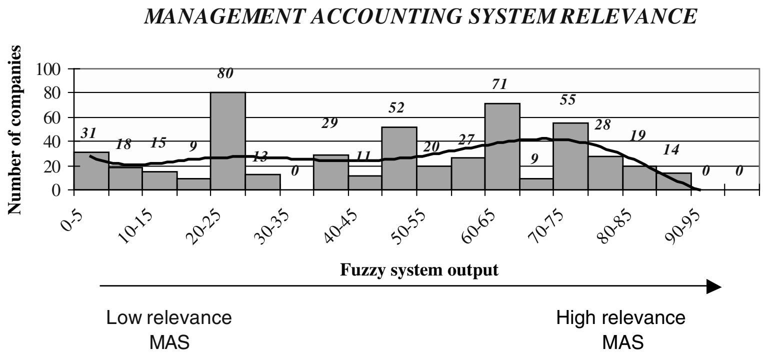

Figure 7. Results of the MAS fuzzy process of classifying the sample companies taken into consideration. The y-axis shows the number of sample companies with a given output value (x-axis).

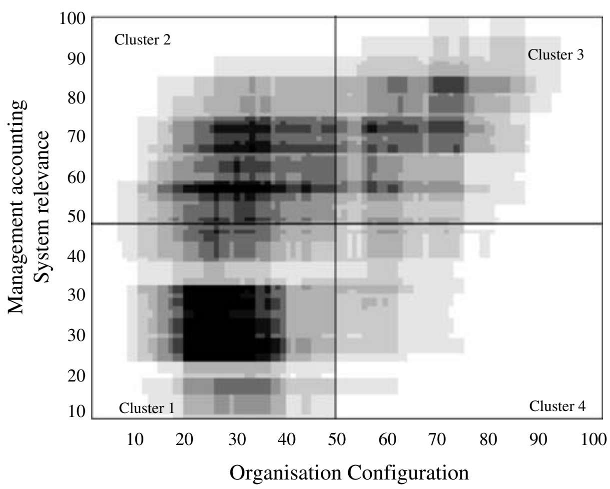

Figure 8. The relationship between the two fuzzy outputs. In particular the organisation configuration is shown on the x-axis, whereas the MAS variable is on the y-axis. The darker regions indicate a higher sample company concentration. The company sample can be divided into four clusters.

unusual either. The main result is the existence of a cluster of firms (cluster 2) with low complexity organisations, as in cluster 1, and high-developed MAS, as in cluster 3. It is also relevant to examine that the dual group of cluster 2, composed by firms having a low level of implementation of MAS and a high complexity organisation (cluster 4), have a much lower concentration.

This finding does not confirm completely the initial hypothesis, since there does not seem to be a linear relationship between organisation configuration and MAS evolution.

In order to explain this result, which seems to be not intuitive, it is necessary to point out that the score by which each firm is classified may be interpreted dynamically. In other words, the position of a firm may represent an intermediate phase in a process of evolution. In particular, the firms having a low complexity organisation and a developed MAS (cluster 2) may be in a transition stage towards more complex forms of organisation. On the other hand, firms belonging to the dual cluster (cluster 4), having high organisational complexity, but an insufficiently relevant MAS, may be incapable of managing the complexity of their organisation, and thus could be torn by internal inconsistencies.

6. Conclusions and limitations

The purpose of this work was to analyze the consistency of management control systems in relation to the organisational configurations adopted by firms. The increased complexity of exogenous conditions and of the company evolution mechanisms has posed the question about this consistency and on the contextual growth hypothesis of MAS implementation with the growth of the complexity of organisational configuration. We have collected data about 501 Italian firms through a questionnaire about the different aspects of their particular type of organisational configuration and of management control system. The innovative method used to process data, fuzzy logic, has allowed classifying firms through not only numeric data (e.g. size and age), but also linguistic variable quantities (e.g. the delegation level and the organisation complexity). Company cluster classification has partially confirmed our hypothesis; in particular, from a 'organisational complexity-MAS relevance' classification one can observe two densely 'populated' areas: one with a simple organisation and a just as simple MAS implementation level, and the other with a complex organisation and a particularly evolved MAS. However, also a third cluster results from data processing consisting in companies with a simple organisational structure yet with a quite evolved MAS. Moreover, the cluster characterized by a complex organisational structure and not so evolved MAS turned out to be basically empty.

Our results are consistent with those already existing in literature, and point out a correlation between the complexity of organisational configurations and MAS relevance.

While the fuzzy method does not eliminate completely the discretion typical of the analysis of a system characterized by both quantitative and qualitative variables, yet, in our opinion, it represents a step forward in dealing with this issue precisely.

By analyzing the results one can interpret in life-cycle terms, and consequently in dynamic terms, the relation between organisational configurations and MAS. The same interpretation may apply in evolution terms. The situations classified in terms of cluster could represent rather than states of balance of each single company, states through which companies evolve, although this needs to be verified with further research.

In particular, companies with a quite evolved MAS and a simple organisational structure might be in the middle of a transition back to more complex organisational solutions. Although further empiric verification would be necessary, based also on the Greiner's model approach (1972), the phase difference between MAS development and the organisational structure adjustment could be due to the entrepreneur's tendency to resist organisational change. By supporting strong MAS the entrepreneur can continue directing a company, at least initially, while delaying the organisational structure evolution and the decision delegation process.

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Notes

[1] The Bergamo area is a territory of almost 1 million people in Lombardy, a region in Northern Italy. The Bergamo province is considered a highly developed area, and its economy is characterized by a strong presence of small-medium manufacturing firms. Its closeness to Milan, the most industrialized area in Italy, is also an advantage. For the above reasons it can provide a good representative sample of the Italian economy.

[2] The authors will be happy to provide a copy of the questionnaire upon request.

[3] Please see Appendix A for the relation between the codes used in this paper and the NACE business classification.

[4] In each fuzzy system we generally tend to employ a greater number of rules to define the two extreme membership function properties (the lowest and the highest) than to define the ones in the middle. This is due to the fact that when it is not possible to meet extreme properties, intermediate properties naturally apply.

[5] Certain procedures involved in fuzzy logic, such as the membership function numbers and the "If-Then" statements, rely on subjective and intuitive judgments, even though the high sample dimension generally makes our results sound.

APPENDIX A

Relation between the used codes and the industrial sectors by NACE classification

Code	Description of the industrial sectors by NACE classification
ALIM	15 – Food products and beverages
	16 – Tobacco products
TESS	17 – Textiles
ABBI	18 – Wearing apparel; clothing and fur dyeing
LEGN	20 – Wood Manufacture, wood and cork products
	36.1 – Furniture
CART	21 – Pulp manufacture, paper and paper products
	22 – Publishing, printing and reproduction of recorded media
CHIM	23 – Coke manufacture, refined petroleum products, and nuclear fuel
	24 – Chemicals and chemical products
GOPL	25 – Rubber and plastic products
MINE	26 – Manufacture of other non-metallic mineral products
META	27 – Basic metals
PRME	28 – Fabricated metal products, except machinery and equipment
MACC	29 – Machinery and equipment
TRAS	34 – Motor vehicles, trailers and semi-trailers
	35 – Manufacture of other transport equipment
ELET	30 – Office machinery and computers
	31 – Electrical equipment
	32 – Radio, television, and communication equipment.
	33 – Medical, precision and optical instruments, watches and clocks
INDU	36 (With the exclusion of 36.1) – Furniture
	37 – Recycling
COST	45 – Construction
COMM	50 – Motor vehicles and motorcycles sale, maintenance and repair; retail sale of automotive fuel
	51 – Wholesale trade and commission trade, except for motor vehicles and motorcycles
SERV	40 – Electricity, gas, steam and hot water supply
	60 – Land transport; pipeline transport
	74 – Other

APPENDIX B

Description of the single variables and their relative membership functions

Variable	Description	Ordered Membership functions
Age	The company age, directly from the questionnaire.	Young, medium, old
Direction priorities	Whether the direction carries out directly R&D, design, quality control, logistic and supply chain management, management accounting system, finance or information technology activities. Each activity scores 12.5. Max 100 points.	Low, medium, high
Staff priorities	Whether there is a specific department to carry out R&D, administration, quality control, logistic and supply chain management, management accounting system, finance or information technology activities. Each activity scores 12.5. Max 100 points.	Low, medium, high
Techno structure priorities	Whether there is a specific department to carry out Design, Engineering, or time and method activities. Each activity scores 33,3. Max 100 point.	Low, medium, high
Middle management priorities	Whether there are foreign subsidiaries or product departments. Max 100 point.	Low, medium, high
Operating units priorities	Whether the operating units carry out directly R&D, design, quality control, logistic and supply chain management, management accounting system, finance or information technology activities. Each activity scores 12.5. Max 100 points.	Low, medium, high
Decentralization	Output variables of the fuzzy system decentralization	Vertical-horizontal centralization, selected horizontal decentralization, selected vertical decentralization, selected vertical-horizontal decentralization, vertical-horizontal decentralization
(Holder of a diploma + graduate)/ employees	The percentage of skilled employees. Directly form the questionnaire.	Low, medium, high
Investment priorities	Whether there have been investments in R&D, Design and Engineering, Production and Logistic, Management control System, Information departments. Each department scores 16.7. Max 100 points.	Scarce, medium, high
Training responsibility	Whether there is an employee responsible for training activities. 100 point.	No, not dedicated, yes
Training Courses	Whether there are frequent training courses.	No, not permanent, yes
Training	Output variables of the fuzzy system training	Low, medium, high
Environmental dynamic	The company industrial field has been classified through the Pavitt taxonomy (High technology-0, Specialised-33.3, Scale-66.6, Traditional-100). Max 100 points.	Dynamic, stable
Environmental complexity	The company industrial field has been classified through the Pavitt taxonomy (High technology-0, Scale-33.3, Specialised-66.6, Traditional-100). Max 100 points.	Very complex, complex, simple, very simple
Turnover	Directly from the questionnaire.	Low, medium, high
Number of employees	Directly from the questionnaire.	Low, medium, high
Dimension	Output variables of the fuzzy system dimension	Low, medium, high
Production	Whether the production system is based on single lots, repetitive lots or high volume products	Single lot, repetitive lots, high volume products

Appendix B
Continued

Variable	Description	Ordered Membership functions
Process	Whether the process is based on single units, lots, series or continuous process.	Single unit, lots, series, continuous
Manufacturing	Whether the manufacturing system is based on departments, production cells or production lines	Departments, cells, lines
Plants	Dedication degree of the company production plants.	Dedicated, Medium specialization, Low specialization
Production system	Output variables of the fuzzy system production system	Sophisticated, low regulation, high regulation
Organisation configuration	Output variables of the fuzzy system organisation	Simple organisation, mechanic Bureaucracy, divisional solution, professional bureaucracy, adhocracy
Objectives	Whether there is a formalized management accounting system, an objective-driven strategy, an employee evaluation system, or an employee incentive system. Each system scores 25. Max 100 points.	Scarce, sufficient, large
MAS usage	Whether there is an activity based costing system, other particular costing methodologies (quality costs or environmental costs), an effective budgetary system, and whether there have been any MAS investments during the last two years. Each activity scores 25. Max 100.	Scarce, sufficient, large
MAS relevance	Output variables of the fuzzy system MAS	Low, limited, sufficient, advanced, high

APPENDIX C

The "If-Then" rule complete list The last column of each table shows the fuzzy system output variable, whereas the preceding columns report the input variables. The logic operator combining the input variables is the 'AND' operator. Composition follows the max-min rule as seen in the research methodology section.

Fuzzy system 'Decentralization'

Rule	Direction priorities	Staff priorities	Techno structure priorities	Middle management priorities	Operating units priorities	Decentralization
1	High	Low	Low	Low		Vertical-horizontal centralization
2	High	Low	Low	High		Selective horizontal decentralization
3	High	Low	High	High	Medium	Selective vertical decentralization
4	High	High	Low	Low	Medium	Selective horizontal decentralization
5	High	High	Low	High		Selective vertical decentralization
6	High	High	High	High		Selective vertical horizontal decentralization
7					High	Vertical horizontal decentralization

Fuzzy system 'Training'

Rule	Employees holding a diploma + graduate employees	Investment priorities	Training responsibility	Courses of training	Training
1	Low	Scarce	No	No	Scarce
2	Low	High	No	No	Medium
3	Low	Scarce	Not dedicated	No	Scarce
4	Low	Medium	Yes	No	Scarce
5	High			Yes	High
6		High	Yes	Yes	High
7		Medium		Not permanent	Medium

Fuzzy system 'Production System'

Rule	Production	Process	Manufacturing	Plants	Production System
1	Single Job	Single unit	Department	Dedicated	Sophisticated
2	Repeated Job	Lots	Production cells	Medium specialized	Low regulation
3	Repeated Job	Series	Production cells	Medium specialized	Low regulation
4	High volume products	Continuous	Line	Low specialized	High regulation

Fuzzy system 'organisation'

Rule	Age	Decentralization	Direction importance	Staff importance	Techno structure importance	Middle management priorities.	Training	Environ-mental dynamic	Environ-mental complexity	Dimension	Production System	Organisation
1		Vertical-horizontal Centralization	Not limited	Not large	Limited	Limited	Scarce	Dynamic	Very simple	Not high	Not Sophisticated	Simple Structure
2		Vertical-horizontal Centralization	Not limited	Not large	Limited	Limited	Scarce	Dynamic	Simple	Not high	Not Sophisticated	Simple Structure
3		Vertical-horizontal Centralization	Not limited	Not large	Limited	Limited	Scarce			Not high	Not Sophisticated	Simple Structure
4	Young	Selected Vertical Decentralization.	Large	Limited	Limited	Large	Medium	Dynamic	Simple	Low	Low regulation	Simple Structure
5	Not young	Selected Horizontal Decentralization.	Not Large	Not limited	Not limited	Not limited	Not High	Stable	Not very complex	Not low	Not Sophisticated	Mechanic Bureaucracy
6	Not young	Selected Horizontal Decentralization.	Limited	Not limited	Not limited	Large	Scarce	Stable	Simple	High		Divisional Solution
7	Medium	Vertical Horizontal Decentralization	Limited	Large	Limited	Middle	High	Stable	Very complex	Middle	Low regulation	Professional
Bureau-cracy												
8	Medium	Non Vertical Horizontal Centralization		Medium	Large	Medium	Medium				Sophisticated	Adhocracy
9	Medium	Non Vertical Horizontal Centralization		Medium	Large	Medium	High				Sophisticated	Adhocracy
10	Medium	Non Vertical Horizontal Centralization		Large	Large	Medium	High				Sophisticated	Adhocracy
11	Medium	Non Vertical Horizontal Centralization		Large	Large	Medium	High				Sophisticated	Adhocracy
12	Young	Non Vertical Horizontal Centralization		Large	Large	Medium	High				Sophisticated	Adhocracy
13	Young	Non Vertical Horizontal Centralization		Large	Large	Medium	Medium				Sophisticated	Adhocracy

Fuzzy system ‘organisation’ (Continued)

14	Young	Non Vertical Horizontal Centralization	Medium	Large	Medium	High	Sophisticated	Adhocracy
15	Young	Non Vertical Horizontal Centralization	Medium	Large	Medium	Medium	Sophisticated	Adhocracy

Fuzzy system ‘MAS’

Rule	Objectives	MAS usage	MAS relevance
1	Scarce	Scarce	Low
2	Large	Large	High
3	Not large	Large	Sufficient
4	Not scarce	Sufficient	Advanced

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