Construction of decision criteria for family – run businesses

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Abstract. This paper focuses on a decision system for family – run businesses. The aim is to capture the leadership instinct and experience in order to guarantee a human resource management instrument for the next entrepreneurial generations. The design of a decision system considers the need of assembling work teams for business orders via the following steps. First, a KSA (Knowledge, Skills and Attitudes) model is analysed for the description of workers and their abilities for each work order. Then, an Apriori algorithm studies the logic by which the leadership makes the work teams. Finally, the information fusion, due to both KSA and Apriori algorithm, allows the reconstruction of leadership decisions with a high accuracy degree. A real case of family – run business is useful to test the approach, showing that the entrepreneurial success is not always due to the best work teams.

Keywords: family – run business, VSA, decision system, KSA, APriori algorithm

1 Introduction

The Family Business phenomena (see [9], [10]) and, in general, all aspects connected to the generation turnover (see [12], [16], [20], [30]) and/or the business continuities have a deeper and deeper effect within economical – social scenarios, either in Italy or in other countries. Indeed, also at an international level, researchers and policy markers are investigating family entrepreneurial realities (see [1], [18], [24]), as they represent a very effective business model, which is adaptable, as for dimension and market, to other enterprise forms and is able to give positive answers also for the survival and viability of entrepreneurial organizations in crisis moments (see [8]). The relevance of the model is due to the logic continuity of the leadership, seen as extention and persistence of the family unit (see [37]) either for the ownership or the guide of the business company (see [4], [17], [23]). The existence of the family, which represents the decisor subject, represents a sort of survival guarantee in case of adverse events and

generation turnover (see [5], [15], [28]), being the last one an effect which is not always physiological and linear (see [6], [29], [31], [33]).

In the context of the family – run businesses, new generations need a tool (a Decision Support System, DSS), that can help them in supporting the activities of Human Resource Management (HRM). Through a DSS, the transition from a generation to the next ones does not necessarily result in a final act of activities, but it would be only the beginning of a new work phase. The whole business life is essentially based on the sales volumes, which can be much higher as higher is the working level that, consequently, implies a certain satisfaction degree of the customer who requests a service. Considering these phenomena from a more macroscopic point of view, the business success is due to the building of work teams for each received work order.

In this paper a procedure, that can capture the leadership instinct and experience for small businesses, is examined, with consequent advantages in terms of realization of work teams. The analysis was made in a real family – run business, the Santonicola Enterprise, located in Siano (Salerno, Italy). In a first phase, the Knowledge, Skills and Attitude model was considered (for further explainations, see [7], [11], [13], [26], [27] and [34]). Precisely, the analysis steps have been the following: a worker KSA was considered to identify the best workers among all; a group of sixteen work orders (corresponding to all typical enterprise requests) was created and the leadership assigned a work team to each work order; a work order KSA was studied to understand the most suitable workers for each work order.

From the obtained results in the first phase, it was noticed that the best workers are not always the most adequate ones and that the leadership almost never chooses the idoneous workers for the specific work order. It follows that the decisions often consider implicit parameters, that have to be captured (an example is in [14]).

Hence, in a second analysis phase, in order to understand the leadership choices in a more proper way, some Data Mining techniques have been examined. In particular, considering a Pattern Mining algorithm, and precisely an Apriori one (more details are in [2], [3], [19], [21], [22], [25], [32], [35], [36]), it was noticed that the leadership often tends to propose typical group of workers, with consequent existence of implicit association rules in team building activities.

Finally, it was verified that a DSS design, that foresees either the KSAs or the Pattern Mining techniques, is able to reproduce most of the leadership choices. Such choices are not optimal in absolute sense, but the most suitable ones for the business, following its history and tradition.

The paper is organized as follows. In Section 2 the Business family phenomena and the generation turnover are described, with emphasis on the importance of the KSA model and the Apriori algorithm. Section 3 presents the case study. Section 4 reports the final research results. The paper ends with Conclusions in Section 5.

2 Business family and generation turnover problem solving

The systematic data collection by national and international observatories confirm the popular relevance of the Family Business phenomenon.

It is considered an interdisciplinary field, which recovers its own identity only in first 80's. As for a definition, *"family businesses are those whose policy and direction are subject to significant influence by one or more family units. This influence is exercised through ownership and sometimes through the participation of family members in management. It is the interaction between two sets of organisation, family and business, that establishes the basic character of the family business and defines its uniqueness"* (see [10]).

Traditionally, family – run businesses have been considered, indeed, as a residual business model, strictly due to a transient (and for this negligible) phase of the dimensional and managerial natural evolution of companies. On the other hand, the relevance of the phenomenon within the modern economies, the fact that family – run businesses are able to grew up to very big dimensions and the interesting implications of generation turnovers let the Family Business become a scientific investigation area with fascinating and instructive managerial implications.

Nowadays, in particular, beside the analysis of business archetypes and their life cycles, interdisciplinary research activities are arising about the generation turnover and the different models of business in families, with the aim of giving detailed scientific contributions in order to support the ideas of business decision makers and professionals (see [9]).

The problem of generation turnover was deeply studied (see [20]) and nowadays it continues to cause a further attention (see [12], [16], [30]). The research activities showed, in general, that only a small percentage of family – run businesses survives to the founder generation and that a lower percentage of them reaches or goes beyond the third transition (see [6], [29]).

In terms of family inheritance, there exists a strong interest within the scientific community as for the preservation of the familiar social – emotional wealth (see [37]) and the ability to transfer the embedded knowledge from the owner founder to his successor. Although the nepotism is the most common explanation in countries of Latin origin, the choice of referring to family members is the optimal decision in highly idiosyncratic family businesses, where professionals can gain knowledge and critical working relationships within the company (see [1], [24]).

Overall, the empirical facts reveal that the continuity of family businesses, as well as their performance, depends on the succession processes planning. In particular, as for the succession decision, the new family decision maker should acquire experience, practices, skills and competencies that characterize the business model. Hence, one wonders whether it is possible to rely on the experiences detection – often of empirical type and, hence, unofficial for this reason – to infer on models and algorithms, that can ensure to the successor a suitable instructive transfer – implicit knowledge vs explicit one, or tradition vs routine – for the business continuity.

This is a topic about the "conversion" of knowledge, which considers another field of analysis, namely the one of Knowledge Management (see [31], [33]). Indeed, there are strong critical situations and uncertainty connected to the generation turnover, with consequent transfer of knowledge assets and responsibility in the governance and management enterprise, in order to guarantee the leadership continuity within the family.

Obviously, there are not certified algorithmic models to solve, in a homogeneous way, the "conversion" problem of the cognitive background and decisions dynamics in leaderships. In this direction this paper focuses on a systemic framework, through which more than a few attempts have been made to measure the influence of the family system on the business criteria (see [4], [23]). The F – PEC model identifies three main influence sources: the power (P), that measures the involvement degree of family members in governance and management; the experience (E), defined as the influence of further generational transitions in terms of learning; the culture (C), namely the family values and commitment in business affairs.

In a systemic perspective, another contribution is given by the Viable Systems Approach – VSA (see [17]), that describes the Family Business as the interaction effect between the viable "enterprise" and "family" systems. In this perspective, the relationships between the two systems are interpreted according to the relevance model, namely according to the criticity/importance of resources the family offers to the enterprise and to the mutual influence for the survival of the two systems (see [5], [28]).

As for the theoretical framework of the VSA and the investigation problem of this paper – the transfer of the practice team building in the familiar successions – the evolutive dynamics of the system refers to a "conceptual matrix" (see Fig. 1), namely a representation of decision moments in terms of the enterprise itself and its way of acting. In particular, it is necessary to refer to four conceptualizations within the field of the entrepreneurial phenomena (see [18]): the set of the structural components that characterize the organization structure; roles, activities and taks of each component within the organizational units; the logic relationships between the components for the common aim of the enterprise survival; constraints and behavioural rules and/or operation of the described components.

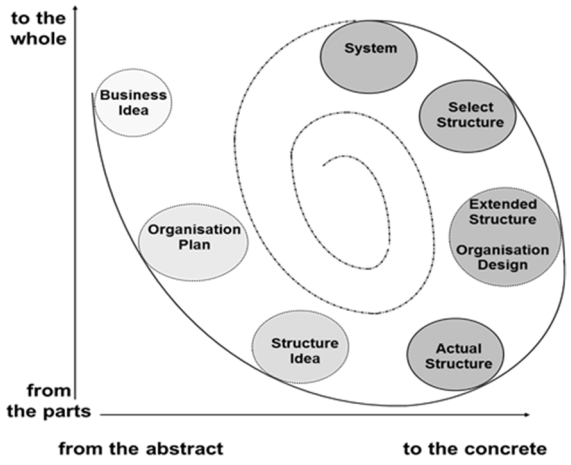

Fig. 1. The VSA conceptual matrix

As for our contribution, the focus is in the logical structure (*structure idea*), defined as the set of suitable logical components for developing a determined role, respecting prefixed rules and specific links/connections with other components.

Such a structural configuration is connected to an organization scheme (*organization scheme*), namely the generic design of processes and activities to realize through a specific sequence of relations between interacting components.

The organization scheme has to be interpreted as follows:

- from the business idea (work teams building) to the logical structure (who does what? How and when?). In this sense, we refer to an *organization plan*;
- from the physical structure/actual structure (defined components and relations) to the system emergence (team operation). In this case, we consider the *organization design*.

The described concepts are fundamental to understand the team building decision dynamics: according to the definition of the structure idea and respecting the organization plan, roles and process relations, that are suitable fot the team building exigence, have to be implemented.

Hence, it is right to think that the familiar decision maker, as for the work teams organization design, must consider the constraints of the actual structure and the ones of the particular efficiency exigencies of the system for the specific work order.

From a practical point of view, the concepts of "enterprise" and "family" have their unit in the leadership decisions, that have to be accurately examined. To achieve this aim, an approach, that refers to a Competence Model (CM) and to a Pattern Mining algorithm, is analysed.

The competence representation (see [27] for details) is defined in terms of Knowledge, Skills and Attitudes. Precisely, Knowledge represents the set of support information for a given task; Skill is the practical capacity for the development of the task; Attitude represents a particular behavior in facing some situations. The CM, which focuses on Knowledge (K), Skills (S) and Attitudes (A), is shortly indicated as KSA Model (see [11], [13], [26], [34]), implemented by some Lightweight Ontologies, written in SKOS language and similar to taxonomies (see [7]). Such ontologies are able to model a particular domain in a hierarchical way and define simple relations. Each element of type K, S and A is characterized by a score, that discriminates the competence levels for a particular knowledge domain.

Pattern Mining techniques are useful to find relevant patterns in data sequences. In this paper, we use a Pattern Mining algorithm called "Apriori" (see [2], [3], [19], [21], [22], [25], [32], [35], [36]), constructed considering that, if a given item set is frequent, its subsets are frequent too. Consider a transaction database T and a support threshold ε. Let C_k be the candidate item set of length k and let L_k be the frequent item set of length k. In the following, a pseudo code for the algorithm is presented.

$Apriori(T, \varepsilon)$

$L_1 \leftarrow \{\text{itemset of length 1}\}$

$k \leftarrow 2$

while $L_{k-1} \neq \varnothing$
$C_k \leftarrow$ generate L_{k-1}
for transactions $t \in T$
$C_t \leftarrow$ subset $\left(C_k, t\right)$
for candidates $c \in C_t$
$count\left[c\right] \leftarrow count\left[c\right] + 1$

$L_k \leftarrow \left\{c \in C_k : count\left[c\right] \geq \varepsilon\right\}$
$k \leftarrow k + 1$
return $\bigcup_k L_k$

Considering both the KSA model and the Apriori algorithm, the possible steps of a design activity for family – run businesses DSS are the following:

- *Define a worker KSA model*, in order to identify the best workers of a given business.
- *Construct a work order KSA model*, in order to establish the best workers for specific work orders.
- *Identify some association rules among workers*, namely: using the Apriori algorithm, consider if leadership decisions involve determined sequence of workers.
- *Establish the DSS criteria via a data fusion*, namely: construct an information integration mechanism due either to KSA or to association rules, and collect the DSS rules.

3 A real case study

In order to define some criteria to manage family – run businesses, the real case of the Santonicola enterprise, located in Siano (Salerno, Italy), was analyzed. Such a business relies on single work orders and is characterized by a leadership, which considers all possible decisions for a correct management. In particular, the leadership assignes a work team to each work order. A work team consists of a subset of workers, chosen according either to their skills or to the characteristics of work orders.

In what follows, the workers are listed. Their names are not reported for privacy reasons. The Santonicola enterprise has four coach builders (indicated by C1, C2, C3 and C4), four varnishers (V1, V2, V3 and V4) and four welders (W1, W2, W3 and W4). There are also some external workers: two electricians (E1 and E2), three mechanics (M1, M2 and M3) and two upholsterers (U1 and U2).

According to the client types, sixteen work orders have been obtained and the leadership assigned a work team to each of them. Details on work orders and work teams are reported in Table 1.

Table 1. Work orders and the chosen work teams

Work order	Work team	Work order	Work team
1 – Engine restoration	C1, M3, V1	9 – Leaf spring substitution	W4
2 – Mobile case restoration	V3, W2	10 – Cabin substitution	C2, E1, M3, V2
3 – Refrigerator restoration	V4	11 – Truck recovery	C1, E2, M2, V1
4 – Cargo bed modifications	V4, W4	12 – Truck restoration	E1, M1, V2, W1
5 – Truck preparation	V1, V2, W2, W3	13 – Tractor transformation	C1, E2, U2, V1, V3
6 – Pitch stretching	E1, M1, V3, W2	14 – Soft top construction	E1, V4, W2, W3
7 – Case painting	V4, W4	15 – Cistern painting	C3, C4, V1, V3
8 – Cabin painting	C1, V1	16 – Bartolini case restoration	V3, V4, W3, W4

The aim is to find some criteria which allow to define a DSS, that could reproduce choices that are similar to the leadership ones, according to the tradition, the history and the experience of the Santonicola enterprise. Hence, as already explained before, the analysis proceeds by defining: first, KSA models for workers and work orders, respectively; second, some association rules via an Apriori algorithm; finally, the results via an information integration mechanism due either to KSA or to association rules.

3.1 Analysis of workers and work orders

For the Santonicola enterprise, two different types of KSA models, for workers and work orders, respectively, are analysed. For each type of worker (coach builder, electrician, mechanic, upholsterer, varnisher and welder), a KSA model is defined. Then, according to the characteristics of the various work orders, subsets of worker KSAs are considered and work orders KSAs are constructed. An example is given by the portion of the ontological KSA Model for Welders (shortly indicated by KMW), represented in Fig. 2.

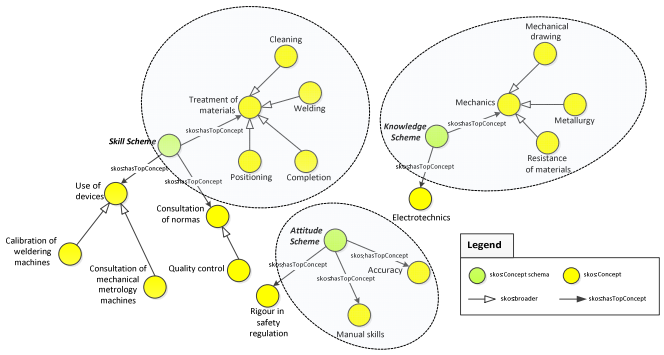

Fig. 2. A portion of KMW

The KMW presents all possible qualities of a welder and focuses on Mechanics and Electronics, as for Knowledge; treatment of materials, use of devices and consultation of norms, as for Skills; accuracy, manual skills and rigor in safety regulations, as for Attitudes. Moreover, the previous topics have further details (for instance, for treatment of materials: cleaning, positioning, welding, completion). On the other hand, a Worker Order KSA model in which a Welder is involved (shortly indicated by WOKMW) is represented by possibles subsets of welder qualities, that are useful for the specific work order. Such subsets are indicated in Fig. 2 by the dashed ellipses, that represent the welder characteristics for the work order 9. The distinction between KMW and WOKMW (and in general between worker KSA and work orders KSA) is crucial. Indeed, KMW focuses on all characteristics of welders and it is often not sufficient, unlike WOKMW, to outline the suitable profiles for a specific work order. This is evident from the case of the work order 9. According to the KMW, the welder to choose is W2, while WOKMW proposes W4. This last choice is coherent with the leadership one (see Table 1), as it indicates the best worker for the assigned work order and not the best welder among all. Hence, as expected, in opportune cases, a work orders KSA is essential to model some leadership dynamics.

3.2 Research of association rules

In opportune contexts and for important work orders, the leadership choices foresee the interaction among workers. This phenomenon is not always easy to model, as it depends either on the qualities of workers or on the empathy among them.

Indeed, the Apriori algorithm, described at the end of Section 2, was able to identify the following couples of workers: (C1, V1), (C1, E2), (E2, V1), (E1, M1), (C1, E2, V1) and (V4, W4). Such couples do not consist of the best workers, but of those who often work together. For instance, consider the presence of (V4, W4) for work orders 4, 7 and 16. Notice that the association rules are a trivial consequence of the characteristics of the enterprise, which is under discussion. In general, it is also possible that these rules do not exist.

4 Results

In this section, we present the results obtained for the Santonicola business. In particular, Table 2 presents the comparison between the leadership work teams (LWT) and the teams obtained via the worker KSA (WKSA), the work orders KSA (WOKSA), the Apriori algorithm (AA), the fusion between KSAs and AA (KSA + AA). Gray columns presents the correspondence percentage of each possible approach with the leadership decisions.

Notice that, using the WKSA, only the work order 2 has a 100 % correspondence percentage, proving that correct choices do not foresee the best workers. This suggests that the work orders influence the leadership choices in the team building process. Indeed, considering the WOKSA, four total correspondence occur for the work orders 2, 3, 9 and 16. Such a phenomenon happens also for the work orders 4, 7 and 8 (see the AA column), as for the only leadership associations. Finally, the KSA + AA approach

is able to capture a full total correspondence for the work orders 1, 2, 3, 4, 6, 7, 8, 9 and 16.

LWT	WO	WKSA		WOKSA		AA		KSA + AA	
C1, M3, V1	1	C1, M3, V3	66 %	C1, M3, V3	66 %	(C1, V1)	66 %	**C1**, **M3**, **V1**	100 %
V3, W2	2	V3, W2	100 %	V3, W2	100 %	/	0 %	**V3**, **W2**	100 %
V4	3	V3	0 %	V4	100 %	/	0 %	**V4**	100 %
V4, W4	4	V3, W2	0 %	V3, W4	50 %	(V4, W4)	100 %	**V4**, **W4**	100 %
V1, V2, W2, W3	5	V1, V3, W2, W3	75 %	V1, V3, W2, W3	75 %	/	0 %	**V1**, V2, **W2**, **W3**	75 %
E1, M1, V3, W2	6	E1, M3, V3, W2	75 %	E1, M3, V3, W2	75 %	(E1, M1)	50 %	**E1**, **M1**, **V3**, **W2**	100 %
V4, W4	7	V3, W2	0 %	V3, W4	50 %	(V4, W4)	100 %	**V4**, **W4**	100 %
C1, V1	8	C1, V3	50 %	C1, V3	50 %	(C1, V1)	100 %	**C1**, **V1**	100%
W4	9	W2	0 %	W4	100 %	/	0 %	**W4**	100 %
C2, E1, M3, V2	10	C1, E1, M3, V3	50 %	C1, E1, M3, V3	50 %	/	0 %	C2, **E1**, **M3**, V2	50 %
C1, E2, M2, V1	11	C1, E1, M3, V3	25 %	C1, E1, M3, V3	25 %	(C1, E2, V1)	75 %	**C1**, **E2**, M2, **V1**	75 %
E1, M1, V2, W1	12	E1, M3, V3, W2	25 %	E1, M3, V3, W2	25 %	(E1, M1)	50 %	**E1**, **M1**, V2, W1	50 %
C1, E2, U2, V1, V3	13	C1, E1, U1, V1, V3	60 %	C1, E1, U1, V1, V3	60 %	(C1, E2, V1)	60 %	**C1**, **E2**, U2, **V1**, **V3**	80 %
E1, V4, W2, W3	14	E1, V3, W2, W3	50 %	E2, V3, W2, W3	50 %	/	0 %	E1, V4, **W2, W3**	50 %
C3, C4, V1, V3	15	C1, C4, V1, V3	75 %	C1, C4, V1, V3	75 %	/	0 %	C3, **C4**, **V1**, **V3**	75 %
V3, V4, W3, W4	16	V1, V3, W2, W3	50 %	V3, V4, W3, W4	100 %	(V4, W4)	50 %	**V3**, **V4**, **W3**, **W4**	100 %

Table 2. Comparison among the various approaches

The previous results, also with reference to other correspondence percentages, are in Table 3. A graphical interpretation, as for the number of work orders, is in in Fig. 3.

Table 3. Different approaches and correspondence percentages with LWT

Approach	100%	More than 50%	Less than 50%
WKSA	1	6	10
WOKSA	4	9	7
AA	3	6	10
KSA + AA	9	13	3

Notice that, using the data fusion KSA + AA, thirteen of sixteen work orders (about 80% of them) have a more than 50% correspondence with the leadership decisions. This indicates that a possible DSS can reconstruct a quite high percentage of the original leadership work teams.

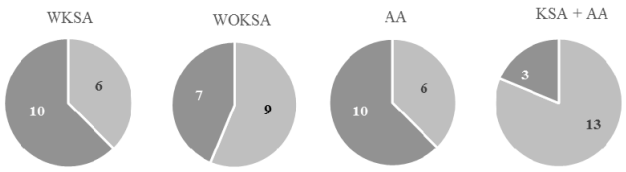

Fig. 3. Work orders with more than 50 % correspondence percentages

Precisely, as for a team building DSS for the Santonicola enterprise, some design criteria are established as follows. A full reconstruction of leadership choices occurs for the following work orders: 1, for which the couple (C1, M3) derives from the KSA model while V1 is chosen through the rule (C1, V1); 2, 3, 9 and 16 through the KSA approaches; 4 and 7 via the rule (V4, W4); 6, for which the triad (E1, V3, W2) is due to the KSA model while M1 is chosen using the rule (E1, M1); 8 through the rule (C1, V1). Moreover, there is a partial correspondence with the leadership decisions for the work orders 5, 10, 11, 12, 13, 14 and 15 for the reasons explained as follows, respectively. There is not a rule to choose V2. The couple (C2, V2) does not obey to an association rule. A criterion for M2 does not exist. There is not an association for V3 and W2. There is not a criterion to prefer E2 and U2. No rules exist to prefer V4 and E1. There is not a rule for C1.

5 Conclusions

In this paper, some criteria for a decision system, which captures the experience and the instinct of leaderships of family – run businesses, have been studied, with emphasis on the real case of the Santonicola family run – business, in Italy.

Through KSA models, it was proved that the best workers are not always adequate for a given work order and that the best workers of specific work orders are not often useful for the reconstruction of the leadership choices. Hence, an Apriori algorithm was analysed to prove the existence of association rules between workers. The result indicated that the leadership constructs teams with defined groups of workers. Via the information fusion between the KSA approaches and the set of association rules, it was possible to reproduce most of the leadership choices (about 80%), with evident positive managerial implications in terms of generation turnover.

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