A Knowledge – based Decision Support System for the Service Quality Improvement in Organizations

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Abstract. This paper focuses on a knowledge – based decision system for human resource management within public administrations, with the aim of improving the service quality. In particular, the construction of decision rules for a generic public administration considers a Skill Gap Analysis among real and ideal workers competence profiles. The procedure foresees the following steps: an analysis of organograms and Job Descriptions; a Knowledge, Skills, Attitudes (KSA) model for Job Descriptions; use of an analyser to transform KSAs of Job Descriptions into an ISFOL – ISTAT model, with integrations of other characteristics; use of a parser to extract information from Curricula Vitae according to the ISFOL – ISTAT KSA model. Finally, a comparison step is useful to understand if employees perform roles, which are coherent with their real profiles. A first experiment allows to test the proposed approach, showing that discrepancies occur in profile choices and confirming what really happens in public administrations.

Keywords: decision system, human management, service quality, Skill Gap Analysis, KSA

1   Introduction

The growing importance in human resources within business organizations implies the adoption of continuous modifications and the development of accurate processes for Human Resource Management. In this sense, the problem deals with the service quality in terms of competences of employees. In last years, this problem has become one of the fundamental research topics, due to the new theories in management fields.

Such studies are not trivial because they rely on two fundamental aspects: the improvement in service qualities, with consequent advantages in logistic flows for organizations; the possibility of identifying weak areas within the businesses plans. Hence, their focus is obviously in human systems management, with particular emphasis on solutions to social questions ([12], [20]), the adoption of opportune rules for business needs ([6], [19]), and accurate mathematical formalisations for problem solving ([14]). A "summa" of all these aspects and phenomena for Human Resource Management is described in [16], with specific details on service quality. In this direction, service science, namely Service Science, Management, Engineering and Design, gives meaningful tools for an accurate description of service systems (see [17], [18]). Moreover, the Viable Systems Approach is also useful (see [1], [10], [13]).

From a practical point of view, the lack in service quality for organizations (see [7], [8]) can be studied via a skill gap analysis within Italian public administrations (see [11]), in order to compare the employees real competences with the ones required for the performed roles. Indeed, an optimal service quality in public administrations is identified in the possibility of providing safe, fast and reliable services to a wide community of common and uncommon people. Eventual improvements for service quality inside public administrations represent a serious topic, especially for the Italian background, where most of work roles are usually assigned on the basis of factors, which are different from merit, competences and experiences. Negative aspects of these phenomena are evident: employees are in the wrong places at the wrong times, leading to delays in common work operations, with creations of bottlenecks, which make the logistic flows, seen as sequences of consecutive operations within the work context, worse.

In this paper, the focus is represented by a procedure, which is useful for the service quality improvements inside the public administrations. Precisely, such an approach allows the analysis of employees competences inside business plans of public administrations, with the aim of identifying weak work areas, and thus defining criteria for a Knowlegde – based Decision Support System (DSS) for the evaluation of the correct employees roles (a similar example is in [3], while analogous studies on competences are in [4] and [5]). Indeed, the possible advantages of such an analysis is evident: from one side, a correct allocation of human resources allows a quite good work quality, hence the logistic flows among the various parts (offices) of the public administration become faster and bottlenecks, due to competence lacks, are avoided; from the other side the guarantee of defining standards for the employment occurs, also in terms of constraints and rules for competition announcements. In any case, the principal beneficiary in this context is the public, either the one, who requires for services, or the one who looks for a job in public administrations.

The proposed approach foresees the following steps: first, in order to construct all characteristics of roles for each worker, organograms of public administrations and Job Descriptions of work profiles are analysed. Then, a competence model, see [15], based on Knowledge, Skills and Attitudes (KSA) and similar to taxonomies (see [2]), is constructed for each Job Description and integrated with other characteristics. Furthermore, a parser allows to extract the competences of employees from their curricula vitae according to the ISFOL – ISTAT[1] KSA model, and a skill gap analysis between competences of ideal and real employees is made. Finally, DSS rules for work roles and employees are constructed. Notice that the steps of the proposed procedure represent a possible way of identifying the correct roles inside public administrations, namely alternative solutions can be identified, also according to contexts, which are quite similar or completely different from the ones described here.

The proposed methodological vision was tested on a real office, precisely at a General and Legal Affairs Office of a Technical – Administrative Department of the Health Service in an Italian region. The analysis involved three different work roles. The chacteristics of profiles, divided into Constraints, Qualifications and KSA, have been kept in an Access Database. Then, using an Access matching algorithm, the skill gap analysis was made among real and ideal profiles. The results indicated that discrepancies occur, showing the gap percentages for each work position, namely: the chosen profiles are not always the most suitable ones for the performed roles. Such a conclusion was also confirmed by a team of "experts" (a possible procedure to choose them is in [9]), who, making manually the same procedure, gave a first evaluation of the correctness of the skill gap analysis.

Unfortunately, the just described approach remains still quite empirical in Italy, due to the complex structure of Italian public administrations. Hence, new studies and experimentations are required in next future. Indeed, a possible preliminary starting point for further research activities is the analysis of curricula vitae of employees and the competence mapping for the KSA construction.

The paper is structured as follows. Section 2 describes the problem of defining correct Job Descriptions inside public administrations, with emphasis on four macro – scenarios, that often occur, allowing to underline problems in real contexts, also in terms of a correct skill gap analysis. Moreover, methodological steps for a correct analysis of competence profiles of employees in public administrations are considered. In Section 3 the case study of a real office in an Italian region is presented, and research results on three different work profiles are analyzed. The paper ends with Conclusions in Section 4.

2 Public Offices and human resource competences

In all public administrations, and in the particular in the Italian ones, there are some logistic flows, whose strength is mainly due to the work quantities and to the service

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[1] ISFOL – ISTAT represents an Italian standard for the classification of work profiles and their characteristics. ISFOL – ISTAT KSA models contain further information, which is not always captured by the basic KSAs for work profiles.

quality. Although this vision appears to be quite simple, some weaknesses points are evident for the following reason: the competences of each employee are not always sufficient and suitable for some services. A such meaningful phenomenon often implies a total reorganization of human resources in order to redistribute work loads and employees, so as to improve the service quality. Within the public administrations context, the key point is a correct knowledge of profiles for all employees, in terms of their competences.

Hence, the starting point for a correct Knowledge Management is a competence model, see [15], whose representation is defined in terms of Knowledge, Skills and Attitudes: Knowledge is the set of support information for a determined task; Skill is the practical capacity for the development of the task; Attitude is a specific behavior in some situations. The competence model, which relies on Knowledge (K), Skills (S) and Attitudes (A), is shortly indicated as KSA Model (see [7]), implemented by some Lightweight Ontologies, written in SKOS language and similar to taxonomies (see [2]). Such ontologies allow the description of a particular domain in a hierarchical way and define simple relations. Each element of type K, S and A has a score, that discriminates the competence levels for a knowledge domain.

Beside KSA models of work profiles of employees, other possible forms of competence representations are possible, such as the ISFOL – ISTAT standards, which enrich the possible descriptions obtained by simples KSAs. Hence, a possible analysis within public administrations starts considering possible profiles according to the ISFOL – ISTAT standards based on KSAs, with consequent identification of ideal work profiles, which have to be compared with the real ones owned by the employees in a next phase of skill gap analysis.

To achieve this aim, the starting idea is to study a whole business plan, which consists of an organogram, a function flow chart, Job Descriptions and Job Specifications. The focus is on Job Specifications, with consequent analysis of Job Descriptions characteristics. In real contexts of public administrations, four macro – scenarios are possible and only one of them occurs. In particular, such situations are as follows.

Situation 1: *Job Specifications follow a structural and formal approach, according to ISTAT – ISFOL standards*. This case is the most suitable for a correct problem solving and represents the solution to which public administrations tend to converge nowadays. The representation of this type of knowledge is achievable with a high degree of accuracy via Knowledge Extraction techniques, based on vocabularies and ontologies.

Situation 2: *A non – structured and informal approach, based on ISFOL – ISTAT criteria, describes the Job Specifications*. In this situation, a generic Job Specification obeys ISFOL – ISTAT standards, but some difficulties of representation arise. Knowledge Extraction techniques are useful to reconstruct this type of Knowledge with a sufficient degree of accuracy. Indeed, such methodologies are more difficult than the ones described in Situation 1, as the description is informal, namely: vocabularies and ontologies are not always adequate for problem solving and further integration techniques involving Knowledge Management are often required.

Situation 3: *Job Specifications follow a structural and/or semi-structured, formal and/or informal approach, according a non – ISTAT – ISFOL standard*. In this case, Job Specifications refer to a standard, that is different from the one used by the system.

Obvious difficulties occur if documents are not structured and not formalized. The difference among the various standards usually considers unusual vocabularies and different Skills and Attitudes. Such a situation is still workable – as it refers to a standard – if correspondences and rules with the ISTAT – ISFOL representation are found. The Knowledge representation foresees a preliminary analysis and matching step (of automatic, semi – automatic and manual type) to establish rules to translate the non – ISTAT – ISFOL standard.

Situation 4: *A non – structured, informal and non – standard approach describes the Job Specifications*. In this last case, Job Specifications do not follow structures and standards, leading to the impossibility of a correct Knowledge representation.

A data flow diagram, which represents the situation 3, is in Fig. 1.
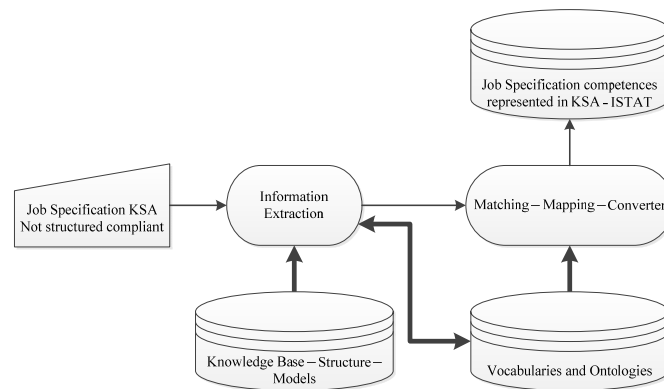

Fig. 1. Complex data flow diagram for the representation processes of situation 3

From previous considerations and, in particular, for the most usual case (represented by situation 2), the possible steps, useful for a support process for a DSS design, are the following:

- *Analysis of organograms of public administrations and Job Descriptions of each employee*. This initial phase is useful to construct all characteristics of roles for each worker.
- *Construction of a KSA model for each Jop Description*.
- *Integration of KSAs with other data*. In this step, some contingent constraints are evaluated and used to create an enhancement of the basic KSA models. As for the integration information, work styles/conditions and behavioural attitudes are also considered.
- *Analysis of public administrations employees curricula vitae and their matching with KSAs*. The curriculum vitae of each employee is reduced to a competence profile in KSA using a parser, realized at the University of Salerno. Such a tool has a vocabulary, which is identical to the one used by ISFOL for the description of the professional units. Moreover, beside the ordinary ISFOL terms, a further integration of the vocabulary allows the descriptions of additive knowledge and professional experiences. The

importance of this procedure is the possibility of defining KSAs of employees with the same characteristics of ISFOL – ISTAT standards.

- *Skill gap analysis between competences of real employees and the ones of ideal employees.* This phase represents the core of the whole proposed approach. Indeed, KSAs of real employees are used to create a match with the ideal profiles described by KSAs obtained in step four. These results are useful to show if real employees are the most suitable ones for the performed roles inside public administrations.
- *Definition of DSS rules for work roles and employees.* In this final step some decision criteria are constructed for the correct management of the logistic flows inside public administrations. Notice that, for a specific public administration, DSS rules are obviously strictly dependent either on the characteristics of the business plan or on the analysed work profiles.

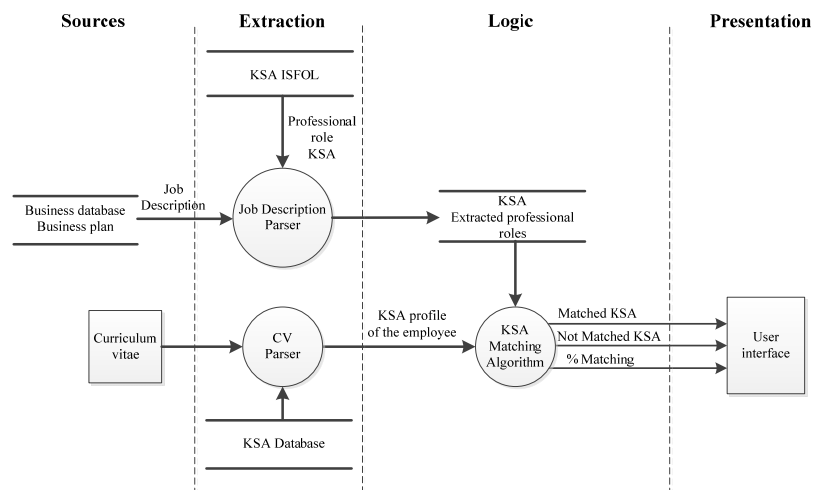In what follows, Fig. 2 shows a first architectural view of the DSS.

Fig. 2. An architectural view of the DSS

3 Case study of a real office in an Italian region

The described approach was analyzed to study the dynamics of a real office, precisely a General and Legal Affairs Office of a Technical – Administrative Department of the Health Service in an Italian region. Notice that the following example, tested on real employees, who belong to a real office in a public administration, shows how the characteristics of employees are not always suitable for their work roles.

The structure organogram (of public domain) is in Fig. 3 where, in particular, the following roles have been analysed: administration manager, administration secretary and legal expert.
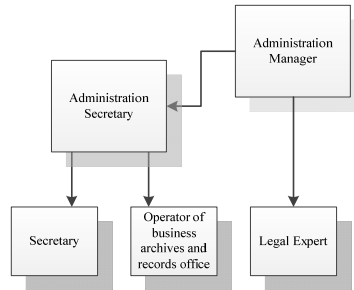
Fig. 3. Organogram of the case study

Beside the organogram, Job Descriptions, which describe roles, tasks and essential qualifications, are considered. Essential qualifications arise from either business characteristics or law articles, in terms of rules and constraints for the employees roles.

From Job Descriptions, suitable KSAs have been obtained and, via associations, an enhancement was obtained in order to define the ideal KSA profile of each work role.

Precisely, the ideal KSA consists of categories Knowledge, Skills and Attitudes, which define the preliminary KSA of Job Descriptions. The integration of KSAs with ISFOL – ISTAT standards is useful to map terms of type Knowledge, Skills and Attitudes into ISFOL vocabularies. The second integration of KSAs with personal data/information allows to: divide terms of type Knowledge into ISFOL ones (briefly indicated by ISFOL K in what follows) and Essential Knowledge constraints; add categories Qualifications and Necessary experiences.

The structure of ideal KSAs is very complicated and is difficult to represent completely but, for a better comprehension, an extract of the ideal KSA for the administration manager role is presented in Fig. 4.
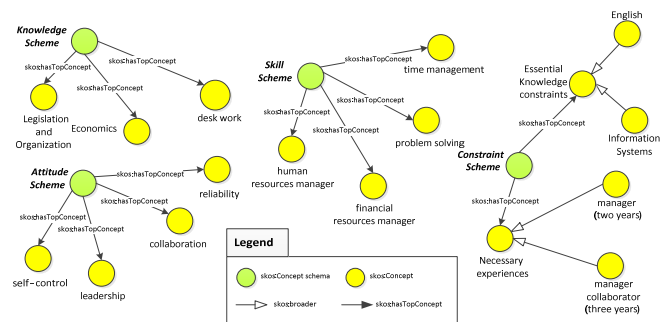

Fig. 4. A portion of the ideal KSA for the administration manager role

As already mentioned in Section 2, the implementation is made via Lightweight Ontologies, written in SKOS language. The representation of the ideal KSA consists of 58 concepts, divided into categories and subcategories, which correspond, respectively, to different skos: Concept schema and skos: Concept.

As for the extract of the ideal KSA in Fig. 4, categories and subcategories are the following:

- *Knowledge*: Legislation and Organization, Economics, desk work.
- *Skills*: human resources manager, financial resources manager, problem solving, time management.
- *Attitudes*: self – control, leadership, collaboration, reliability.
- *Qualifications*: degree in Law, Master in Organization of public administrations.
- *Constraints*, in terms of:
  - *Essential Knowledge ones*: English, Information Systems.
  - *Necessary experiences*: two years as a manager in public administrations, three years as a manager collaborator in public administrations.

For the construction of real KSA profiles, curricula vitae (of public domain) of real employees have been considered. A parser was necessary in order to recognise the needed information through Knowledge Extraction techniques. The used parser was able to identify the vocabularies of curricula vitae and associate them (via similarities, correlations and associations) to the categories of the ideal KSAs (Knowledge, Skills, Attitudes, Qualification, Essential Knowledge constraints and Necessary experiences). Such a system was realized within research projects by a spin off of the University of Salerno and, at this moment, there is a reliability of 70%.

After all real KSAs have been obtained, the skill gap analysis was made using an Access Database for the comparison of real and ideal profiles of each work role. The results are in Table 1 where, for simplicity, the various work positions (administration manager, administration secretary and legal expert) are indicated, respectively, by the acronyms AM, AS and LE. Moreover, for a better comprehension, colums for the required competences and gaps are in gray with respect to the ones for the owned competences and suitability percentages.

Table 1. Results of the skill gap analysis for the different profiles

Competences	Required ones			Owned ones			Gaps			Suitability (%)		
Position	AM	AS	LE	AM	AS	LE	AM	AS	LE	AM	AS	LE
Knowledge	12	12	7	8	6	5	4	6	2	66.7	50	71.4
ISFOL K	8	8	5	6	4	3	2	4	2	75	50	60
Essential Knowledge constraints	4	4	2	2	2	2	2	2	0	50	50	100
Skills	16	15	13	9	10	8	7	5	5	56.3	66.7	61.5
Attitudes	22	20	22	15	16	16	7	4	6	68.2	80	72.7
Qualifications	2	1	2	1	0	2	1	1	0	50	0	100
Necessary experiences	2	1	1	1	1	1	1	0	0	50	100	100
ISFOL KSA	46	43	40	30	30	27	16	13	13	65.2	69.7	67.5
Integration	8	6	5	4	3	5	4	3	0	50	50	100
Total	54	49	45	34	33	32	20	16	13	63	67.3	71.1

Notice that competences for a work profile are of the following types: required (column 2) and owned (column 3). The difference between required competences and owned ones gives the competence gap (column 4), while column 5 reports the suitability percentages for each work profile. Indeed, for each work role, required competences represent the ideal KSA, while owned ones the real KSA.

Results of Table 1 are interpreted as follows. For the administration manager, the ideal KSA indicates the following competences: 12 of Knowledge type, divided into ISFOL K (8) and Essential Knowledge constraints (4); 16 of category Skills, 22 of type Attitudes, 2 of category Qualifications and 2 of type Necessary experience. The preliminary KSA, enriched by the ISFOL – ISTAT descriptions, contains 46 competences (ISFOL K + Skills + Attitudes), see row ISFOL KSA. Personal data/information contains 8 competences (Essential Knowledge constraints + Qualifications + Necessary experiences), see row Integration. Hence, for the position of administration manager, the ideal KSA consists of 54 competences, see row Total. Indeed, the real KSA indicates that the employee in the administration manager role has only 34 competences, with a consequent gap equal to 20, namely: the administration manager employee performs his role with a 63% suitability. These results are also indicated in Fig. 5.
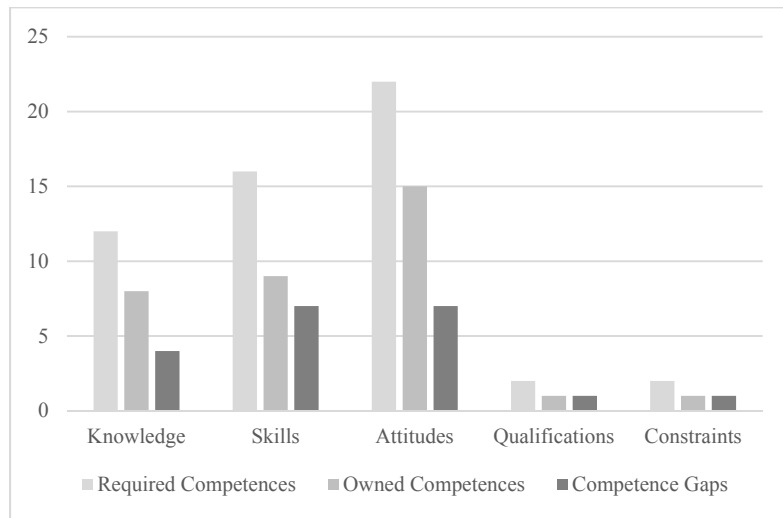

Fig. 5. Histogram of results for the administration manager role

For administration secretary and legal expert roles, the situation is the following: competence gaps for the administration secretary and the legal expert are, respectively, 16/49 and 13/45, with 67.3% and 71.1% suitability. The obtained results are further summarized in Table 2 for each work position, as for Required compentences, Owned competences, Competence gaps and ISFOL KSA, Integration and Total suitability percentages.

Table 2. Short scheme of skill gap analysis results

	Administration manager	Administration secretary	Legal expert
Required competences	54	49	45
Owned competences	34	33	32
Competence gaps	20	16	13
ISFOL KSA suitability percentages	65.2 %	69.7 %	67.5%
Integration suitability percentages	50 %	50 %	100 %
Total suitability percentages	63 %	67.3 %	71.1

The proposed approach appears to be promising, as the discussed results are due to accurate automatic processes, which have not elements of subjectivity in evaluations, unlike the human case. Indeed, a first reliability of results have been also proved by consultation of five experts (E1, E2, E3, E4 and E5). Such experts, unaware of the skill gap analysis, have analysed the curricula vitae and Job Descriptions of the three professional roles described before. Their opinions are in Table 3.

Table 3. Opinions of experts about the three considered work roles

Position	E1	E2	E3	E4	E5
Administration manager	Low	Low	Sufficient	Low	Sufficient
Administration secretary	Good	Sufficient	Sufficient	Sufficient	Low
Legal expert	Good	Sufficient	High	Good	Good

Opinions of experts have an optimal correspondence with the skill gap analysis results. Indeed, also according to their point of view, the less corresponding profile is the administration manager one.

4   Conclusions

In this paper, it was defined an automatic/semi – automatic process for a Knowledge – based DSS design, in order to establish the correctness of Human Resource Management within public administrations, with a particular focus on a General and Legal Affairs Office of a Technical – Administrative Department of the Health Service in an Italian region.

A DSS prototype, whose an architectural view was considered, was designed and realized. The DSS results have been compared with the ones achieved by a team of experts, and appear to be comforting.

In the next future the research activities will focus on: the possibility to increase the parser reliability; the analysis of wider sets of employees and more experiments; the definition of opportune bounds to express judgements about the employees suitability in the roles they perform inside public administrations.

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