An Exploratory Survey on SOA Knowledge, Adoption and Trend in the Italian Industry

Maurizio Leotta, Filippo Ricca, Marina Ribaudo, Gianna Reggio, Egidio Astesiano, Tullio Vernazza

Abstract:

The main aim of this work is investigating the level of knowledge and diffusion of SOA (Service Oriented Architecture) in the Italian industry. We are also interested to understand what is the trend of SOA (positive or negative?) and what are the methods, technologies and tools really used in the industry.

We carried out a personal opinion survey receiving 159 answers by Italian software professionals in two different rounds (2008 and 2011). The data were collected with the help of self-administered Internet questionnaires.

The findings suggest that SOA is a relevant phenomenon in the Italian industry, it is well-known (and used enough) and the same is true for its key components (Web services and RESTFul services). On the contrary, orchestration languages and UDDI seem little known and used. Currently, the adoption of SOA is medium with a perceived trend that is more stable than positive (but surely not negative).

An Exploratory Survey on SOA Knowledge, Adoption and Trend in the Italian Industry

Maurizio Leotta, Filippo Ricca, Marina Ribaudo, Gianna Reggio, Egidio Astesiano, Tullio Vernazza
Dipartimento interscuola di Informatica, Bioingegneria, Robotica e Ingegneria dei Sistemi (DIBRIS)
Università di Genova, Italy
{*maurizio.leotta*|*filippo.ricca*|*marina.ribaudo*|*gianna.reggio*|*egidio.astesiano*|*tullio.vernazza*}*@unige.it*

Abstract— The main aim of this work is investigating the level of knowledge and diffusion of SOA (Service Oriented Architecture) in the Italian industry. We are also interested to understand what is the trend of SOA (positive or negative?) and what are the methods, technologies and tools really used in the industry.

We carried out a personal opinion survey receiving 159 answers by Italian software professionals in two different rounds (2008 and 2011). The data were collected with the help of self-administered Internet questionnaires.

The findings suggest that SOA is a relevant phenomenon in the Italian industry, it is well-known (and used enough) and the same is true for its key components (Web services and RESTFul services). On the contrary, orchestration languages and UDDI seem little known and used. Currently, the adoption of SOA is medium with a perceived trend that is more stable than positive (but surely not negative).

Keywords-SOA, Web services, REST, Personal Opinion Survey, Level of Adoption, Trend of Pervasiveness.

I. INTRODUCTION

Service Oriented Architecture (SOA) is an architectural style for the development and management of software systems. Applications based on SOA employ services as their basic computational entities [4].

Key to the SOA approach is the ability to compose existing services into more complex ones; these compositions are usually built with orchestration languages (e.g., BPEL [1]). Another core SOA standard is UDDI[1], a mechanism to register and locate Web services. Main claimed benefits of SOA are the following: more flexible IT systems that can be adapted to change faster, integration of new and existing applications, speed in custom applications development and reduced cost of maintaining applications [4].

We are interested in SOA for research, didactic and collaboration purposes with the local industry (we are looking for project partners). In general, the industry can help us to understand: (1) whether SOA can be considered a promising research field and (2) whether it deserves (more) space in the current university courses. Moreover, given that we are also interested in methods, technologies and tools used for developing SOA systems and for migrating legacy systems towards SOA [14], the industry can help us to understand which of them are really used and with which results / problems. In addition, we need real applications to experiment available prototype tools / techniques and our proposals (e.g., [9], [10], [11]). On the other hand, we can help the industry to adopt best practices in software development and migration towards SOA, discovering and introducing new technologies in the development process and producing qualified personnel with the proper expertise.

For reaching this reciprocal exchange, we need to know more about industry. For this purpose, we designed an exploratory survey (preliminary results presented as a poster in [12]) and carried out it in two different rounds (2008 and 2011), by interviewing key people from Italian companies to understand how many professionals know SOA and the related technologies (e.g., BPEL, Web and REST [17] services), what is the level of adoption (or diffusion) achieved by SOA and what is the perceived trend of SOA in the Italian industry.

The survey is the most common method of gathering information. It can be administered in several ways [7]: self-administered questionnaires (usually mail but increasingly Internet), telephone surveys and one-to-one interviews. We selected the first option, putting on-line a questionnaire and inviting people to answer, because an Internet survey is generally the most cost-effective interview method [23] even if it presents well-known limitations / problems [20].

After looking through the related literature (Section V), the survey has been conducted through the following four steps: (1) Web-based questionnaire development; (2) questionnaire diffusion by means of several mailing lists and Web groups; (3) survey execution, by collecting answers; and (4) analysis of results and packaging.

Overall, we received 40 fully completed questionnaires in the first round (2008) and 119 in the second one (2011).

The paper is organized as follows: Section II describes the survey definition, design and planning. Results are reported in Section III, and discussed in Section IV, together with threats to validity. Section V discusses the related literature, while Section VI concludes the paper and outlines directions for future work.

---

[1] http://www.oasis-open.org/committees/uddi-spec/

II. Study Definition, Design, and Procedure

The survey has been carried out two times: during 2008 (first round) and during the end of 2011 (second round). For this reason, this work can be considered a longitudinal study[2]. The main aim of this work is to investigate to what extent and how Italian companies know/adopt SOA and how they perceive the trend of SOA. We are also interested in understanding which methods, technologies and tools are really used in the industry for developing SOA systems and for migrating legacy systems towards SOA.

To implement this survey, we: (i) used the same framework of [21], [22] (based on [6]), (ii) followed as much as possible the suggestions given in [7] and (iii) adopted an on-line questionnaire to collect information.

The *goals* of the survey are four:

1) *Research*: understanding whether or not SOA can be considered a promising research field;
2) *Education*: evaluating whether and which SOA methods/technologies/tools have to be integrated in university courses;
3) *Collaboration purposes*: finding new opportunities for collaboration with the industry to experiment our proposals. In particular, we are interested in migration strategies towards SOA;
4) *Dissemination*: using the results of this survey to provide the Italian industry with interesting information about market and technological trends.

The perspective is mainly of software engineering researchers, interested in understanding how much and how SOA is known and applied in industry, but the results could be also useful as guidelines for IT professionals often forced to take decisions without sufficient information. The context consists of a sample of Italian professionals[3] working in companies having different sizes (e.g., small, medium and large[4]) and belonging to different domains (in prevalence IT companies and consultancy).

A. Research Questions

Given the above goals the survey aimed at addressing the following *research questions*:

RQ1: *What is the knowledge and the usage of SOA in the Italian industry?* We are interested in evaluating and identifying how many professionals know SOA and which

are the related technologies really used (i.e., BPEL, Web services, REST). We would like to understand which are the most common methods, technologies and tools used (or followed) for the creation of new systems and for the migration of existing systems towards SOA.

RQ2: *What is the level of adoption of SOA in the Italian industry?* We are interested in evaluating the level of adoption/diffusion achieved by SOA in the Italian industry. This information is essential to infer the relevance of SOA.

RQ3: *What is the trend of pervasiveness of SOA in the Italian industry?* We are interested in evaluating the trend of pervasiveness of SOA for the future (positive, stable or negative?). This information become interesting when compared with the results of RQ2. For example, it may be interesting to conduct research about SOA and teach SOA even if the adoption is not widespread while the trend is positive.

B. Target Population and Sample Identification

The target population is the set of individuals to whom the survey applies. In our case the population consists of Italian software professionals (e.g., project managers, architects, developers). Our sample consists of: (1) professionals working in companies of the IT field; their skills are related to the production, maintenance or management of software systems (the larger part); (2) professionals who work in companies that do not directly belong to the IT field (a smaller part) but that use information systems to carry out and support the company's business activities; (3) professionals who work for public agencies, government enterprise or performing other kinds of activities (remainder of the sample).

The sample was obtained in two ways: (1) by convenience, i.e., relying on the network contacts of our research group and (2) by sending invitation messages on mailing lists and Web groups concerning software engineering. In particular, we have used some lists available at the university (such as former students or people who have participated in previous surveys about other topics) and some professional groups (e.g., LinkedIn). We opted for non-probabilistic sampling methods even if we know all the problems of this sampling (e.g., the risk of using a sample not representative of the target population) [7] because this survey is exploratory and because we thought that the target population was hard to identify and of limited availability.

In total, we received 159 complete responses to our survey. Unfortunately, we do not know exactly: (1) the number of involved Italian professionals in both rounds of the survey — the reason is explained in footnote 3 — and (2) how many people have been reached by our invitation messages and advertisements, so we cannot calculate the response rate. The same problem is present also in other software engineering surveys (e.g., in [13]).

---

[2] The essential feature of a longitudinal survey is that it provides repeated observations over time on a set of variables for the set of persons belonging to the survey [3].

[3] We cannot compute exactly this number due to the "partial" adopted anonymity policy. We received 40 questionnaire in the first execution (2008) and 119 in the second one (2011). Surely 11 professionals answered to both the executions (in these 11 cases the professionals reported their personal details), but they could be more.

[4] According to Recommendation 2003/361/EC:
micro: < 10; small: 10-50; medium: 51-250; large: > 500.

ID	Kind[a]	2011 only	Question[b]
1.1	ME		Do you know the Web service technology? [*Yes (with experience), Yes (no experience), No*][cd]
1.2	ME	YES	Do you know REST and the RESTful Web services? [*Yes (with experience), Yes (no experience), No*][d]
1.3	ME		Do you know SOA (Service Oriented Architecture)? [*Yes (with experience), Yes (no experience), No*][cd]
2.1	ME	YES	Which of the following definitions do you consider more appropriate for SOA? [*SoaML [2], Sensoria [24], WS Glossary [5]*]
2.2	ME	YES	Do you know orchestration languages (e.g., BPEL - Business Process Execution Language)? [*Yes (with experience), Yes (no experience), No*][d]
2.3	ME		Do you know methods/technologies/tools for the development of SOA-based systems? [*Yes (with experience), Yes (no experience), No*][cd]
3.1	OP		Please, listing methods/technologies/tools for the development of SOA-based systems used in your company
4.1	ME		Is there personnel with expertise/experience on methods, technologies or tools for the development/realization of SOA systems in the company where you are working? [*Yes, No, Don't know*]
4.2	ME	YES	Is there personnel with expertise/experience on methods, technologies or tools for the migration of legacy systems towards SOA in the company where you are working? [*Yes, No, Don't know*]
4.3	ME	YES	How do you assess the level of adoption of SOA in the IT field? [*High, Medium, Low*][e]
4.4	ME	YES	How do you assess the trend of pervasiveness of SOA in the IT field (over the last 2/3 years and for the next future)? [*Positive, Stable, Negative*]
5.1	OP	YES	In your opinion, what is gradually replacing SOA (if any)?
6.1	NE / OP		What is your current profession? [*IT Manager, Project Manager, SW Architect, SW Developer, Other*]
6.2	ME / OP		What is your degree? [*Bachelor Degree, Master Degree, PhD, High-school, Other*]
6.3	OP		Please, specify Year of graduation
6.4	ME		Is your degree IT specific (Information Technology)? [*Yes, No*]
6.5	ME / OP		What is the type of the company you work for? [*IT, non-IT, Other (e.g., public administrations and companies with an IT department)*]
6.6	OP		What is the number of employees (full and part-time) of your company?
6.7	OP		What is the number of employees (full and part-time) of your business units?
6.8	ME / OP		What is the main business activity of your company? [*IT Service Provider and Telecom, SW Development, Consultancy, Public Administration, Other*]

[a] "ME" means mutually exclusive multiple-choice question, "NE" means non-exclusive multiple-choice question, "OP" means open question

[b] Predefined choices of the answers are given in italic.

[c] In 2008 execution, only [*Yes, No*]

[d] *Yes (with experience)* = used personally in at least a project, *Yes (no experience)* = known but no personal experience

[e] As reported in the questionnaire: High ($\approx > 70\%$), Medium ($\approx 30\% - 70\%$), Low ($\approx < 30\%$)

Table I
QUESTIONNAIRE.

C. Data Collection

Data were collected in 2008 by means of an email questionnaire and in 2011 through the creation of an on line questionnaire.

The use of a web-based tool simplifies and speeds the completion of the questionnaire by professionals with clear advantages in terms of the number of responses obtained [6].

In the second execution, the questionnaire has been developed using a service offered by Google Doc[5]. The service allows one to create and publish an on-line questionnaire. It can handle several types of answers such as: checkboxes, grid, drop-down lists with options, multiple choice, paragraph text (for long answers). Once the questionnaire is created and published on-line a URL linking to the questionnaire is provided; it can be sent to the participants who can easily access and compile the questionnaire. The responses of the questionnaire are automatically collected in a spreadsheet.

D. Validity

A pilot study was performed before the first execution of the survey (i) to tune the questionnaire and (ii) to reduce the ambiguities contained in the questions. Two industrial IT professionals carefully read all the documentation and provided their judgement on the questionnaire. Following the suggestions of the two contacted professionals, minor changes to the questionnaire were made. After this pilot study we concluded that the survey was well suited for IT professionals and that the questions were clear enough. Finally, the final set of questions was agreed.

[5] http://www.google.com/google-d-s/forms/

E. Questionnaire Design

The questionnaire is organized into two high-level sections. The first section contains a series of questions designed to assess the knowledge of SOA and getting information about the adoption in the industry and the trend of pervasiveness of SOA. The second section contains questions designed to get information about the professionals participating to the survey.

In the on-line questionnaire, the first section is divided into several Web pages, while the second section consists of a single page; each page contains one or more questions. This division was necessary to create different paths to complete the questionnaire depending on the type of response given by the professionals. The complete list of (mandatory) questions is shown in Table I. The identifier of each question is created juxtaposing page-number, "." and the question number. The questionnaire contains both multiple choice questions (mutually exclusive and non-exclusive) and open-ended (see column "Kind" in Table I). The total number of questions to compile is variable depending on the responses given by the professional completing the questionnaire.

To harvest more answers, we decided that the questionnaire should take no longer than approximately 10 minutes to complete (long questionnaires get less response than short questionnaires [23]) and we designed it accordingly.

We have chosen to force the professionals to answer all the (mandatory) questions in the questionnaire using a special option provided by the Google service; in this way it was possible to get all the questionnaires filled out correctly. The only optional questions (not shown in Table I) concern first name, last name and email; so we allowed the professionals to complete the questionnaire anonymously (some studies have shown that response rate is affected by the anonymity policy of a study [23]).

The questionnaire was introduced with a brief motivation statement about the purpose of our research (as suggested in [7]) and we added a sentence to clarify that all the collected information had to be considered highly confidential. All the participants were informed that: *"Data collected will be used only for research purposes and they will be revealed only in aggregated form"* [6] (as it is done in this paper).

F. Survey Execution

The first execution of the survey was put on-line since 15th of July 2008 until the 15th of September 2008 (2 months). The second execution of the survey was put on-line since 15th of November 2011 until the 31st of December 2011 (about 1 month and half). Approximately every 15 days, we sent to our contacts, mailing lists and groups on LinkedIn a reminder to participate to the survey. The procedure followed to prepare, administer, and collect the

---

[6] In conformity with privacy Italian law: "D.lgs. n. 196/2003".

questionnaire data is made up of the following five main steps:

1) *Preparation and Design of the Questionnaire*. Starting from similar questionnaires and tailoring them to our objectives, an initial set of questions was agreed among us.
2) *Pilot Study*. A pilot study was performed before the execution phase as explained in Section II-D.
3) *On-line Deployment*. Once the questionnaire was refined after the pilot study, it was deployed on-line by using Google Doc as explained in Section II-C.
4) *Monitoring*. During the data capture phase, our research unit monitored the progress of the questionnaire submission. Some people reporting difficulties about the questions asked us for clarifications.
5) *Data Analysis*. After questionnaires have been collected, analyses were performed with the aim of answering the research questions. Given the nature of this survey, that is mainly descriptive (it describes some conditions or factors found in a population in terms of its frequency and impact [7]) and exploratory, we applied quite exclusively descriptive statistics and showed our findings by means of charts.

III. RESULTS

In the following, we first present some information about the background of the respondents and the characteristics of the sampled companies, then some results from the two executions of the survey. When possible, we will compare the results between the two executions (common questions are indicated in Table I with a blank in the column "2011 only"). It is important to highlight that for space reasons not all the results presented in this paper can be shown by means of a chart. For the interested reader, a complete report of the survey containing other charts and analyses is available at `http://softeng.disi.unige.it/TR/SurveySOA2011.pdf`

A. Respondents' Background and Characteristics of the Sampled Companies

For what concerns the respondents' role in the company (Q6.1), 51% of the respondents of the 2008 sample are developers or software architects while 39% stated that they have a technical-coordination role, i.e., project management and IT management. The remaining ones (10% in total) are: IT technicians, marketing/sales employees and CEOs. Similarly in 2011: 45% of the respondents are developers or software architects, 31% are project managers and IT managers. Also in this case we have a portion of respondents (24%) that does not belong to these categories.

We have information about the kind of company in which the respondents work (Q6.5). The distributions are approximately the same in the two executions of the survey: 75% IT companies, 15% non-IT and 10% other (public

administrations and companies with an IT department belong to this category).

For what concerns the size (Q6.6), 60% of the companies in the 2008 sample are micro, small and medium-sized (i.e., <250 employees) and 40% are large. The situation is similar in 2011, where we have 43% of large companies.

Concerning the companies in which the respondents work (Q6.8), we can say that they operate in different industrial domains. The distributions obtained in 2008 and 2011 are similar. Most of the companies in the sample 2008 work in the area of software development (29%) or consultancy (34%). The sample is completed with IT service providers and telecommunication (18%), public administrations (11%) and other (8%). Similarly, in 2011 we obtained the following subdivision: software development (32%), consultancy (29%), IT service provider and telecommunication (13%), public administration (8%) and other (18%).

From these data, we can see that the two samples are quite similar for all the considered variables.

B. RQ1: Knowledge and Usage of SOA

We found that Web services are well-known (Q1.1), indeed 98% of the 2008 sample and 96% of the 2011 sample know them (Fig. 1). In 2011, 71% of the respondents state to have used them at least in a project. Surprisingly, also RESTful services and the REST technology (Q1.2) are known given that 65% of the entire 2011 sample affirm to know them (although only 38% of the entire sample have personal experience with them). This is particularly true for the IT companies.

Concerning the knowledge of SOA (Q1.3), it seems that it is rising (82% in 2008 and 88% in 2011) as shown in Fig. 2 (the bar plot has 2 y-axes, left for 2008 data and right for
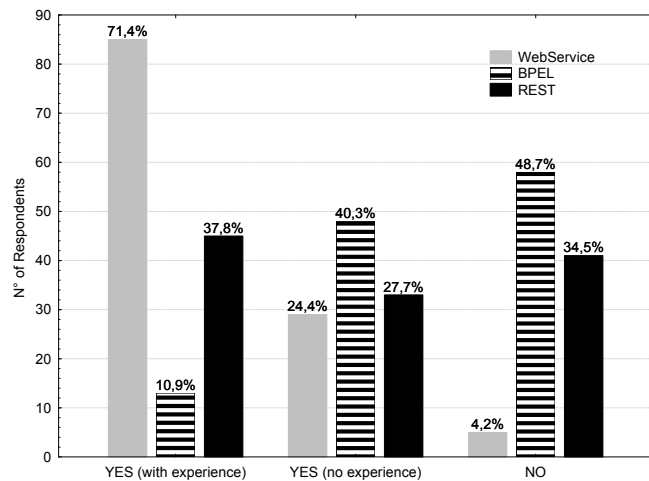

Figure 1. WS (Q1.1), REST (Q1.2) and BPEL (Q2.2) knowledge (2011 only)

Type	N	Name
technology	10	Web services
sw architecture model	7	ESB (Enterprise Service Bus)
framework	7	Apache Axis (v. 1 and 2)
API	5	Microsoft WCF
sw architecture style	5	REST
XML-based language	5	WSDL
API	4	JAX-WS
data interchange format	4	JSON
communication paradigm	4	RPC (Remote Procedure Call)
protocol	4	SOAP
process server	2	IBM WebSphere Process Server
application server	2	JBoss Application Server
enterprise service bus	2	Microsoft BizTalk Server
technology	2	SAP NetWeaver
tool	2	WebRatio
registry	2	UDDI
protocol	1	AMQP
enterprise service bus	1	Apache ServiceMix
SOA infrastructure	1	Apache Tuscany
platform product-family	1	BEA WebLogic
orchestration language	1	BPEL4People
notation	1	BPMN
web-based app tool	1	bxModeller
standard	1	CORBA
technology	1	DCOM
specification	1	DDS (Data distribution service)
toolkit	1	GWT (Google Web Toolkit)
EA tool	1	IBM Rational System Architect
tool	1	IBM RMC - RUP for SOA
methodology	1	IBM SOMA
API	1	JAX-RPC
middleware	1	MS App Platform MW for SOA
web app framework	1	MS ASP.NET MVC Framework
tool	1	Microsoft WCF RIA Services
technology	1	MS Workflow Foundation
tool	1	Microsoft WSE
middleware	1	Message-Oriented Middleware
enterprise service bus	1	Mule ESB
IDE	1	NetBeans SOA
enterprise service bus	1	Open ESB
BPEL engine	1	Oracle BPEL Process Manager
BPM application	1	ProcessMaker
REST framework	1	Restlet
API	1	RMI
framework	1	SOFA
SOA Runtime FW	1	Swordfish SOA Project
framework for EA	1	TOGAF
language	1	XPDL
integrated portfolio	1	Intalio Products

Table II
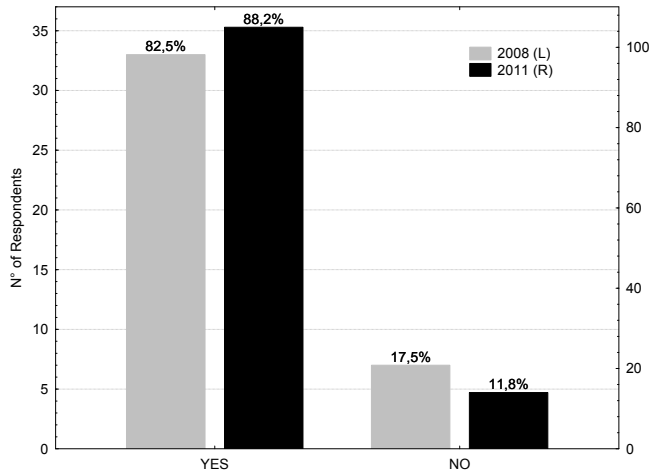METHODS, TECHNOLOGIES AND TOOLS USED IN THE ITALIAN INDUSTRY (Q3.1). FREQUENCIES ARE INDICATED IN COLUMN "N".

Figure 2. Q1.3: Do you know SOA (Service Oriented Architecture)?

2011; for the 2011 execution *YES = YES (with experience) + YES (no experience)*). SOA is better known and used in large companies than in smaller ones. This is more evident in the 2011 sample where SOA scores approximately 7 points more (92% *YES* vs. 85% *YES*) in large companies than in medium, small and micro companies.

The respondents interpret SOA applications (Q2.1) as "*Applications employing services as their basic computational entities ...*" [24] in 63% of the cases while the more concrete option (i.e., a set of communicating Web services) [5] and the more abstract one (i.e., an architectural paradigm for defining how people, organizations and systems provide and use services to achieve results) [2] are chosen, respectively, in 29% and 8% of the cases. It is interesting to note that micro companies and IT providers
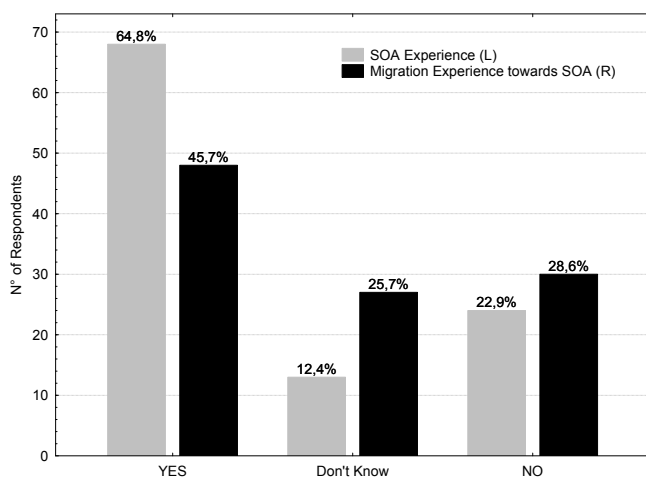

Figure 3. SOA (Q4.1) and Migration (Q4.2) Experience (2011 only)

have in proportion a more concrete vision of SOA (i.e., SOA = Web services) than the other categories.

Conversely, BPEL (Fig. 1) and in general the orchestration languages (Q2.2) are not so used in the industry (only 11% of the sample use them), even if a large proportion of our sample known its existence (51% in total). Orchestration languages are better known and used in large companies than in smaller ones.

Also for methods/technologies and SOA tools (Q2.3) the knowledge seems rising (68% in 2008 vs. 79% in 2011) even if there is a decrease of their personal usage (37% in 2008 vs. 33% in 2011). Partitioning the data about the size, it appears that in 2008 the knowledge of SOA methods/technologies/tools in large companies (54% *YES* and 46% *NO*) was smaller with respect to medium/small and micro companies (74% *YES* and 26% *NO*). This is no more true in the 2011 sample, where the knowledge of SOA methods/technologies/tools in large companies (85% *YES* and 15% *NO*) is greater with respect to medium/small and micro companies (73% *YES* and 27% *NO*). Table II lists the SOA methods/technologies/tools really used by our sample. The most frequent are: Web services (10), Enterprise Service Bus (7), Axis (7), WCF (5), REST (5) and WSDL (5).

Fig. 3 summarizes the answers to Q4.1 (SOA experience in the company of the respondent) and Q4.2 (migration experience towards SOA in the company of the respondent) for the 2011 sample. Also in this case, as for the personal knowledge (Q2.3), the percentage is increased in the 2011 sample (61% in 2008 vs. 65% in 2011). Concerning the experience to migrate legacy systems towards SOA (Q4.2), we cannot compare these results with the sample 2008 (the question was absent in the first execution, see Table I), but we can affirm that is quite high (46%). This result in not completely in line with what we obtained in [21] where only three projects out of 40 dealt with a migration towards SOA. Looking more in detail to the data, it appears that in the 2011 sample the companies in the area of software development are the more experienced both in SOA and in migration towards SOA. In addition, micro companies have few experience in migration towards SOA (65% of the respondents working in a micro company answered *NO* at Q4.2).

C. RQ2: Level of Adoption of SOA

Fig. 4 summarizes the SOA level of adoption in the IT field of our sample partitioned by company size. Overall, the adoption of SOA is medium/low given that 48% and 43% of the sample has indicated, respectively, as *Medium* and *Low* the SOA diffusion and only 9% has indicated it as *High*. Looking at Fig. 4, it appears that respondents working in micro and small companies are in proportion the more negative about SOA adoption, while the others (medium+large) are more positive.
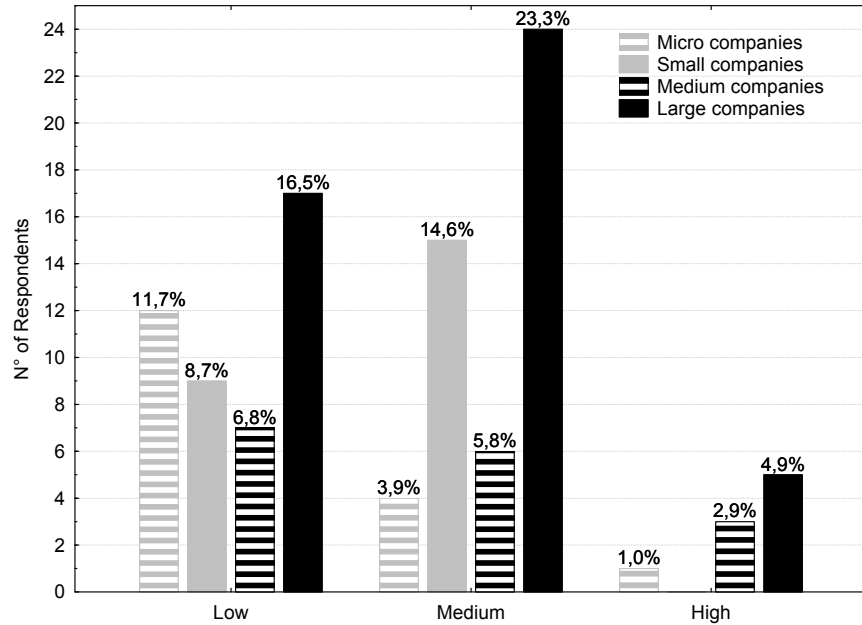
Figure 4. Q4.3: How do you assess the level of adoption of SOA in the IT field? (2011 only)
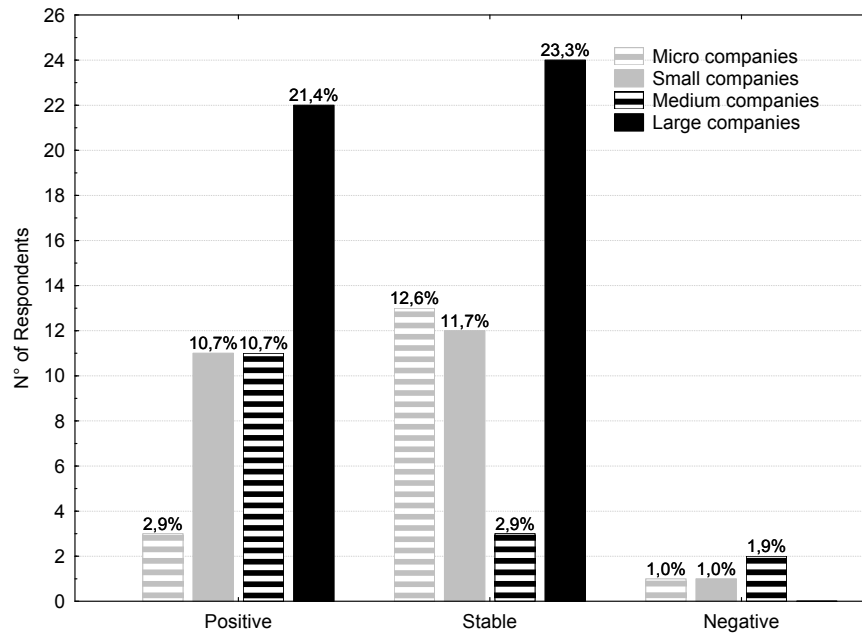

Figure 5. Q4.4: How do you assess the trend of pervasiveness of SOA in the IT field (over the last 2/3 years and for the next future)? (2011 only)

D. RQ3: Trend of Pervasiveness of SOA

Overall, our sample estimates as stable/positive the trend of pervasiveness of SOA; 51% of the complete sample opted for *Stable*, 45% for *Positive* and only 4% for *Negative*. Looking more in detail the data and partitioning for company size (see Fig. 5), we discover that respondents working in large companies always opted for *Positive* and *Stable* (precisely 21% *Positive* and 23% *Stable*). The more sceptical about a positive trend of SOA are the respondents working in micro companies (13% *Stable*, 3% *Positive* and 1% *Negative*).

IV. DISCUSSION

We found that SOA and its key technological components such as, e.g., Web services and RESTful web services are well-known in the Italian industry (RQ1). SOA is known by a relevant proportion of the respondents (respectively, 82% of the sample in 2008 and 88% in 2011) and among them a fairly good number has personal experience with it. In the Italian companies, IT professionals have expertise/experience on methods, technologies and tools for the realization of SOA systems (65% in 2011) and the same is true for migrating legacy systems towards SOA (46% in 2011). Instead, the low knowledge (only 51% of the sample know it) and low usage (only 11% of the sample use it) of orchestration languages (e.g., BPEL) deserve a deeper investigation to understand the motivation (future work).

Currently, the adoption of SOA (RQ2) is medium (low) with a trend (RQ3) that is more stable than positive (but surely not negative). This result, confirmed also by the comparison between the two survey rounds, is unexpected given that "the cloud" — a logical hosting environment for services — is growing exponentially (this is also true in Italy, see [18]). It seems that SOA goes forward slowly in the Italian industry, as whether one or more obstacles would limit its diffusion/usage. Also this aspect deserves more empirical studies and specific surveys.

With the data collected so far we can only speculate a possible reason of this finding: it could be found in the long list of standards, frameworks and tools used to implement SOA solutions and rarely shared in the IT community that we have summarized in Table II. They are really too many and so different from each other to trouble even the more experienced professional.

When we analysed the SOA knowledge, adoption and trend of companies as a function of their size, we discovered that large companies have more knowledge, expertise and experience about SOA than medium, small and micro ones. The same is true for migration towards SOA. This seems reasonable given that, very often: (i) large companies have more money for research purposes, training and tools (usually software licence are very expensive in the SOA context), (ii) SOA is used for large software systems in which large companies are often involved and (iii) migration projects are very complex and usually they need expensive budgets. The large companies are also the more positive about the SOA level of adoption and trend. This could be a direct consequence of the fact that large companies are more involved in large-sized projects where SOA is more useful and in migration projects towards SOA than the other companies.

The evidence-based answers we provided to the research questions hold a value in themselves as important knowledge assets in the software engineering field. In addition, if confirmed, they will bring important implications in the practice of both software development and education/training.

A. Threats to Validity

In our opinion the main threats to validity of this study are the following: (1) non-probabilistic sampling method, (2) possible self-exclusion from participants not interested in SOA and (3) a non-completely shared definition of SOA.

We opted for non-probabilistic sampling method, even if we know all the problems of this sampling, for two reasons. First, this survey is exploratory. Second, we thought that the target population was hard to identify (in particular respondents with expertise in migration towards SOA) and of limited availability (this is often true in software engineering surveys).

Our goal was to obtain responses from professionals involved in software development and management but not necessarily adopting SOA in their companies. Unfortunately, we cannot exclude that some participants could have lost interest in the survey when they realized it was related to SOA. We think that this threat could affect the percentage of respondents who declared interest in SOA and underpinning technologies. In particular, it is possible that the percentages of knowledge/usage of SOA (and beneath technologies) obtained from our sample is over-amplified with respect to the real values of the target population.

Another possible threat concerns the definition of SOA that could be interpreted in different ways. This threat could have biased the obtained findings. We tried to limit this threat inserting the question Q2.1 to understand which meaning the respondents assigned to the word SOA. Moreover, we computed all the percentages categorizing for the three possible answers to Q2.1 obtaining similar outcomes as for the complete dataset.

V. RELATED WORK

First, we have considered SOA surveys carried out by research and advisory firms and presented as technical reports. Generally, these works are focused on understanding what is the SOA level of adoption in the industry and what will be its trend in the near future. Second, we have searched for empirical studies about SOA surfing the scientific literature. We found two recent technical reports and we will present them from the most to the less recent.

The Wolfgang Martin Team publishes from several years a report[7] on the adoption of SOA in Germany, Austria and Switzerland. In the 2010 version [15] emerges that the usage of SOA is increased in the last years. Indeed, the portions of the sample that have deployed SOA, that have planned to use

---

[7] http://www.soa-check.eu

SOA and that not use SOA are respectively: 63%-31%-6% in 2010, 47%-37%-16% in 2009, 36%-48%-16% in 2008 and 31%-42%-27% in 2007. The report clearly highlights that SOA, in the German market, is now well known and in progress of adoption. Hence, SOA seems more widespread in Germany than in Italy.

In 2008, Gartner [19] analysed in detail the SOA adoption worldwide; the initial sample is constituted of more than 200 large companies from Europe, North America and Asia. It reported[8] that: *"According to the survey, 53 percent of the respondents were already using SOA in some part of their organizations. Another 25 percent were not using it but had plans to do so in the next 12 months; and 16 percent had no plans to use SOA at all."*

Now, we will present two empirical studies about SOA that we have considered closer to our.

Differently from us Razavian et al. [16] have carried out a survey focused on the migration towards SOA. The work points out the differences between SOA migration approaches defined in academia and those used in industry. The authors conducted an industrial survey (by means of interviews) in seven leading SOA solution provider companies and they found that all the companies focused on the same SOA migration approach. Usually, scientific approaches take a reverse engineering perspective while industrial practitioners prefer forward engineering strategies (e.g., where legacy code is not transformed but used as a reference). This work highlights the importance of the techniques for migrating legacy systems towards SOA.

In their empirical exploratory study, Kokko et al. [8] investigated, by mean of interviews, the SOA adoption in nine Finnish organizations. The major obstacles to the SOA diffusion as testified by the interviewed organizations were: internal resistance to learning new things, absence of business process models and the immaturity of the SOA tools compared to traditional approaches (we can speculate that this last aspect is also present in Italy). Differently from us, the authors focus on the SOA adoption process, especially describing and analysing how the adoption began, what the experiences were, and how the adoption process evolved.

VI. Conclusions and Future Work

In this paper we presented some results from a survey performed to investigate knowledge, adoption and trend of SOA in the Italian industry.

The main findings of this survey can be thus summarized. SOA is a relevant phenomenon in the Italian industry. It is well-known and used. The same is true for its key components such as Web services and RESTFul services. On the contrary, orchestration languages, UDDI and SOA

analysis and development methods seem less known and used.

These results suggest that in Italy SOA is interpreted in a more simplistic way with respect to the definitions reported in scientific books (i.e., without the concepts of orchestration/choreography and registry). Currently, the adoption of SOA is medium (low) with a perceived trend, over the last 2/3 years and for the next future, that is more stable than positive. The evident widespread knowledge of SOA emerging from our survey, but also the results about adoption/trend and its immature usage, deserves attention from industries and universities.

As future work we would like to compare the state of knowledge and adoption of SOA in Italian companies to the situation in other countries replicating this study in other nations. Moreover, we planned next year to execute a third round of this survey inserting in the questionnaire more specific and "deep" questions (e.g., to reveal the reasons of the reduced usage of UDDI and BPEL).

References

[1] Web Services Business Process Execution Language, v. 2.0. Standard, OASIS, 2007.

[2] Service Oriented Architecture Modeling Language (SoaML). Technical report, Object Management Group, OMG, 2009.

[3] N. Buck and J. Ermisch. Assessment of Longitudinal Survey Designs. Report prepared for New Zealand Treasury, 1995.

[4] T. Erl. *SOA Principles of Service Design*. Prentice Hall, 2007.

[5] H. Haas and A. Brown. Web Services Glossary. Technical report, W3C Working Group Note, World Wide Web Consortium(W3C), 2004.

[6] A. Jedlitschka, M. Ciolkowski, C. Denger, B. Freimut, and A. Schlichting. Relevant Information Sources for Successful Technology Transfer: A Survey Using Inspections as an Example. In *Proceedings of 1st International Symposium on Empirical Software Engineering and Measurement (ESEM 2007)*, pages 31–40. IEEE Computer Society, 2007.

[7] B. A. Kitchenham and S. L. Pfleeger. Personal opinion surveys. In F. Shull, J. Singer, and D. I. K. Sjoberg, editors, *Guide to Advanced Empirical Software Engineering*, pages 63–92. Springer London, 2008.

[8] T. Kokko, J. Antikainen, and T. Systä. Adopting SOA - Experiences from Nine Finnish Organizations. In *Proceedings of 13th European Conference on Software Maintenance and Reengineering (CSMR 2009)*, pages 129–138. IEEE, 2009.

[9] M. Leotta, G. Reggio, F. Ricca, and E. Astesiano. Towards a Lightweight Model Driven Method for Developing SOA Systems Using Existing Assets. In *Proceedings of 14th International Symposium on Web Systems Evolution (WSE 2012 co-located with ICSM 2012)*, page (to appear). IEEE.

---

[8] http://www.gartner.com/it/page.jsp?id=790717

[10] M. Leotta, G. Reggio, F. Ricca, and E. Astesiano. Building VECM-based Systems with a Model Driven Approach: an Experience Report. In *Proceedings of 1st International Workshop on Experiences and Empirical Studies in Software Modeling (EESSMod 2011 co-located with MODELS 2011)*, volume 785, pages 38–47. CEUR Workshop Proceedings, 2011.

[11] M. Leotta, F. Ricca, G. Reggio, and E. Astesiano. Comparing the Maintainability of two Alternative Architectures of a Postal System: SOA vs. non-SOA. In *Proceedings of 15th European Conference on Software Maintenance and Reengineering (CSMR 2011)*, pages 317–320. IEEE, 2011.

[12] M. Leotta, F. Ricca, M. Ribaudo, G. Reggio, E. Astesiano, and T. Vernazza. SOA Adoption in the Italian Industry. In *Proceedings of 34th International Conference on Software Engineering (ICSE 2012)*, pages 1441–1442. IEEE, 2012.

[13] T. C. Lethbridge. A Survey of the Relevance of Computer Science and Software Engineering Education. In *Proceedings of the 11th Conference on Software Engineering Education and Training (CSEET 1998)*, pages 56–66, Washington, DC, USA, 1998. IEEE.

[14] A. Marchetto and F. Ricca. From objects to services: toward a stepwise migration approach for Java applications. *International Journal on Software Tools for Technology Transfer (STTT)*, 11:427–440, 2009.

[15] W. Martin. SOA Check 2010. Technical report, Wolfgang Martin Team.

[16] M. Razavian and P. Lago. A Survey of SOA Migration in Industry. In G. Kappel, Z. Maamar, and H. Motahari-Nezhad, editors, *Service-Oriented Computing*, volume 7084 of *Lecture Notes in Computer Science*, pages 618–626. Springer Berlin / Heidelberg, 2011.

[17] L. Richardson and S. Ruby. *RESTful web services*. O'Reilly Series. O'Reilly, 2007.

[18] N. Sfondrini and G. Motta. Cloud Computing: a survey. In *AICA 2011 National Congress*, 2011.

[19] D. Sholle. SOA User Survey: Adoption Trends and Characteristics. Technical report, Gartner, 2008.

[20] J. Singer, M. Storey, and D. Damian. Selecting Empirical Methods for Software Engineering Research. In F. Shull and Singer, editors, *Guide to Advanced Empirical Software Engineering*, pages 285–311. Springer, 2008.

[21] M. Torchiano, M. Di Penta, F. Ricca, A. De Lucia, and F. Lanubile. Migration of information systems in the Italian industry: A state of the practice survey. *Inf. Softw. Technol.*, 53:71–86, January 2011.

[22] M. Torchiano, F. Tomassetti, A. Tiso, F. Ricca, and G. Reggio. Maturity of Software Modelling and Model Driven Engineering: a Survey in the Italian Industry. In *Proceedings of the 16th International Conference on Evaluation & Assessment in Software Engineering (EASE 2012)*, page (to appear), 2012.

[23] D. S. Walonick. *Survival Statistics*. StatPac, Inc., 1997.

[24] M. Wirsing, L. Bocchi, J. L. Fiadeiro, S. Gilmore, M. Hoelzl, N. Koch, P. Mayer, R. Pugliese, and A. Schroeder. *Sensoria: Engineering for Service-Oriented Overlay Computers*. MIT Press, 2008.